Term 1

Term 2

Term 3

Activity 3 **The Tallest Tower Challenge** **1 session**

Design and build the tallest possible tower that will support the cup and 10 marbles without collapsing.

Club Leader Notes

Introducing the activity: Some discussion into how to make strong structures from sheets of paper, by rolling into tubes or making corrugated sections will help focus the club members' minds on building strong structures. Also look at photos of existing structures and see what methods have been used - the Fact Sheet contains some photos, or do a Google image search. Remind the club members that the tower must not only be tall, but stable and strong - it will have to support a plastic cup filled with 10 marbles.

Wrapping things up: Add the 10 marbles SLOWLY to the finished structures. The winner is the tallest successful tower (measured from the base to the bottom of the cup holding the marbles). Ask the club members to consider what attributes the successful and winning towers had compared to any failures.

Resources table (for 5 groups)

CONSUMABLES: Item & *preparation*	**Qty**	**Possible Source**
A4 paper	50 sheets	School stationery cupboard
Plastic cups	5	Supermarket
Sticky tape – *cut strips for teams*	1 roll	School stationery cupboard
EQUIPMENT: Items *and use*	**Qty**	**Possible Source**
Marbles	50	D&T resource catalogue
Rulers	5	Club member pencil case
Pencils	5	Club member pencil case
Scissors	5	Club member pencil case

Activity Extensions/Variations

To add an element of environmental consideration and to prevent overuse of sticky tape:

Either: limit the amount of sticky tape available to each team by giving them a few 10 cm strips to work from (they can carefully attach these to the edge of a table and then cut what they require from the end)

Or: weigh the completed towers to give an indication of how conservative the teams were with their resources.

Curriculum Links

Design & Technology (Key Stage 3) 1 Developing, planning and communicating ideas 2 Working with tools, equipment, materials and components to produce quality products 3 Evaluating processes and products	4 Knowledge and understanding of materials and components 6 Knowledge and understanding of structures *Breadth of Study*
Mathematics (Key Stage 3) *Shape, space and measures* 4 Measures and construction	**English (Key Stage 3)** 3 Group discussion and interaction

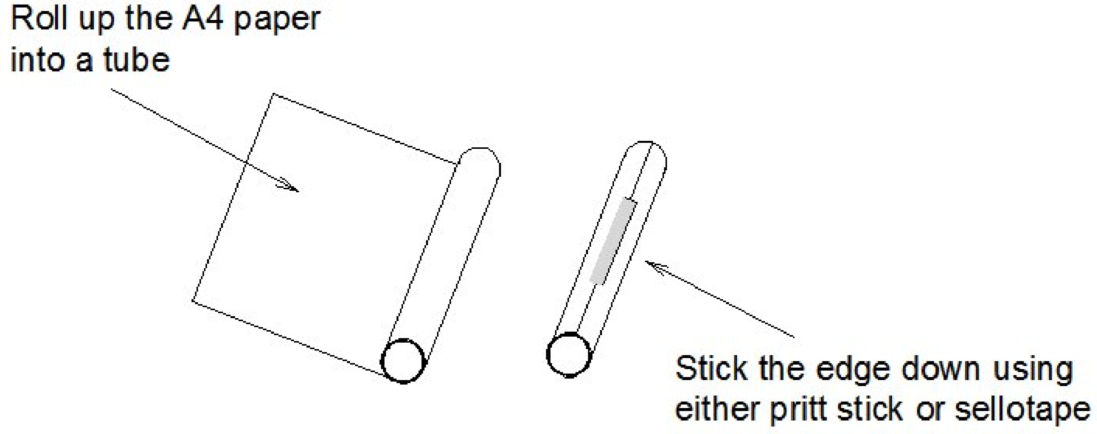
Activity 3 The Tallest Tower Challenge 1 session

Scenario

You are an architect working for one of the world leaders in skyscraper design. Your company has just won a multi-million pound contract to design and build a new skyscraper to rival the world's tallest - the Petronas Towers in Malaysia. Design and construct the tower using the materials and resources provided by your company.

Instructions

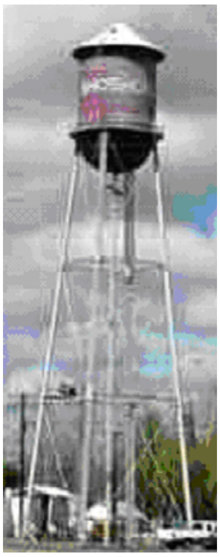
Decide how to make strong shapes with your 10 sheets of paper. Make the strong shapes. This is one of the best methods:



As you build your tower, check at regular intervals that it can support the cup plus marbles (add the marbles one at a time). Construct your tower with the cup on the top.

