
THE EMPIRE STATE BUILDING

EDUCATIONAL MATERIALS

ENGINEERING:
GRADES 6-8



EXPLORING THE ENGINEERING DESIGN PROCESS: SKYSCRAPERS AND THE EMPIRE STATE BUILDING

Exhibit Connections: Wonder of the Modern World, Construction, Modern Marvel, Observation Deck

OVERVIEW OF LESSON PLAN

The Empire State Building was one of the most amazing (and most challenging) engineering marvels of its time. This unprecedented leap in skyscraper innovation set new standards for height, design, construction timelines, and new building techniques. In this unique field trip experience, students will examine skyscraper engineering challenges, explore the forces that allow the elevators to reach such heights, and test designs for their own “Office Supply-scraper.” This workshop’s structure-building and problem-solving activities will support students’ understanding of the Engineering Design Process (EDP).

OBJECTIVES

Students will:

- Explore the steps of the Engineering Design Process
- Apply the steps to imaginative challenges
- Create their own EDP chart to solve a problem
- Utilize office supplies to create their own skyscraper in a building challenge

SUGGESTED TIME ALLOWANCE:

One hour



RESOURCES/ MATERIALS:

- Video [Impossible Science on Location](#)
- Pencil
- Provided handouts
- Basic office supplies are required for the post-trip activity.
 - Index cards and cardstock paper of varying sizes
 - ½" wide masking tape rolls (1 per student)
 - Paper clips of varying sizes

ACTIVITIES/ PROCEDURES:

PRE-TRIP ACTIVITY

In this pre-trip lesson, students investigate the Engineering Design Process and apply it to solve a unique (and creative) need.

Engineering Design Process

- Lead a facilitated class discussion about what engineers do. What do the students already know?
- Have the students turn and talk to their neighbors, asking them “what do engineers build/design?”
- Allow time for the students to share what they discussed, record the students’ ideas on the board or chart paper.
- Next, introduce the steps of the Engineering Design Process one by one, as part of a group discussion.
- As the terms are discussed, ask the students to cite examples from their everyday lives.
- Separate students into small groups to create their own “need” to solve using the EDP

Once in small groups, challenge the students to think about a problem they could solve by creating a “mock” EDP chart. Build a jetpack? Perfect! Underwater monster trucks? You bet! Robot pizza delivery? Even better! For this exercise, the sky’s the limit. Think tall!

Utilizing chart paper and markers, the student should trace the path of their challenge creating a visual of the EDP. Allow plenty of time for students to share their processes.

To extend the activity, ask the students to relive the Engineering Design Process when faced with a challenge at home. Provide a blank EDP chart to fill in.

Students can also read **An Innovative Skyscraper** to learn more about the innovations

that made the Empire State Building possible.

[See Pre-Trip Worksheet]

ON-SITE ACTIVITIES One hour

EXHIBIT: WONDER OF THE MODERN WORLD (15 minutes)

The Empire State Building was, at the time, the tallest structure ever built. Students will view the time-lapsed recreation of the Empire State building being constructed from start to finish in just one year and 45 days. Write a reflective paragraph (3-5 sentences) about how you yourself might have felt watching this amazing skyscraper being constructed.

EXHIBIT: CONSTRUCTION (15 minutes)

The Empire State Building is being built all around you! Take a moment to observe the pieces coming together, and how the workers are connecting them. Sketch the path of a material as it connects to others. Add pictures and notes to describe what you see. (For example, you could track the path of a rivet or a beam.)

EXHIBIT: OTIS ELEVATORS (15 minutes)

The Otis Elevator company created an innovative and new elevator system for the Empire State Building twice—the first in 1931, then again in 2011. The Empire State Building has also made many modern improvements to the building’s energy efficiency, design, and environmental impact. Use the signage in the exhibit to answer the questions below.

EXHIBIT: OBSERVATION DECK (15 minutes)

As you take in the amazing view from the Observation Deck, look at the other tall buildings being constructed around the island of Manhattan. What do you notice about these new buildings? How many of them are there? What about their construction looks similar to what you saw in the Construction exhibit downstairs? What looks different? Sketch some of the buildings you see and record a few observations about each.

HOMEWORK/FURTHER DISCUSSION:

In small groups, students can research the current tallest buildings in the world to compare and contrast their construction with the Empire State Building’s. What challenges do engineers face when building skyscrapers? What has changed since the Empire State Building was built? What is the same? Additional research can be done by the students to learn about how structures are built to withstand the forces of both gravity and wind.

POST-TRIP ACTIVITY: “OFFICE SUPPLY-SCRAPER”

In this post-trip lesson, students design and build their own skyscraper made from everyday office supplies.

Facilitate a class discussion about the Empire State Building elevators after rewatching

- Lead a facilitated class discussion about the construction of the Empire State Building.
- Suggest the students to turn and talk to their neighbors, asking them “What do you remember about the construction process? The design? The materials?”
- Allow time for the students to share what they discussed, record the students’ ideas on the board or chart paper.
- Next, discuss the office supply materials, and how they can be utilized to build a tall structure.
- Separate students into small groups, with identical sets of materials, to design and build their structures.
- Measure each groups’ tower to find the tallest.

