Welcome

Institution of Engineering & Technology
160,000 Engineers World-Wide
Professional Home For Life ® For Engineers and Technicians

Paper Towers

Paper Bridges

Teacher Guide

Click The Title For Next Slide
Make a Tower out of Recycled Paper

Member-Designed Schools Activity
Make a Tower out of Recycled Paper

TV Tower
TV Tower in Japan
Electricity Pylon

Eiffel Tower in Paris

Member-Designed Schools Activity
Paper Towers

Design, Cost, Build and Test
A Tower
Made From
Recycled Paper

A Team Exercise
Paper Towers

Working in teams:
- using recycled materials
- paper
- nuts and bolts
- sticky tape
- scissors
- hole punches

You will Design, Make and Test your Tower against Hurricanes and Earthquakes
Paper Towers

Programme:

Design - 20 min.
Request funding - 10 min
Make the design - 60 min.
Demonstrate and test the product - 3 min. each
## Budget Planning

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity to make the Design</th>
<th>( F ) Faradays Per Qty</th>
<th>( F ) Faradays Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper Sheets</td>
<td>Free</td>
<td>Free</td>
<td>Free</td>
</tr>
<tr>
<td>Other Recycled</td>
<td>Free</td>
<td>Free</td>
<td>Free</td>
</tr>
<tr>
<td>Nuts and Bolts</td>
<td>( F ) 20 per 20</td>
<td>( F )</td>
<td></td>
</tr>
<tr>
<td>Sticky Tape</td>
<td>( F ) 20 per reel</td>
<td>( F )</td>
<td></td>
</tr>
<tr>
<td>( F ) Sub Total</td>
<td></td>
<td>( F )</td>
<td></td>
</tr>
<tr>
<td>Contingency %</td>
<td></td>
<td>( F )</td>
<td></td>
</tr>
<tr>
<td>( F ) Total</td>
<td></td>
<td>( F )</td>
<td></td>
</tr>
</tbody>
</table>

You will be charged 1 point per Faraday for underspending your budget excluding contingency overspending your budget including contingency.
## Budget Planning

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity to make the Design</th>
<th>$F$ Faradays Per Qty</th>
<th>$F$ Faradays Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper Sheets</td>
<td>Free</td>
<td>Free</td>
<td>Free</td>
</tr>
<tr>
<td>Other Recycled</td>
<td>Free</td>
<td>Free</td>
<td>Free</td>
</tr>
<tr>
<td>Nuts and Bolts</td>
<td>20 per 20</td>
<td>$F$</td>
<td></td>
</tr>
<tr>
<td>Sticky Tape</td>
<td>20 per reel</td>
<td>$F$</td>
<td></td>
</tr>
<tr>
<td><strong>$F$ Sub Total</strong></td>
<td></td>
<td>$F$</td>
<td></td>
</tr>
<tr>
<td>Contingency %</td>
<td></td>
<td>$F$</td>
<td></td>
</tr>
<tr>
<td><strong>$F$ Total</strong></td>
<td></td>
<td>$F$</td>
<td></td>
</tr>
</tbody>
</table>

You will be charged 1 point per Faraday for underspending your budget excluding contingency, overspending your budget including contingency.
## Budget Planning

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity to make the Design</th>
<th>$F$ Faradays Per Qty</th>
<th>$F$ Faradays Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper Sheets</td>
<td>Free</td>
<td>Free</td>
<td>Free</td>
</tr>
<tr>
<td>Other Recycled</td>
<td>Free</td>
<td>Free</td>
<td>Free</td>
</tr>
<tr>
<td>Nuts and Bolts</td>
<td>$F$ 20 per 20</td>
<td></td>
<td>$F$</td>
</tr>
<tr>
<td>Sticky Tape</td>
<td>$F$ 20 per reel</td>
<td></td>
<td>$F$</td>
</tr>
<tr>
<td>$F$ Sub Total</td>
<td></td>
<td></td>
<td>$F$</td>
</tr>
<tr>
<td>Contingency %</td>
<td></td>
<td></td>
<td>$F$</td>
</tr>
<tr>
<td>$F$ Total</td>
<td></td>
<td></td>
<td>$F$</td>
</tr>
</tbody>
</table>

