STUDENT WORKBOOK

Year 6

Name: __________________________________________________________

Other group members: ____________________________________________

________________________________________________________________

________________________________________________________________

________________________________________________________________

Group Number: __________________________ Class: __________________

School: _______________________________________________________

Lyn English, Donna King, Les Dawes and Peter Hudson
DESIGNING AN EARTHQUAKE RESISTANT BUILDING

1. PROBLEM

Your team has been asked by AusAid, an organization that manages projects for countries in need, to design a building that can withstand an earthquake in the Philippines. Acting like structural engineers, you will design, build and test a structure that can withstand an earthquake simulated by a shaker table constructed by a QUT engineer. Since the Earth has limited resources, so too do engineers. For this reason you will need to work within a budget.

Remember to follow the Engineering Design Model.

2. Materials and Equipment

- toothpicks ($0.30 each)
- skewers ($1.00 each)
- plasticine ($1.00 per stick)
- scissors
- shaker table

3. Challenge

Using the materials listed, you will design a building with the following constraints:

a. The building must be at least 12cm (two storeys) high
b. The building must contain at least one triangle
c. The building must contain at least one square
d. There must be evidence of cross-bracing to reinforce the structure
e. You may use whole toothpicks or skewers cut to size
f. You have a budget of $40.00 (maximum) to spend

The group whose final design does not fall over and remains in the exact shape it was before testing is the winner of the Engineering Challenge. If more than one group achieves this, the highest and/or least expensive structure will win.
THINKING SPACE
… drawings, diagrams, observations, notes, reflections …
4. **BRAINSTORM**

Discuss the questions below with your group. Record your answers in the box.

- **What shapes** will you use for your building?

- **How tall** will your building be?

- **Where** will you use either cross-bracing, base isolation or tapered geometry?

- **How** will you make it strong?

- Draw and label some draft designs in the ‘Thinking Space’ on page 4.

5. **EXPERIMENT**

- You will be given 50 toothpicks, 10 skewers and a stick of plasticine to start with.

- If you wish, you can work with the materials and experiment with different construction methods.

- If you need to cut a skewer, you will have to measure the required length and mark it on the skewer. An adult will then cut the skewer at the mark.

- Discuss possible designs with your group, taking into account the cost of materials.
THINKING SPACE

… drawings, diagrams, observations, notes, reflections …
6. **DESIGN**

- **Draw** and **label** your first design.
- Make sure you **label the shapes** you used with the correct names.
- **Remember** to put **measurements** on the design.
- **Note** the **amount of materials** you use.
THINKING SPACE
… drawings, diagrams, observations, notes, reflections …
7. BUILD

Build your structure using the materials supplied.

Calculate the cost of your building. Record the cost in the table below.

<table>
<thead>
<tr>
<th>Materials</th>
<th>Cost</th>
<th>No. Used</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toothpicks</td>
<td>$0.30 each</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skewers</td>
<td>$1.00 each</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plasticine sticks</td>
<td>$1.00 each</td>
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</tbody>
</table>

**GRAND TOTAL**

8. TEST

Write answers to the following questions.

a. Place your structure on the shaker table. Pull the tab on the shaker table to represent an earthquake of Richter Scale 4. Describe what happened.

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b. Repeat at Richter Scale 8. Describe what happened.

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c. What did you learn about your building from the test (including any maths and science that you used)?

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THINKING SPACE
… drawings, diagrams, observations, notes, reflections …
9. EXPERIMENT AND REDESIGN

Write answers to the following questions.

a. What can you change to improve your design?

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b. How will these changes make your structure better?

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Building models, created by student teams for a design contest, combine structural and cost-benefit considerations to ensure both safety and economic performance.
THINKING SPACE
… drawings, diagrams, observations, notes, reflections …
• **Draw** and **label** your improved design below.
THINKING SPACE
… drawings, diagrams, observations, notes, reflections …
10. **REBUILD**

**Rebuild** your new and improved structure.

**Calculate** the cost of your new building. **Record** the cost in the table below.

<table>
<thead>
<tr>
<th>Materials</th>
<th>Cost</th>
<th>No. Used</th>
<th>Total</th>
</tr>
</thead>
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</tr>
<tr>
<td>Plasticine sticks</td>
<td>$1.00 each</td>
<td></td>
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</tr>
</tbody>
</table>

**GRAND TOTAL**

11. **RETEST**

**Write** answers to the following questions.

a. **Place** your structure on the shaker table. **Pull the tab** on the shaker table to represent an earthquake of **Richter Scale 4**. **Describe** what happened.

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b. **Repeat** at **Richter Scale 8**. **Describe** what happened.

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THINKING SPACE

… drawings, diagrams, observations, notes, reflections …
12. **Presentation**

**Present** your best design to the class.

- Use the ‘Thinking Space’ on page 16 to **plan your presentation**.
- Include the following **points** in your presentation.

- A **description** of your building including engineering features (e.g. cross-bracing, tapered geometry, base isolation, large ‘footprints’) and how this will help the people of the Philippines for future earthquake resistant buildings.

- The **cost** of your building.

- **Why** this was your **best** design.
THINKING SPACE

… drawings, diagrams, observations, notes, reflections …
13. Reflecting

Write answers to the following questions.

a. Which was your best design and why?

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___________________________________________________________________
___________________________________________________________________

b. What would you do to further improve your design?

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In what ways were you working like an earthquake engineer today?

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_________________________________________________________________
_________________________________________________________________

Write down everything about how you were using mathematics today for the design of your building. You can use diagrams in your explanation.
THINKING SPACE

… drawings, diagrams, observations, notes, reflections …
**EARTHQUAKE ENGINEERING CHALLENGE FEEDBACK**

Please **colour in the face** to show how you felt about the different parts of the *Earthquake Engineering Challenge*

<table>
<thead>
<tr>
<th>Did you like:</th>
<th>Did not like it</th>
<th>Not sure</th>
<th>Liked it</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ... the activities about earthquakes?</td>
<td>🙁</td>
<td>😞</td>
<td>😊</td>
</tr>
<tr>
<td>2. ... having a real problem to solve?</td>
<td>🙁</td>
<td>😞</td>
<td>😊</td>
</tr>
<tr>
<td>3. ... designing a model of an earthquake resistant building?</td>
<td>🙁</td>
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<tr>
<td>4. ... making a model of an earthquake resistant building?</td>
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<td>😊</td>
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<tr>
<td>5. ... testing your model of an earthquake resistant building?</td>
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<td>😊</td>
</tr>
<tr>
<td>6. ... recording the results of the test of your model of an earthquake resistant building?</td>
<td>🙁</td>
<td>😞</td>
<td>😊</td>
</tr>
<tr>
<td>7. ... doing a presentation about your model of an earthquake resistant building?</td>
<td>🙁</td>
<td>😞</td>
<td>😊</td>
</tr>
<tr>
<td>8. ... thinking about how to make your model of an earthquake resistant building better?</td>
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<td>😞</td>
<td>😊</td>
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</tbody>
</table>

**Next time I would like to:**

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