EVALUATION AND ASSESSMENT

Students can be evaluated based on their usage of the materials, tower height, teamwork, and ability to document what they learned about their successes (and failures) in their tower design. There is also an opportunity for expansion of the structure testing by utilizing a box fan to test the structures for their strength against “wind”.



CONNECTIONS TO THE STANDARDS

- MS-ETS1-1.** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, considering relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- MS-ETS1-2.** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS1-3.** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- MS-ETS1-4.** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

PRE-TRIP WORKSHEET

NAME _____

DATE _____

PREPARING FOR YOUR TRIP TO THE EMPIRE STATE BUILDING

The Empire State Building was one of the most amazing (and most challenging) engineering marvels of its time. The height, materials, construction timeline, and new building techniques all set the stage for an amazing advance in skyscraper innovation.

In today's activity, you will prepare for your trip by learning about the Engineering Design Process and use it to make a plan to build something from your imagination!

As your teacher leads your class through the KW (Know, Want to Know) process, write down:

- some of the things you already know about what Engineers design/build
- what you want to learn about Engineers
- what your classmates know/want to know about the process

Know	Want to Know

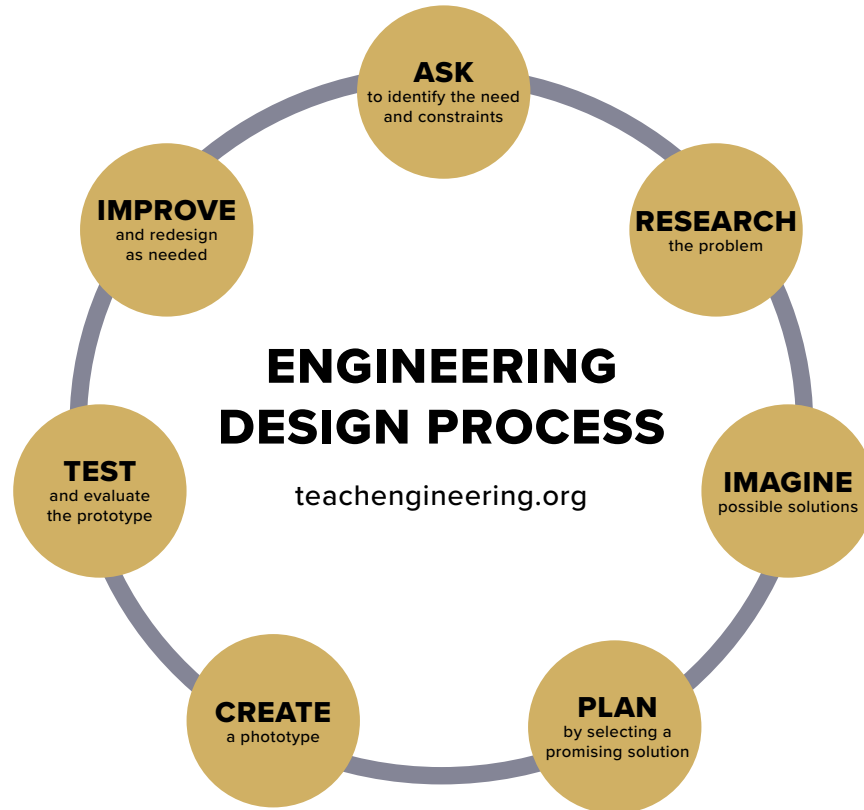
PRE-TRIP WORKSHEET

NAME _____

DATE _____

The Engineering Design process is a step-by-step way to think about a problem, and how to create a solution. Use the space below to write your thoughts.

