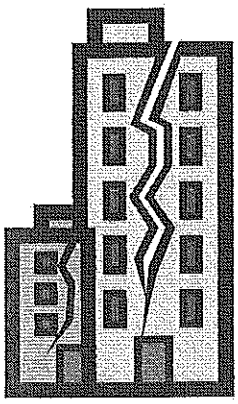
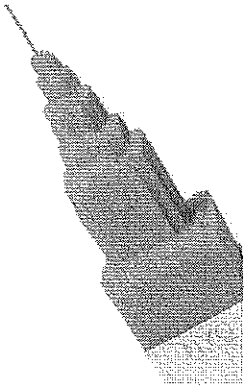
SPAGHETTI EARTHQUAKE





Earthquakes and other natural disasters can damage or destroy man-made structures. Imagine that you and your teammates work for a company that specializes in building disaster-proof structures. For this project you have been asked to design a skyscraper that will be built in a city where earthquakes sometimes occur. The city planners would like to see your design along with the designs of other companies. They will select the best design for the construction of the skyscraper.

The Task:

Each team will design, build, and test a model structure made out of uncooked spaghetti noodles. Your model will be tested on a specially-built earthquake machine. This machine simulates the stresses that occur during earthquakes. Your model should be able to withstand a 10 second earthquake without collapsing. To make sure the structure can withstand weight as well as earthquake forces, an egg will be placed within your structure and should be supported throughout the test. You will be competing against other companies (teams) by attempting to build the structure that lasts the longest while supporting the egg.

The Procedure:

- DRAW a rough-draft of <u>your</u> idea for a tower in your booklet – come up name for your design. EACH member must come up with their own design to share with the team.
- DISCUSS with your group possible designs—what it look like, how the egg be held in, how your tower will be supported/strengthened, how your base be shaped, etc.

- COLLABORATE with your team and pick the best ideas to come up with a final design. Designate one person to be in charge of making a final blueprint of your group tower. Design carefully! Your structure must be strong yet flexible. Your actual structure must closely match your drawing. Only minor changes will be allowed. Your blue print must be complete before any supplies can be purchased. (This is not your scaled drawing.)
- DESIGNATE a purchasing agent for your team. Only that person may authorize purchase orders and get supplies for your tower.
- COMPLETE purchase order #1 and purchase the materials needed to create your skyscraper. You have a budget of **$4,875.00**. Prices of the available materials are listed in this packet. You must fill out a purchase order every time you wish to buy materials, and you may use a maximum of 3 purchase orders throughout your build. You may NOT bring in additional materials, return materials, use another team's materials, or donate materials to another team. You may only use those materials you have purchased.

<u>OTHER</u>:

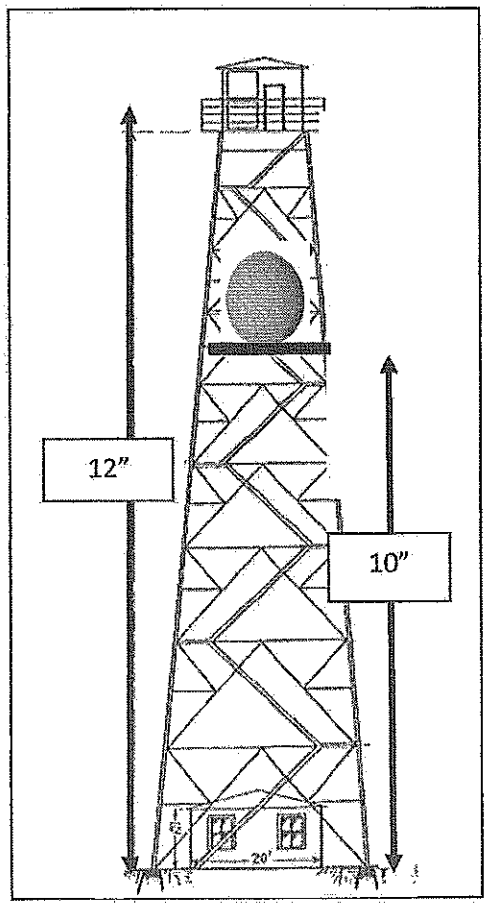
Clean up your area when you are finished building. YOU MAY NOT EAT YOUR BUILDING SUPPLIES! Part of your grade will be how efficient you are with this task.

Your group will give a short presentation to the class before testing your structure. You will discuss your company, show your Blue Prints and explain your structural design and what decisions you made so that it will withstand an earthquake.

Test your structure: the company's skyscraper that supports the egg longest, wins! In case of a tie, the team whose egg is the highest will win!