You will be charged 1 point per Faraday for underspending your budget excluding contingency overspending your budget including contingency.
Paper Towers

Teams will be judged on:

- your design 20 points
- your budget 20 points
- your product 20 points
- cost v budget -1 point per Faraday underspend budget overspend budget + contingency
- hurricane test 20 points
- earthquake test 20 points
- tower height 1 point per centimetre
- innovation 20, 15, 10, 5 points
  (teams vote for innovation)
Paper Towers

Teams will be judged on:

- your design 20 points
- your budget 20 points
- your product 20 points
- cost v budget overspend budget overspend budget + contingency
- hurricane test 20 points
- earthquake test 20 points
- tower height 1 point per centimetre
- innovation 20, 15, 10, 5 points

(teams vote for innovation)
Some Ideas for Construction
Some Ideas for Construction

Punch Holes

Folded Paper

You may have some other ideas

For extra strength use more than one sheet
Some Ideas for Construction

- Punch Holes
- Folded Paper
- Tube
  - Roll Round a Dowel & Stick With Tape

For extra strength use more than one sheet
Some Ideas for Construction

Punch Holes

Folded Paper

Folded Paper

Tube
Roll Round a Dowel & Stick With Tape

Folded Paper
L-Shaped

For extra strength use more than one sheet
Some Ideas for Construction

- Punch Holes
- Folded Paper
- Tube
- Roll Round a Dowel & Stick With Tape
- L-Shaped

You may have some other ideas

For extra strength use more than one sheet
Use the dowels to roll up the paper and glue the final turn.

You can roll up the paper longways or widthways and also cut the roll to size.

Use a hole punch to make the holes for the bolts and nuts.
Secure with Nuts and Bolts
Some More Ideas
Another Idea
Secure with Nuts and Bolts

Use paper sheet to make shape rigid
Some Ideas

But You Need To Build In 3 Dimensions!!
Paper Towers

Working in teams:

- using recycled materials
- paper
- nuts and bolts
- sticky tape
- scissors
- hole punches

You will Design, Make and Test your Tower against Hurricanes and Earthquakes
Paper Towers

Programme:

Design - 20 min.
Request funding - 10 min
Make the design - 60 min.
Demonstrate and test the product - 3 min. each
# Budget Planning

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity to make the Design</th>
<th>$F$ Faradays Per Qty</th>
<th>$F$ Faradays Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper Sheets</td>
<td>Free</td>
<td>Free</td>
<td>Free</td>
</tr>
<tr>
<td>Other Recycled</td>
<td>Free</td>
<td>Free</td>
<td>Free</td>
</tr>
<tr>
<td>Nuts and Bolts</td>
<td>$F$ 20 per 20</td>
<td></td>
<td>$F$</td>
</tr>
<tr>
<td>Sticky Tape</td>
<td>$F$ 20 per reel</td>
<td></td>
<td>$F$</td>
</tr>
<tr>
<td>$F$ Sub Total</td>
<td></td>
<td>$F$</td>
<td></td>
</tr>
<tr>
<td>Contingency %</td>
<td></td>
<td></td>
<td>$F$</td>
</tr>
<tr>
<td>$F$ Total</td>
<td></td>
<td>$F$</td>
<td></td>
</tr>
</tbody>
</table>

You will be charged 1 point per Faraday for underspending your budget excluding contingency overspending your budget including contingency.
Paper Towers

Teams will be judged on:

- Your design 20 points
- Your budget 20 points
- Your product 20 points
- Cost vs budget 1 point per Faraday underspend budget overspend budget + contingency
- Hurricane test 20 points
- Earthquake test 20 points
- Tower height 1 point per centimetre
- Innovation 20, 15, 10, 5 points (teams vote for innovation)
# Budget Planning

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity to make the Design</th>
<th>$F$ Faradays Per Qty</th>
<th>$F$ Faradays Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper Sheets</td>
<td>Free</td>
<td></td>
<td>Free</td>
</tr>
<tr>
<td>Other Recycled</td>
<td>Free</td>
<td></td>
<td>Free</td>
</tr>
<tr>
<td>Nuts and Bolts</td>
<td>$F$ 20 per 20</td>
<td></td>
<td>$F$</td>
</tr>
<tr>
<td>Sticky Tape</td>
<td>$F$ 20 per reel</td>
<td></td>
<td>$F$</td>
</tr>
<tr>
<td>$F$ Sub Total</td>
<td></td>
<td></td>
<td>$F$</td>
</tr>
<tr>
<td>Contingency %</td>
<td></td>
<td></td>
<td>$F$</td>
</tr>
<tr>
<td>$F$ Total</td>
<td></td>
<td></td>
<td>$F$</td>
</tr>
</tbody>
</table>

You will be charged 1 point per Faraday for underspending your budget excluding contingency or overspending your budget including contingency.
Testing

Hurricane
- no effect = 20 points
- small effect = 12 points
- big effect = 6 points
- collapse = 0 points

Earthquake
- no effect = 20 points
- small effect = 12 points
- big effect = 6 points
- collapse = 0 points
We have learnt to:

• Work and think as engineers by being innovative
• Design and build with the resources available
• Understand the importance of design
• Understand the importance of stable structures
• Understand the importance of budgets and cost control
• Work as a team
The Winners
Thank You
Make a Bridge out of Recycled Paper
Make a Bridge out of Recycled Paper
Paper Bridges

Design, Cost, Build and Test
A Bridge
Made From
Recycled Paper

A Team Exercise
Paper Bridges

Working in teams:

- using recycled materials
- paper
- nuts and bolts
- sticky tape
- scissors
- hole punches

You will Design, Make and Test your Bridge against Hurricanes and Earthquakes
Paper Bridges

Programme:

Design the bridge                      - 20 min.
Request funding                        - 10 min
Make and test the design               - 60 min.
Demonstrate and test the product       - 3 min. each
# Budget Planning

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity to make the Design</th>
<th>$F$ Faradays Per Qty</th>
<th>$F$ Faradays Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper Sheets</td>
<td>Free</td>
<td>Free</td>
<td>Free</td>
</tr>
<tr>
<td>Other Recycled</td>
<td>Free</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nuts and Bolts</td>
<td>$F$ 20 per 20</td>
<td></td>
<td>$F$</td>
</tr>
<tr>
<td>Sticky Tape</td>
<td>$F$ 20 per reel</td>
<td></td>
<td>$F$</td>
</tr>
<tr>
<td>$F$ Sub Total</td>
<td></td>
<td></td>
<td>$F$</td>
</tr>
<tr>
<td>Contingency %</td>
<td></td>
<td></td>
<td>$F$</td>
</tr>
<tr>
<td>$F$ Total</td>
<td></td>
<td></td>
<td>$F$</td>
</tr>
</tbody>
</table>

You will be charged 1 point per Faraday for underspending your budget excluding contingency overspending your budget including contingency.
## Budget Planning

