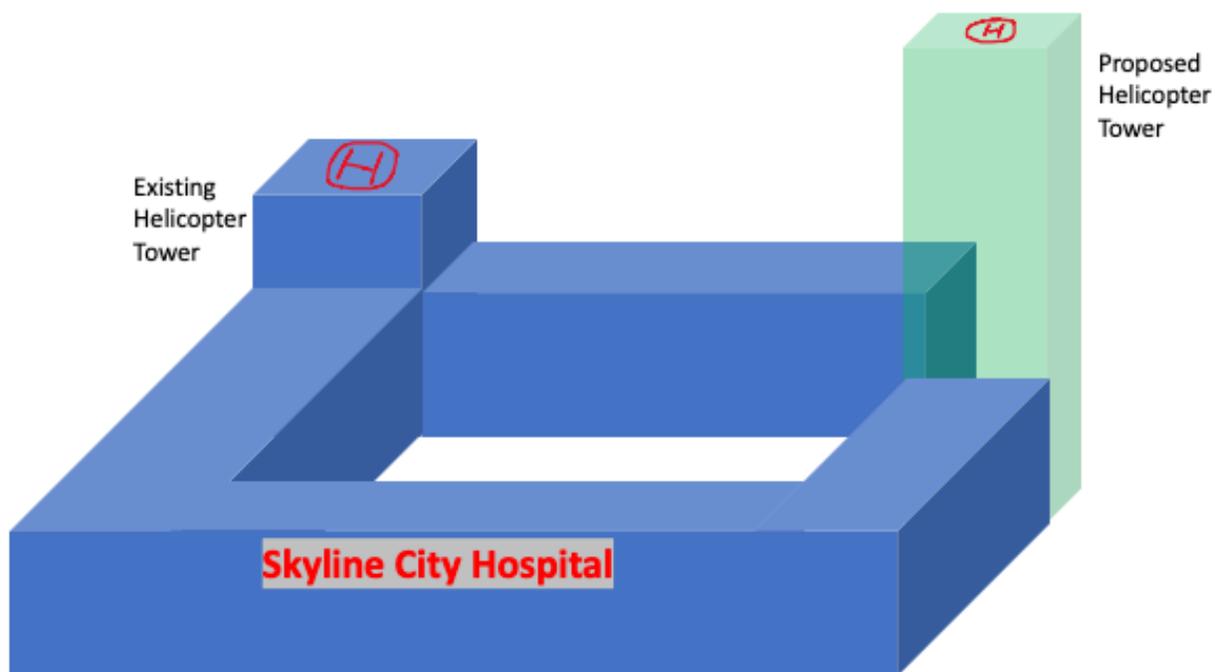




## Building a Tower from Recycled Materials

### Tower-Building:

Paper, cardboard, and many other materials found around the house may seem flimsy, but you can use them to make a tower that is quite sturdy! In this activity, you'll be able to build a tower that can hold a book, or two, or maybe even more! The setting of the challenge is Skyline City, a city that is searching for a company that is able to design and build a new helicopter landing tower for the local hospital. You will run your own construction and design company that is competing for the contract to build Skyline City's new helicopter landing tower.



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*This activity is courtesy of ICE, the Institute for Chemical Education at UW-Madison's Chemistry Department. It is adapted from an Engineering Challenge Activity at a hands-on Fun with Chemistry Camp summer program.*

## **Your project:**

Skyline City has decided to expand its hospital to serve more people. The city plans to convert the existing helicopter tower into additional space for patients so the hospital needs a new tower. The hospital has budgeted \$1,000,000 for the tower. The landing zone in the new tower must support the combined weight of four helicopters because the hospital plans to store all of its helicopters there. The new tower must be taller than the old tower to reduce sound levels in the hospital when the helicopters are taking off and landing.

Your design and construction company has decided to enter the competition to design and build the helicopter tower for Skyline City and its people. The tower that meets the specifications below and that holds the most weight (in books) will win!

## **Specifications:**

- The helicopter platform must be the top of the tower.
- The helicopter platform must be level.
- The tower must be free-standing. It cannot be attached to any horizontal or vertical surface.
- The helicopter platform must be rectangular, with a minimum width of 6 inches and minimum length of 6 inches.
- The tower must be at least 18 inches tall.
- The tower must be able to support the weight of the helicopters that will land and be stored on it. Use books to represent helicopters. The strongest tower wins!
- The maximum that can be spent on materials is \$1,000,000. Use ten bottle caps, can tabs, marbles, pebbles, pencil eraser caps, or something else found around the house to represent \$100,000 each. (Choose something that can be reused or recycled)

## **Suggested Materials List:**

*The tower can be made primarily with materials found around the house that would be recycled.*