FACT SHEET

The Tallest Tower Challenge




Skyscrapers

Throughout the history of architecture, there has been a continual quest for height. Thousands of workers toiled on the pyramids of ancient Egypt, the cathedrals of Europe and countless other towers, all striving to create something awe-inspiring. People build skyscrapers nowadays primarily because they are convenient -- you can create a lot of real-estate out of a relatively small ground area. But ego and grandeur do also sometimes play a role in the scope of the construction, just as it did in earlier civilizations.

Up until relatively recently, we could only go so high. After a certain point, it just wasn't feasible to keep building up. In the late 1800s, new technology redefined these limits. Suddenly, it was possible to live and work in colossal towers, hundreds of feet above the ground.

Fighting Gravity

The main obstacle in building upward is the downward pull of **gravity**. Imagine carrying a friend on your shoulders. If the person is fairly light, you can support them pretty well by yourself. But if you were to put another person on your friend's shoulders (build your tower higher), the weight would probably be too much for you to carry alone. To make a tower that is "multiple-people-high," you need more people on the bottom to support the weight of everybody above. This is how "cheerleader pyramids" work, and it's also how the real pyramids and other stone buildings work: there has to be more material at the bottom to support the combined weight of all the material above. Every time you add a new vertical layer, the total force on every point below that layer increases. If you kept increasing the base of a pyramid, you could build it up indefinitely, but this becomes infeasible very quickly, since the bottom base takes up too much available land.

In normal buildings made of **bricks and mortar**, you have to keep thickening the lower walls as you build new upper floors. In the late 1800s, a number of advances led to engineers being able to break the upper limit of the time, which was about 10 stories.

FACT SHEET **The Tallest Tower Challenge**

The social circumstances that led to skyscrapers being built were the growing metropolitan American centres - most notably Chicago. Businesses all wanted their offices near the centre of town, but there wasn't enough space. In these cities, architects needed a way to expand the metropolis upward, rather than outward. The main technological advancement that made skyscrapers possible was the development of mass **iron and steel** production. New manufacturing processes made it possible to produce long beams of solid iron. Essentially, this gave architects a whole new set of building blocks to work with: narrow, relatively lightweight metal beams could support much more weight than the solid brick walls in older buildings, while taking up a fraction of the space.

Wind Resistance

In addition to the vertical force of gravity, skyscrapers also have to deal with the **horizontal force of wind**. Most skyscrapers can easily move several feet in either direction, like a swaying tree, without damaging their structural integrity. The main problem with this horizontal movement is how it affects the people inside. If the building moves a substantial horizontal distance, the occupants fell ‘sea-sick’. The most basic method for controlling horizontal sway is to simply tighten up the structure. At the point where the horizontal girders attach to the vertical column, the construction crew bolts and welds them on the top and bottom, as well as the side. This makes the entire steel super structure move more as one unit.

Onward and Upward

The "world's tallest tower" title passes regularly from skyscraper to skyscraper. This is one of the most competitive contests in construction, which appeals to both architects and engineers, and corporations and cities, who are all drawn by the glory of towering over the competition. The current champ is the Petronas Towers in Malaysia.



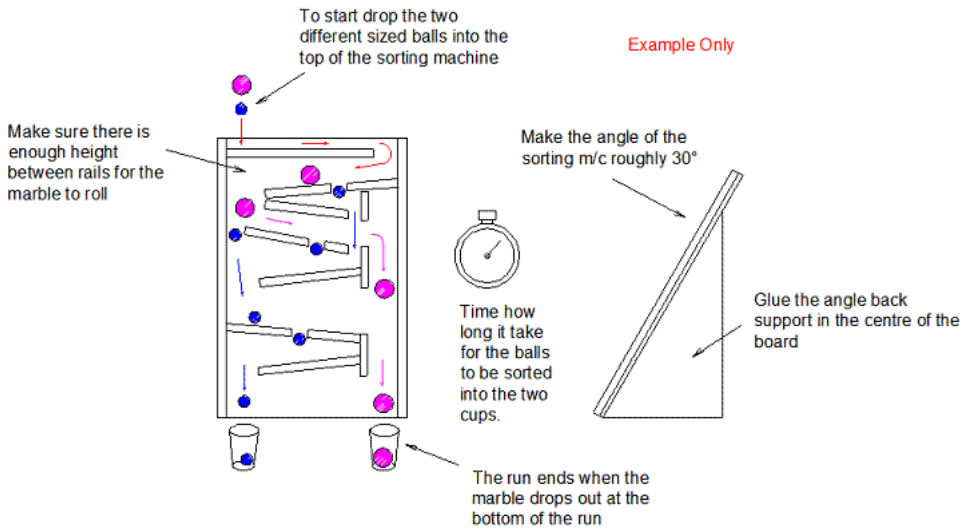
The images and information contained in this fact sheet were obtained from the internet using ***Google Image Search****,* ***howstuffworks.com*** *and* ***wikipedia.org*** *and are a small taster of the huge amount of information that can be found relating to this topic from internet research. Information gained from the internet is not guaranteed to be accurate and needs verification from several sources – these fact sheets were compiled and verified by qualified engineers to ensure the accuracy of the facts within them.*

Activity 7 The Sorting Machine Challenge 2 sessions

Design and make a self standing sorting machine that will hold 20 marbles, 10 of each size. When released the marbles will be separated into their sizes and collected in two cups.

