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studio di una struttura a traliccio

- Durante le lezioni abbiamo studiato diversi argomenti, tra cui le forze, i loro momenti e la loro scomposizione
- l'esecuzione di una tavola di disegno tecnico
- l'utilizzo dei fogli di calcolo
- la costruzione di grafici
- Applichiamo quanto abbiamo visto allo studio di una struttura a traliccio.

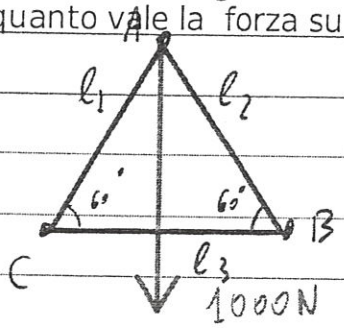
- vi presento alcuni tipi di struttura:
https://www.marcodepisapia.com/travature-reticolari-in-acciaio/

- Per valutare le prestazioni del traliccio dovremo:
  - progettare la struttura
  - scrivere una formula per determinare il numero di pezzi necessario in funzione della distanza che vogliamo coprire
  - costruire il ponte
  - misurare lo stress del ponte
  - misurare la deformazione del ponte
  - eseguire sia su carta che su pc un grafico stress/deformazione

- confrontare i risultati ottenuti dai vari gruppi (4 gruppi) e dai vari tipi di tralicci realizzati
- eseguire la relazione tecnica (relazione di laboratorio)

- rispondere alle seguenti domande:

1) quali sono le forze che agiscono sulla nostra struttura
2) qual'è il principio di funzionamento di una struttura a traliccio
3) nel nostro traliccio quali parti sono compresse e quali sono tese
4) perchè ci aspettiamo che la deformazione maggiore sia nel centro
5) considera la seguente struttura:
   a) quali lati sono in compressione e quali in tensione
   b) quanta forza agisce sui tre vertici e
   c) quanto vale la forza su ciascun lato (puoi usare il metodo che preferisci)



6) prova a immaginare, progettare e spiegare un modo per misurare direttamente la tensione o la compressione di un elemento della struttura che hai costruito

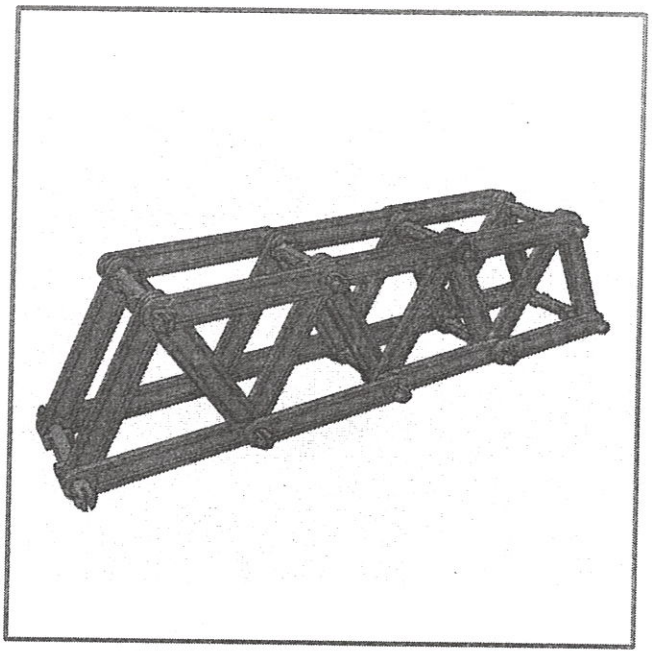
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LearningBlade® - MAKER QUESTS