Rules:

- Your structure must fit within these specifications in order to be drawn correctly on the drafting paper, as well as being able to fit on the earthquake machine for testing.
- Your structure must be at <u>least</u> 12 inches tall (no more than 16").
- The bottom of the egg must be at least 10 inches above the tabletop when your skyscraper is tested.
- The width at the base may NOT be larger than 10" from any view (front, back, side, etc.)
- Your team may not exceed its budget of $4,875.00.
- To purchase materials you must fill out a purchase order, maximum of 3 orders will be filled.
- You may only use materials that are available for purchase, you may not buy (steal, borrow, trade, confiscate, barter, etc.) from another team. You may not bring in your own materials.



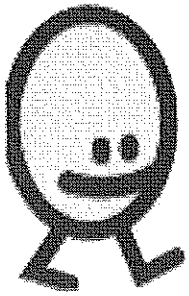
<u>Marshmallows</u> may not be torn or broken into smaller pieces

<u>Spaghetti</u> noodles may not be broken smaller than 2" (1/5 a stick).

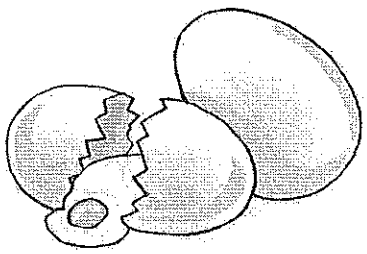
You may not block your egg in with the structure; the teacher will set the egg in/on the tower right before testing.

The structure must stay intact (no leaning, breaking, falling, etc.) and support the egg for 10 seconds after the earthquake begins.

Individuals or entire group may lose points for any of the following:

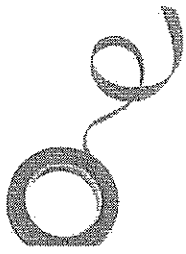


* Inappropriate use of materials
* Not cleaning up at the end of each class
* Disturbing other groups
* Being too loud
* Not doing your fair share of work



Materials available for purchase:

<u>Product</u>	<u>Cost per item</u>	<u>Item number</u>
Spaghetti noodle (3)	$100	spa-1234
Mini-Marshmallow (1)	$50	mar-5678
Masking Tape (1 inch)	$25	tap-9000



Individual Rough Draft:

In the space below, draw a rough-draft drawing of your idea for an earthquake tower. Make your drawing with pencil, use a straight-edge for all lines. Always keep in mind what materials you would use for each part of the structure.

Suggested Tower Name:

KEY:

= Spaghetti Noodles
= Marshmallows
= Masking Tape

Blue Print

(name of tower)

Name of Company:

KEY:

= Spaghetti Noodles

= Penne noodles

= Marshmallows

SPAGHETTI EARTHQUAKE - DATA SHEET

Company Name:_____

Tower Name:_____

Purchase Order Record:

Amount spent with Purchase Order #1: _____

Amount spent with Purchase Order #2: _____

Amount spent with Purchase Order #3 _____

TOTAL SPENT ($4,875 max) _____

Structure Data:

Total height of structure: _____

Height to bottom of egg: _____

Length & width of tower base: _____

Predicted time: _____

Actual time: _____

CLASS TESTING OBSERVATIONS

Group Number: _____ Tower Name: Predicted Time: _____ Actual Time: _____ Observations:	Rough Sketch:
Group Number: _____ Tower Name: Predicted Time: _____ Actual Time: _____ Observations:	Rough Sketch:

6. Predict what would happen if we had put your tower on top of a slab of Jell-O and then turned on the earthquake?

7. Predict what would have happened if we had put your project on top of a box of sand:

8. If you were to do this again, what would you do differently? Think of at least 2 changes you would make to the design of your tower:

   a.

   b.

9. What are two tips you would give to an architect who is designing a new hotel that is going to be built in San Francisco?

   a.

   b.

Questions After Testing:

1. Which group did the best?

   Name of Tower: _____

   Time: _____

2. What do you think made that particular group's tower do the best?

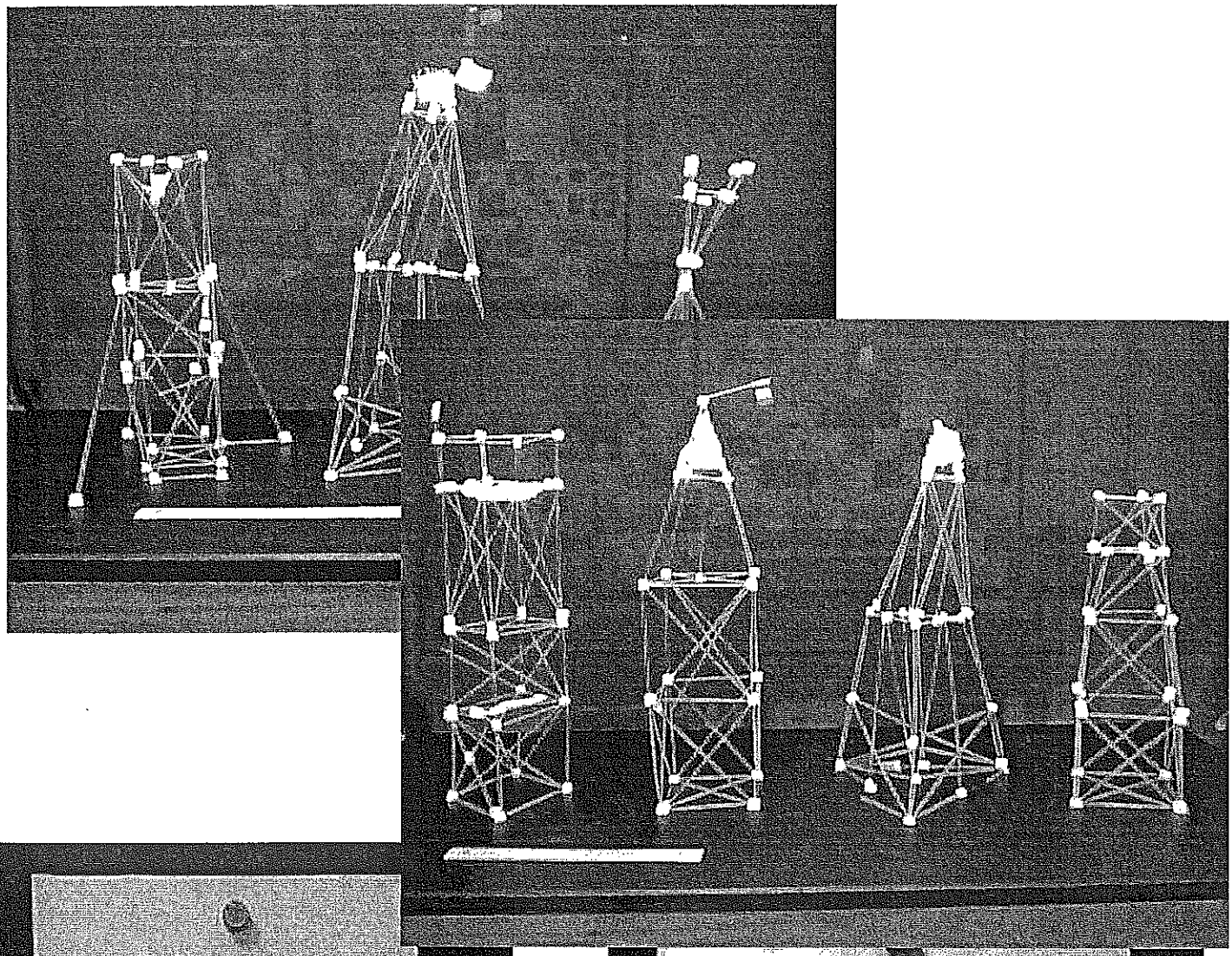
3. Did your team add any components that would resist shear? Describe:

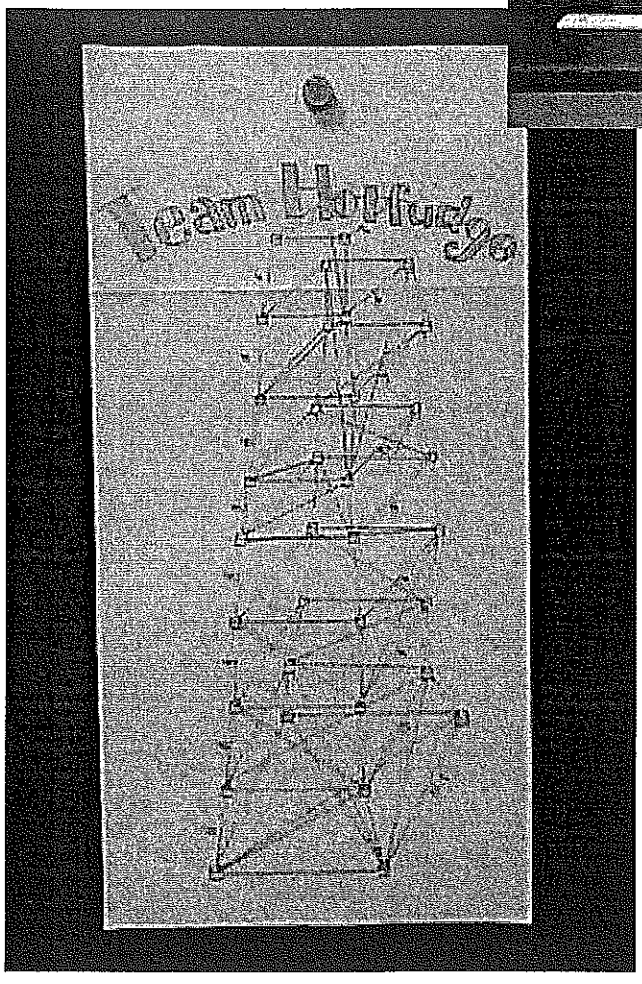
4. What components did you add to make your structure more stable (not tip over)?