Club Leader Notes

Introducing the activity: Advise the club members to think very carefully before starting – if they launch straight into the build, one of the elements of the design brief will probably cause them problems if they don't consider solutions for each one in advance. This example should only be shown to groups who get really stuck for ideas.



Wrapping things up: The machine which separates best over 3 runs is the winner. If there is a draw the winner is the machine that can separate fastest.

Resources table (for 5 groups)

CONSUMABLES: Item & *preparation*	**Qty**	**Possible Source**
Plastic cups	20	Supermarket
Thin Card - *pieces approx A4 size.*	15	School stationery cupboard
Thick grey card - *pieces approx A3 size.*	5	D&T resource catalogue
Wood strip 8 x 8 x 590	15	D&T resource catalogue
A4 paper	25	School stationery cupboard
EQUIPMENT: Items *and use*	**Qty**	**Possible Source**
2 sizes of marbles/wooden balls – *suggested size 20mm and 15mm*	50 of each	D&T resource catalogue
Junior hacksaws	5	D&T department
Scissors	5	D&T department
Glue gun	5	D&T department

These resources will allow 5 teams to make a sorting machine. To add to the challenge and allow more creativity, you could expand this list and supply additional scrap materials so the club members have more choice.

Curriculum Links

Design & Technology (Key Stage 3) 1 Developing, planning and communicating ideas 2 Working with tools, equipment, materials and components to produce quality products 3 Evaluating processes and products 4 Knowledge and understanding of materials and components 5 Knowledge and understanding of systems and control *Breadth of Study*	**Mathematics (Key Stage 3)** *Shape, space and measures* 1 Using and applying shape, space and measures 4 Measures and construction **English (Key Stage 3)** 3 Group discussion and interaction **Geography (Key Stage 3)** 4 Knowledge and understanding of patterns and processes

Activity 7 The Sorting Machine Challenge 2 sessions

Scenario

You work for a chocolate company that manufactures and packages chocolate truffles. The truffles are produced by an automated system on a conveyer belt in their hundreds. Before the chocolate truffles go into their packaging they have to be sorted to remove all the small / undersized defects from the good quality truffles. To do this you have been tasked with designing a chocolate sorting machine to sort the two different sized (good and bad) truffles.

Instructions

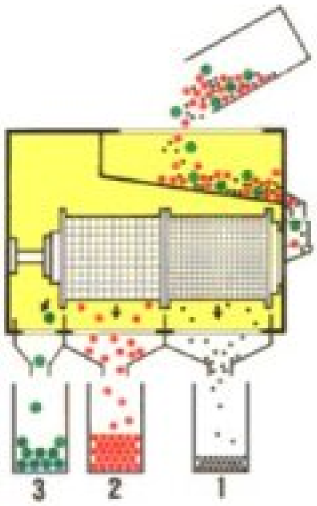
1. Consider designs for your machine. It must be:
    a. Be self standing
    b. Be able to hold at least 20 marbles of two different sizes
    c. Have some method of sorting them
    d. Have two collecting containers, one for each size of marble

   Start by trying to work out how different sized marbles can be separated. Produce several ideas before constructing your agreed design.
2. Design and build the rest of the machine around your sorting mechanism.

FACT SHEET # The Sorting Machine Challenge

Introduction

Sorting machines are used by industries to sort and organize items and products as quickly as possible. Before sorting machines, this process would have had to be done by hand costing companies considerable time and money. Sorting machines come in all different shapes and sizes, designed to suit the item needing to be sorted. Two of the main industries using sorting machines are: the food industry – for sorting food such as oranges and potatoes, and the postal industry – for sorting mail.



Gravity and Motion

So how does a sorting machine work? The principles are the same as the marble run - sorting machines largely (although not in all cases) rely upon gravity and motion to work.

Machines and Efficiency

A **machine** is any mechanical or organic device that transmits or modifies energy to perform or assist in the performance of tasks. It normally requires some energy source (input) and accomplishes some sort of work (output). People have used mechanisms and machines since the stone age. A machine is any device that decreases the amount of force required to do a task. The **mechanical advantage** of a machine is the ratio between the force it exerts on the load and the input force applied. This does not entirely describe the machine's performance, as force is required to overcome friction as well. The **mechanical efficiency** of a machine is the ratio of the actual mechanical advantage (AMA) to the ideal mechanical advantage (IMA). Functioning physical machines are always less than 100% efficient. The petrol engine about 30% efficient. Engineers are constantly working to improve and design new machines which are more efficient.

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