Bridge Design – Transportation

QUEST OBJECTIVES

To explore structural design using 3D printed construction elements



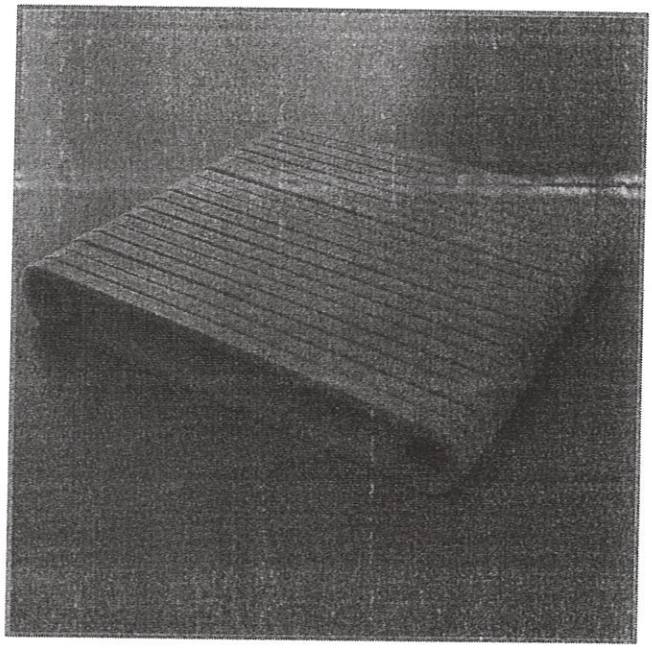
QUEST SITUATION

Have you ever considered how massive construction projects are possible? Modern buildings roadways, bridges, and other structures can be enormous, yet most are usually constructed from much simpler and smaller components.

This Maker Quest gives students practice designing a bridge structure using simple 3D printed spans and connecting pins. The model files in this lesson provide a basic starting point for simple bridge construction. However, the main purpose of the exercise is to encourage students to go beyond a simple, triangular truss bridge design, and create their own unique solutions.

MATERIALS

A 3D printer with PLA, or another printer-compatible filament
The 3D model files for this Maker Quest
3d modeling application
3D slicing software
Weights (at least 5 lbs)
Desks or stacks of books (a gap for the bridge to cross)
A yard or meter stick
A ruler or tape measure



QUEST PROCEDURE

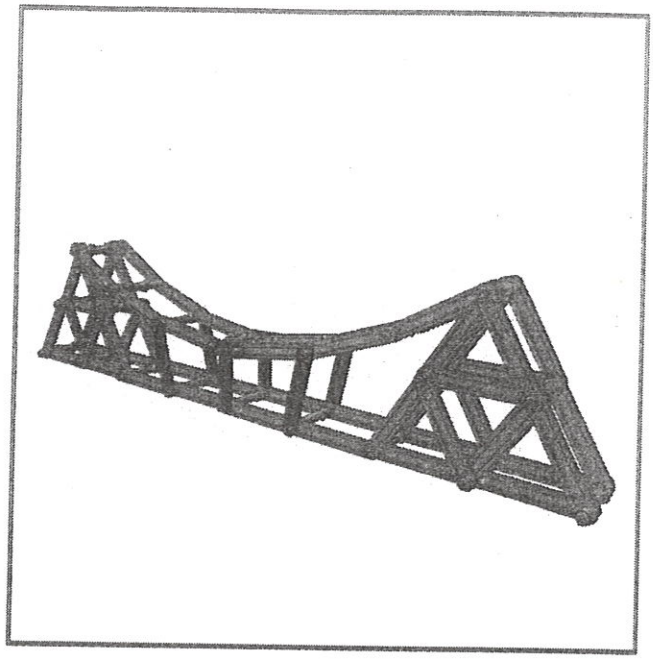
Read to students, or have them read, the Quest Situation section before beginning. Review the Materials list and make sure students have access to the required materials.

Download the Bridge Design Files

Digital files for this Maker Quest have been prepared, and may be downloaded at: http://www.thingiverse.com/thing:2451811. Students should identify and download those files to their computer.

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This basic design could also be modified into a suspension bridge design with two towers made of the existing spans, connected by a series of shortened or lengthened spans and pins to form suspension cables.



Discussion Questions

Teachers can facilitate class discussion about the Bridge Design project by asking the following questions:

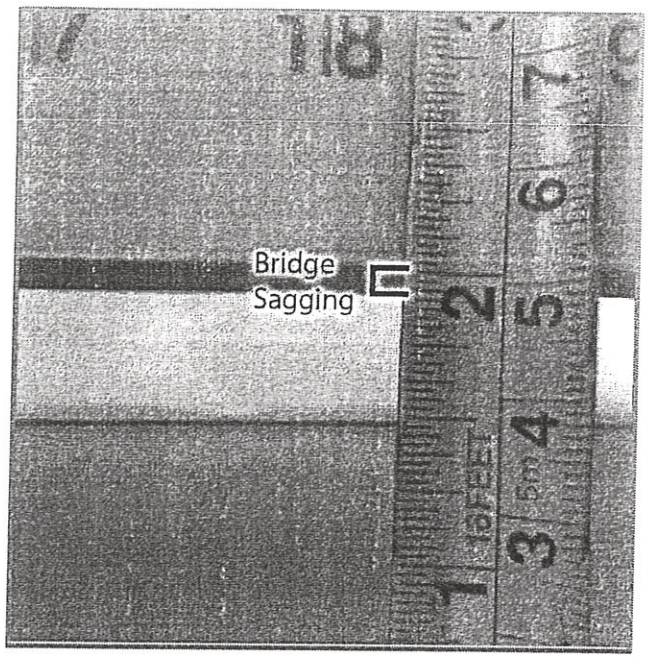
The project used two methods of measuring a bridge's strength: rigidity and load capacity. What conditions would require different bridges to have different load capacities? What conditions would require bridges to have different levels or rigidity?