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity to make the Design</th>
<th>$F$ Faradays Per Qty</th>
<th>$F$ Faradays Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper Sheets</td>
<td>Free</td>
<td>Free</td>
<td>Free</td>
</tr>
<tr>
<td>Other Recycled</td>
<td>Free</td>
<td>Free</td>
<td>Free</td>
</tr>
<tr>
<td>Nuts and Bolts</td>
<td>$F$ 20 per 20</td>
<td>$F$</td>
<td></td>
</tr>
<tr>
<td>Sticky Tape</td>
<td>$F$ 20 per reel</td>
<td>$F$</td>
<td></td>
</tr>
<tr>
<td>$F$ Sub Total</td>
<td></td>
<td>$F$</td>
<td></td>
</tr>
<tr>
<td>Contingency %</td>
<td></td>
<td>$F$</td>
<td></td>
</tr>
<tr>
<td>$F$ Total</td>
<td></td>
<td>$F$</td>
<td></td>
</tr>
</tbody>
</table>

You will be charged 1 point per Faraday for underspending your budget excluding contingency overspending your budget including contingency.
Paper Bridges

Teams will be judged on:

- your design 20 points
- your budget 20 points
- your product 20 points
- cost v budget -1 point per Faraday
  
  underspend budget excluding contingency
  overspend budget + contingency

- hurricane test 20 points
- earthquake test 20 points
- bridge width 1 point per centimetre
- innovation 20, 15, 10, 5 points

(teams vote for innovation)
Paper Bridges

Teams will be judged on:

- your design 20 points
- your budget 20 points
- your product 20 points
- cost v budget 
  - underspend budget excluding contingency 1 point per Faraday
  - overspend budget + contingency
- hurricane test 20 points
- earthquake test 20 points
- bridge width 1 point per centimetre
- innovation 20, 15, 10, 5 points
  (teams vote for innovation)
Some Ideas for Construction
Some Ideas for Construction

Punch Holes

Folded Paper

You may have some other ideas

For extra strength use more than one sheet
Some Ideas for Construction

Punch Holes

Folded Paper

Tube

Roll Round a Dowel & Stick With Tape

For extra strength use more than one sheet
Some Ideas for Construction

- Folded Paper
- Tube
  - Roll Round a Dowel & Stick With Tape
- Folded Paper
  - L-Shaped

For extra strength use more than one sheet
Some Ideas for Construction

You may have some other ideas

- Folded Paper
- Tube
- L-Shaped
- Punch Holes
- Roll Round a Dowel & Stick With Tape

For extra strength use more than one sheet
Secure with Nuts and Bolts
Some More Ideas
Another Idea
Use paper sheet to make shape rigid

Secure with Nuts and Bolts
But You Need To Build In 3 Dimensions!!

Not allowed
Must have flat top section

Some Ideas
Paper Bridges

Teams will be judged on:

- your design 20 points
- your budget 20 points
- your product 20 points
- cost v budget -1 point per Faraday
  underspend budget excluding contingency
  overspend budget + contingency
- hurricane test 20 points
- earthquake test 20 points
- bridge width 1 point per centimetre
- innovation 20, 15, 10, 5 points
  (teams vote for innovation)
## Budget Planning

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity to make the Design</th>
<th>$F$ Faradays Per Qty</th>
<th>$F$ Faradays Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper Sheets</td>
<td>Free</td>
<td>Free</td>
<td>Free</td>
</tr>
<tr>
<td>Other Recycled</td>
<td>Free</td>
<td>Free</td>
<td>Free</td>
</tr>
<tr>
<td>Nuts and Bolts</td>
<td>$F$ 20 per 20</td>
<td></td>
<td>$F$</td>
</tr>
<tr>
<td>Sticky Tape</td>
<td>$F$ 20 per reel</td>
<td></td>
<td>$F$</td>
</tr>
<tr>
<td><strong>$F$ Sub Total</strong></td>
<td></td>
<td></td>
<td><strong>$F$</strong></td>
</tr>
<tr>
<td>Contingency %</td>
<td></td>
<td></td>
<td>$F$</td>
</tr>
<tr>
<td><strong>$F$ Total</strong></td>
<td></td>
<td></td>
<td><strong>$F$</strong></td>
</tr>
</tbody>
</table>

You will be charged 1 point per Faraday for
underspending your budget excluding contingency
overspending your budget including contingency