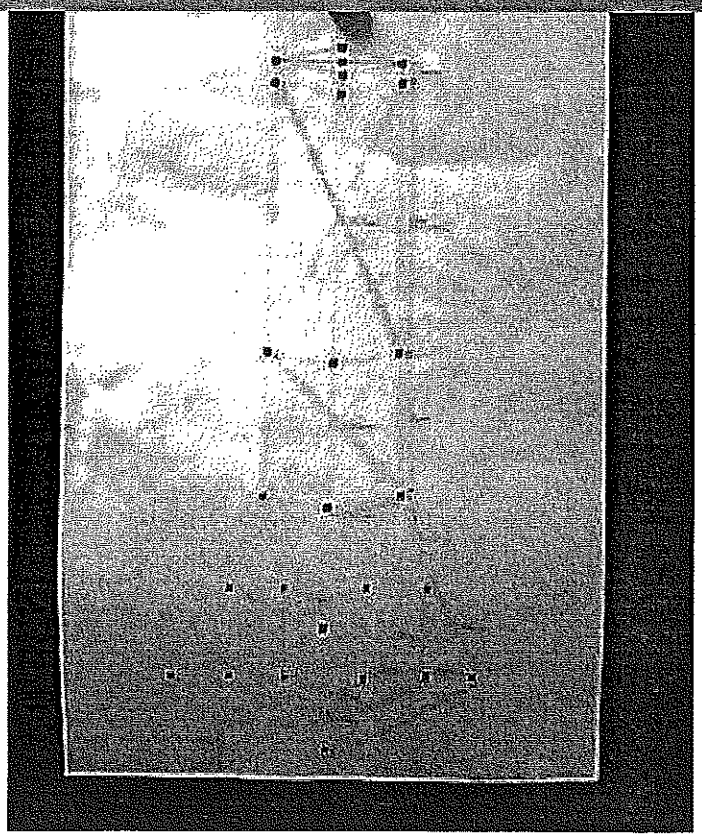
5. Why do you think your tower lasted the amount of time it did?

ASSESSMENT

REQUIREMENTS	Pts Possible
1. Spaghetti Earthquake Booklet Completed	10
2. Planning/Building Phase/Site Management: Cleaned up site daily Good Time-Management Managed Budget	10
3. Team Cooperation / Individual Behavior Group blueprint completed, neat, etc. Group worked very well together All members participated Stayed on task	10
4. Structure Design Holds Egg Stands on Own Egg Height _____ (10" minimum) Overall Height _____(12" minimum)	20
5. Final Test Time on table: _____ sec (10 sec required)	10
6. INDIVIDUAL Diagram: Full Scale (1" = 1") Accurate blueprint of final tower All dimensions (lengths, heights, etc.) indicated TITLE of tower (not company name) KEY of materials Overall neatness: completed in pencil, used straight-edge for lines, erasures neat	20
	80 Total







How Do Earthquakes Affect Buildings?

Have you ever seen pictures of a city after a strong earthquake has hit? You may have noticed that some buildings don't have very much damage. Other buildings, however, are totally destroyed. Engineers can study the damage to learn how to make buildings that are stronger and safer.