The basic bridge design in this project used a truss bridge with triangular bracings. What are the advantages of using triangles to brace a structure? In addition to bridges, what other types of structures benefit from triangular bracing?

Suspension bridges are another common bridge design, but unlike simpler truss or span-type bridges, suspension bridges use a series of towers and cables to distribute and bear a bridge's load. In what conditions would a suspension bridge be preferable to a truss or span-type bridge?

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Next, add a weight to the center of the bridge. The weight can either be placed atop the bridge, or possibly hung beneath the bridge if you have string, tape, or hooks to securely attach it to the bridge.



Once the weight is attached, place the yard stick on its edge and across the gap beside the bridge exactly as you did in the measurement with no weight. Find the middle point of the bridge, and use the ruler or tape measure to measure the distance from the bottom of the yard stick to the bottom of the bridge. Record this distance on the bridge testing worksheet.

If you have multiple weights, you can continue adding weights and measuring the amount of sagging they produce. There is space on your worksheet to record and graph multiple measurements.

Testing Bridge Strength – Load Capacity

Some classes may wish to also test the bridges to the point of failure. If so, additional weights can be added to test whether the bridge can support specific loads. This kind of testing will require many additional weights, and a testing gap that ensure enough room for the load to be supported beneath the bridge (if necessary). Students should also observe basic safety precautions when stressing bridges to their failure points.

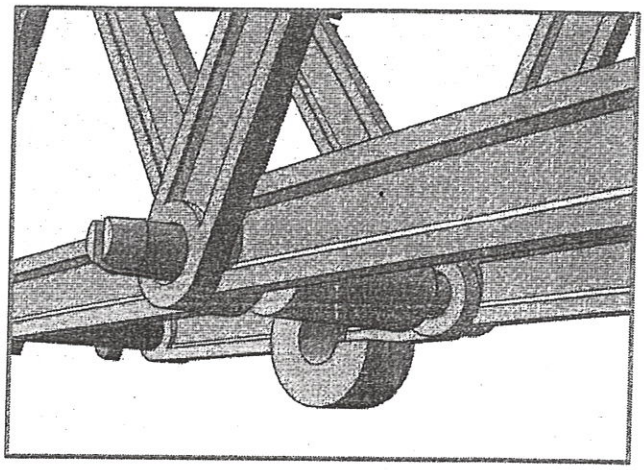
Calculating the Economy of Materials

Engineers have many ways to calculate the economy of materials and how cost-efficient projects will be. In this experiment, we'll use a simple ratio, based on the weight of the bridge, to determine materials economy.

To calculate the economy of material, take the bridge's Strain amount under the greatest weight tested, and divide it by the weight of the bridge (do not include the load's weight). This result tells the amount of material (by weight) required for the bridge to bear the strain of a particular load.

Additional Ideas

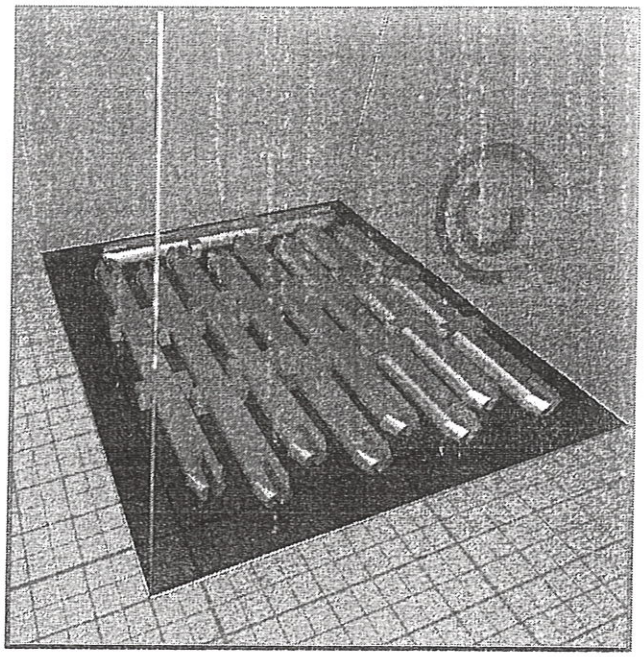
Students could design and 3D print additional structural elements for their bridge design. These elements could be functional, decorative, or a mix of both. For example, in its basic design, the bridge has no actual road or railway between the spans. Students could model and print a series of roadway sections that attach to the bridge's pins.