Cost control and sound budgeting is a vital part of engineering and technology
Paper Bridges

Programme:

Design the bridge - 20 min.
Request funding - 10 min
Make and test the design - 60 min.
Demonstrate and test the product - 3 min. each
Testing

Hurricane
- no effect = 20 points
- small effect = 12 points
- big effect = 6 points
- collapse = 0 points

Earthquake
- no effect = 20 points
- small effect = 12 points
- big effect = 6 points
- collapse = 0 points
Add weights until bridge fails
  e.g. marbles, two-p coins
  potatoes, water

Container may be
  bottle
  saucepan
  etc.
  placed on
  wooden support

Support e.g. Chair

Weigh the load withstood before collapse,
  1 point per 100 grams

Support e.g. Chair
We have learnt to:

• Work and think as engineers by being innovative
• Design and build with the resources available
• Understand the importance of design
• Understand the importance of stable structures
• Understand the importance of budgets and cost control
• Work as a team
The Winners
Thank You
Teacher Guide

Materials
Recycled paper
Scissors
Hole punches
Nuts and bolts
Sticky tape
Faraday money
Trays (e.g. from refectory) or home made earthquake generator or board to simulate earthquake
Air Zuka (About £13, e.g. from Amazon UK) to simulate hurricane - or very fast fan
Earthquake = teacher shakes the tray or earthquake generator
Chairs or similar for bridge version (bridge spans the chairs)
Scales
Container (e.g. milk bottle)
Weights (e.g. marbles, two-p coins)
Dowels (e.g. 10mm dia - for rolling the paper into tubes)

Teams
Usually 4 or 5

Timing
Introduction – about 15 minutes
Design – about 30 minutes
Make – 60-90 minutes
Test – 3 minutes per team

Scoring
Design – 20 points
Budget = 20 points
Teamwork – 20 points
Construction – 20 points
Spend v Budget
-1 point per Faraday
underspend budget excluding contingency
overspend budget + contingency
Test – 20 points for passing each test (hurricane and earthquake)
Weight test for bridge - 1 point per 100grams
Innovation – 20 points
(pupil teams vote - give these points as 1st. = 20, 2nd. = 15, 3rd. = 10 points, 4th = 5points)
Timing

Introduction – 15 minutes
Design – 30 minutes
Make – 60-90 minutes
Test – 3 minutes per team
Scoring - 10 minutes
Summary - 5 minutes
Air Zuka

Approx. £12

Create a “Hurricane Air Blast”

Use a Cone to increase flow

paper. al-foil, plastic
Shake back and forth and side to side about 15cm/6in once every 3-4 seconds

Omit earthquake test if impractical
Member-Designed Schools Activity
# Budget Planning

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity to make the Design</th>
<th>$F$ Faradays Per Qty</th>
<th>$F$ Faradays Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper Sheets</td>
<td>Free</td>
<td></td>
<td>Free</td>
</tr>
<tr>
<td>Other Recycled</td>
<td>Free</td>
<td></td>
<td>Free</td>
</tr>
<tr>
<td>Nuts and Bolts</td>
<td>$F$ 20 per 20</td>
<td></td>
<td>$F$</td>
</tr>
<tr>
<td>Sticky Tape</td>
<td>$F$ 20 per reel</td>
<td></td>
<td>$F$</td>
</tr>
<tr>
<td>$F$ Sub Total</td>
<td></td>
<td></td>
<td>$F$</td>
</tr>
<tr>
<td>Contingency %</td>
<td></td>
<td></td>
<td>$F$</td>
</tr>
<tr>
<td>$F$ Total</td>
<td></td>
<td></td>
<td>$F$</td>
</tr>
</tbody>
</table>
# Score Sheet

<table>
<thead>
<tr>
<th>Team</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Budget</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height/Span</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hurricane</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earthquake</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (Bridge)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spend v Budget</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teamwork</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Innovation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Member-Designed Schools Activity**