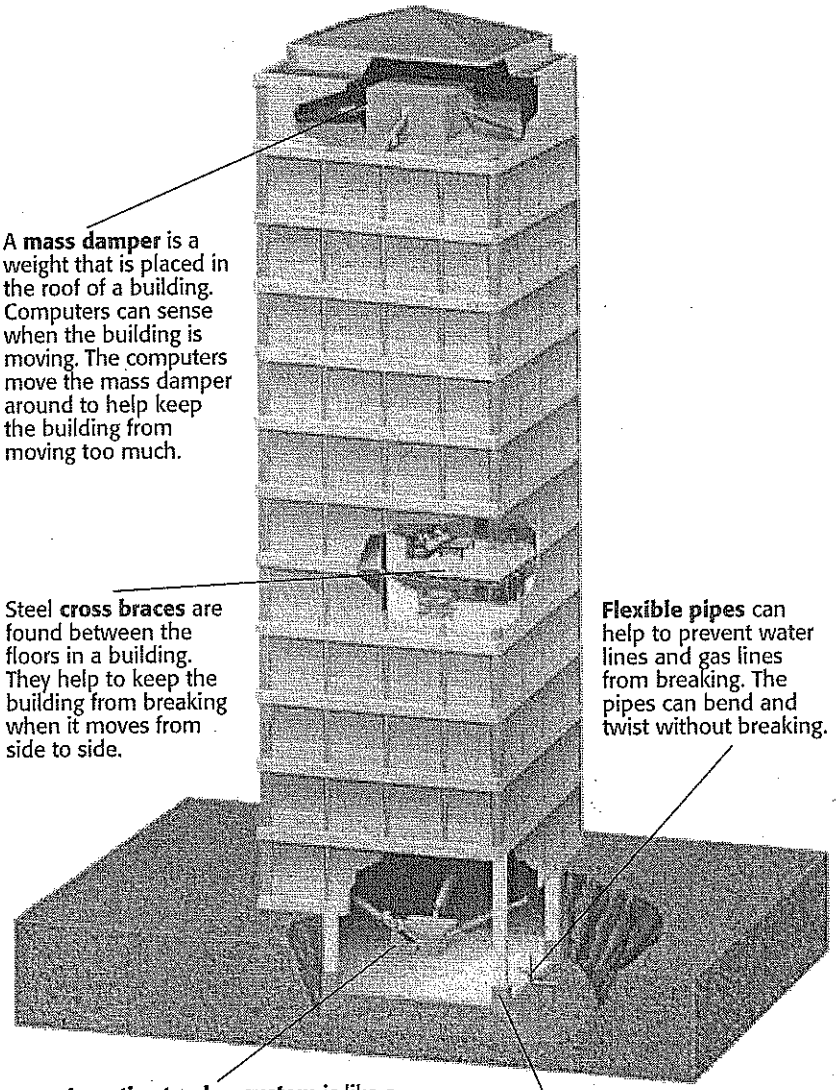
Critical Thinking

4. List Give three factors that can affect how much a building will be damaged by an earthquake.

_____

_____

_____



A **mass damper** is a weight that is placed in the roof of a building. Computers can sense when the building is moving. The computers move the mass damper around to help keep the building from moving too much.

Steel **cross braces** are found between the floors in a building. They help to keep the building from breaking when it moves from side to side.

Flexible pipes can help to prevent water lines and gas lines from breaking. The pipes can bend and twist without breaking.

An **active tendon system** is like a mass damper, except it is placed under the building.

Base isolators can absorb energy during an earthquake. They keep seismic waves from moving through the building. Base isolators are made of rubber, steel, and lead.

TAKE A LOOK

5. Compare How is a mass damper different from an active tendon system?

_____

_____

_____

Company Name: _____

Hour: _____

Group #: _____

Budget Available: $4,875.00

PURCHASE ORDER #1

Quantity	Item Number	Product Description	Unit Price	Total
				$

Authorized by: _____ TOTAL: $

Budget Available: $_____

PURCHASE ORDER #2

Quantity	Item Number	Product Description	Unit Price	Total
				$

Authorized by: _____ TOTAL: $

Budget Available: $_____

PURCHASE ORDER #3

Quantity	Item Number	Product Description	Unit Price	Total
				$

Authorized by: _____ TOTAL: $

Remaining in Budget: $_____

Name _____ Date ____ Hour ____

Group Performance Evaluation

Cooperation & Contribution during planning *and* building phase of Spaghetti Earthquake Tower

This is your opportunity to evaluate yourself and other members of your group. Give a score out of 10 points that you feel each member earned during the group project. Do not hold an absence against a group member. Be sure to list reasons/examples for points being deducted. Be honest and fair. Your opinion is confidential.

Self: _____ Cooperation Score ____/10
Contribution Score ____/10

Rationale for scores:

_____

_____

_____

Member 1: _____ Cooperation Score ____/10
Contribution Score ____/10

Rationale for scores:

_____

_____

_____

Member 2: _____ Cooperation Score ____/10
Contribution Score ____/10

Rationale for scores:

_____

_____

_____

Member 3: _____ Cooperation Score ____/10
Contribution Score ____/10

Rationale for scores:

_____

_____

_____

Additional Comments:

_____

_____