Students could also design a way to more easily attach a hanging weight below the bridge. The standard 3D pin and span files could be modified with such an attachment.

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Printing and Assembling the Bridge Components



Once the files are ready to print, students should import them into the 3D slicing software. The individual components of the bridge are designed to print within a 110 mm x 100 mm x 100 mm print volume. The components could be scaled, but the any changes in scale could affect the fit of the components.

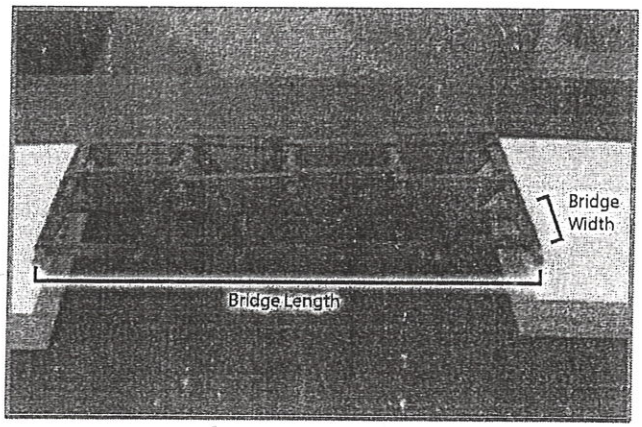
Once the slicing software has prepared the printing instructions, all of the bridge components should be printed and carefully removed from the printing surface. Make sure to print enough bridge spans and pins to build the desired bridge design.

The bridge pins are designed to join up to six spans, with the ends of the pins fitting through the holes in the spans.

Students should attach spans to each side of the pins so the bridge has 2 sides, and a passage for a roadway between them.

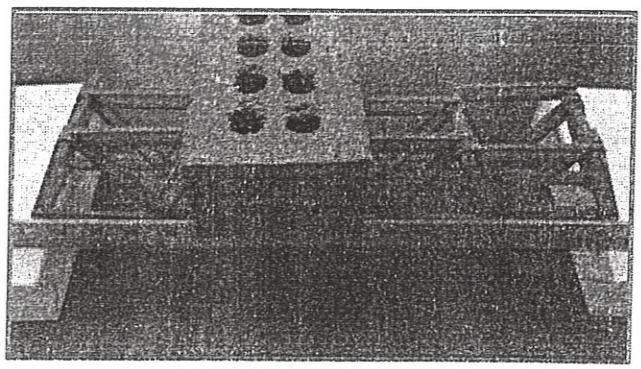
After construction, bridges can be tested for rigidity, load bearing strength, and the economy of materials used.

Testing Bridge Rigidity – Strain Under Stress



Begin this test by weighing the bridge itself and recording it on the included worksheet. Next, set up a gap for the bridge to cross. Place two desks, tables, or stacks of book a specific distance apart. A gap of at least 12 inches is recommended. Once the gap is setup, place the bridge across the gap with no additional weight on it.

Each bridge will flex and deform once a load is placed on it. This deformation is expressed as the amount of **Strain** under **Stress**. Stress is typically expressed in pounds per square inch (psi) or kg/mm^2. To calculate a bridge's stress, first calculate the bridge load area. Measure the length of the bridge from the two support points that touch the base just outside the gap. Also measure the average width of the bridge. Record those measurements on the included worksheet and use them to calculate the bridge load area.



Next, turn the yard stick on its edge and place it across the gap next to the bridge. Find the middle point of the bridge, and use the ruler or tape measure to measure the distance from the bottom of the yard stick to the bottom of the bridge. Record this distance on the bridge testing worksheet.

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