- 12 inches of tape (\$100,000)
- 4 sheets of standard-sized paper (8.5 x 11.0 in), sold only in a set of 4 (\$100,000)
- 10 popsicle sticks (\$100,000)
- 1 stick of hot glue\*\* (\$100,000)
- 10 old pencils (\$100,000)
- 1 cardboard box (\$100,000)

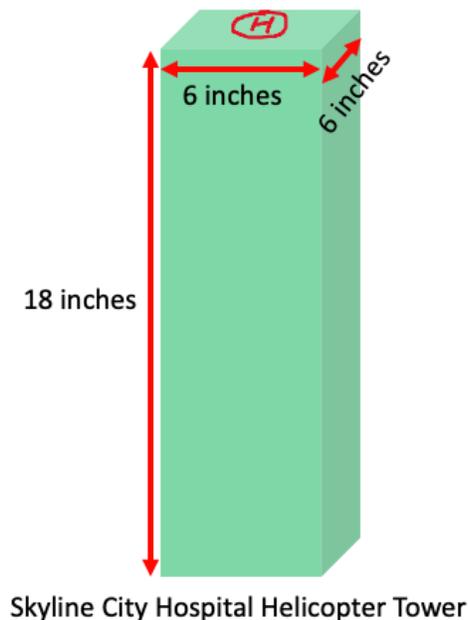
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- Anything else that is safe to use and that is going to be recycled! (Cost can be determined by those running the challenge.)
- Scissors\*\*, a ruler, markers for drawing the landing zone, paper for drafting plans, pencils (\$100,000 to “rent” for the entirety of the tower building challenge)

**\*\*Note:** *It is strongly recommended that young children be supervised when handling scissors and that parents/guardians handle the hot glue to prevent injuries.*

### Diagram of the Setup with Minimum Dimensions



### Tower-Building Competition:

- Each tower should be tested one at a time.
- Place the books on the tower one by one, in the same order for each tower to maintain consistency.
- If the tower tips over, the number of books that the tower was able to support is one fewer than the number of books placed on the tower during the trial.
- If the tower collapses, the number of books that the tower was able to support is one fewer than the number of books placed on the tower during the trial.

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## Learning Objectives:

- Introduction to design—writing a plan and drawing a sketch before beginning to build the tower makes this activity a fabulous introduction to design, especially if the plan explains various features of the design of the tower.
- Introduction to budgeting—budgeting is an important life skill. Making a budget and sticking to it has applications in both industrial settings and in daily life. In this exercise, paying for the use of scissors, measuring tools, and drawing utensils substitutes for the cost of running the machines used to construct buildings. Bottle caps, marbles, etc. substitute for construction expenses.
- Introduction to the strength of materials—The strength of materials is also called the mechanics of materials. Each material used in the construction of the tower has a different strength. Some materials are better suited for building a tower than others. String is a poor construction material for the vertical building supports but it could be woven into an excellent horizontal support for the platform. Likewise, paper makes a poor platform, but cardboard is excellent. After the tower has been constructed and tested, explaining the use of materials for the tower and which are optimally suited for certain locations is an excellent way to begin to explore the mechanics of the materials used in this activity.

## Troubleshooting:

- *If the platform does not hold as many books as you would like it to...*

Explore different ways to construct supports for the tower and different ways of reinforcing the tower supports. Some materials work better for different functions and some ways of reinforcing tower supports are better than others. Which materials are best suited for what use? What are good ways to prevent the supports from failing?

- *If the supports keep collapsing...*

How are the supports reinforced? Was the tower built with four supports and only a connection at the top? Are the supports connected to each other at the base and at the top? Consider adding additional reinforcement to connect the supports midway up the tower.

- *If the tower keeps tipping over or is otherwise unstable...*

How many supports does the tower have? Three points make a plane, so three supports will be the easiest to keep the tower level. It is still possible to have more than three supports for the tower, but if keeping the tower level is the major issue, then trying

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three supports first and then making modifications can help. Additionally, ensure the tower is resting on a level surface.

## **Modifications**

- *If only one person is participating in the engineering activity...*

Guess how many books the tower will support and see if your tower meets or exceeds your expectations! If the tower does not, consider how you would re-design the tower or modify the tower to hold more books and test your theory!

- *If the budget is too low and/or the prices of the materials are too high...*

The budget in this activity and the cost of the materials for the activity listed above are suggestions. It is possible to complete the engineering challenge with a modification to the budget or modifications to the cost of materials. It is encouraged that the participants discuss and come to an agreement about the budget and the cost of the materials prior to beginning the competition.

- *If the dimensions of the tower are too large or too small...*

The dimensions of the tower in this activity are suggestions. It is encouraged that the participants discuss and come to an agreement about the dimensions of the tower prior to beginning the competition.