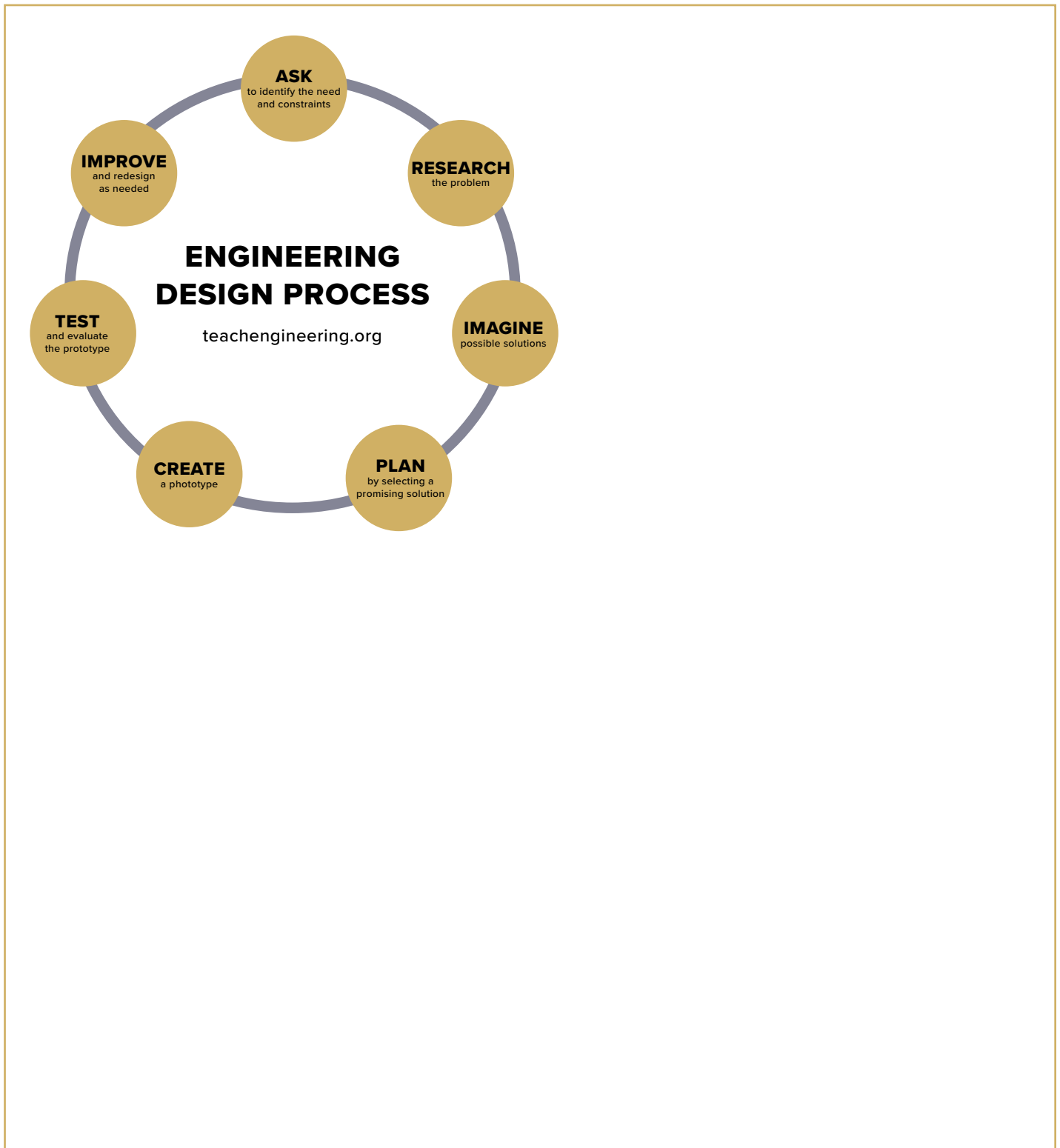
Then, during the class discussion, jot down notes about what your classmates think about each step in the process.



Ask	Research	Imagine	Plan	Create	Test	Improve

Now it's your turn! It's time to bring out that wildly creative idea that you've been imagining and put it through the process. And if you're still imagining one, that's ok too! Want to build a jetpack? Perfect! Race underwater monster trucks? You bet! Order robot pizza delivery? Even better! For this activity, the sky's the limit. Think tall! You could also work as part of a team and choose an idea to work on together!

Use the space below to write your thoughts about each step. Start with "Ask," and work your way around the circle from there. You may find you have new questions when you get back to Ask! Just keep repeating the process. That's what Engineers do!



TRIP WORKSHEET

NAME _____

DATE _____

WELCOME TO THE EMPIRE STATE BUILDING

Get ready for an exciting trip through history, 102 stories into the sky! During your trip, you'll take what you've learned about the Engineering Design Process and put it to work in one of the world's most iconic buildings! In today's field trip, you will experience the record-breaking construction of the Empire State Building.

Wonder of the Modern World

The Empire State Building was, at the time, the tallest structure ever built. Write a reflective paragraph (3-5 sentences) about how you yourself might have felt watching this amazing skyscraper being constructed.

Reflection on how quickly the Empire State Building was constructed:

Construction

The Empire State Building is being built all around you! Take a moment to observe the pieces coming together, and how the workers are connecting them.

Sketch the path of a material, tool, or builder as they connect to others and build the structure. Add pictures and notes to describe what you see. (For example, you could track the path of a rivet or where a crane carries a beam.)



TRIP WORKSHEET

NAME _____

DATE _____

OTIS ELEVATORS

The Otis Elevator company created an innovative and new elevator system for the Empire State Building twice—first in 1931, then again in 2011.

The Empire State Building has also made many modern improvements to the building's energy efficiency, design, and environmental impact.

Use the signage and touch panels in the exhibit to answer the questions below.

1931 OTIS ELEVATORS:

How many elevator cars were there?

How many trips per day did they make?

How many miles of rope were used?

2011 OTIS ELEVATORS:

How many trips per year?

How much more efficient (%) are the new elevators during rush hour?

If 20% of NYC's largest buildings follow the Empire State Building's example, the city's total energy consumption could reduce by how much (%)?

How many tower lights were changed to LED fixtures?

How many windows were rebuilt with the insulating krypton/argon gas?

OBSERVATION DECK

As you take in the amazing view from the Observation Deck, look at the other tall buildings being constructed around the island of Manhattan.

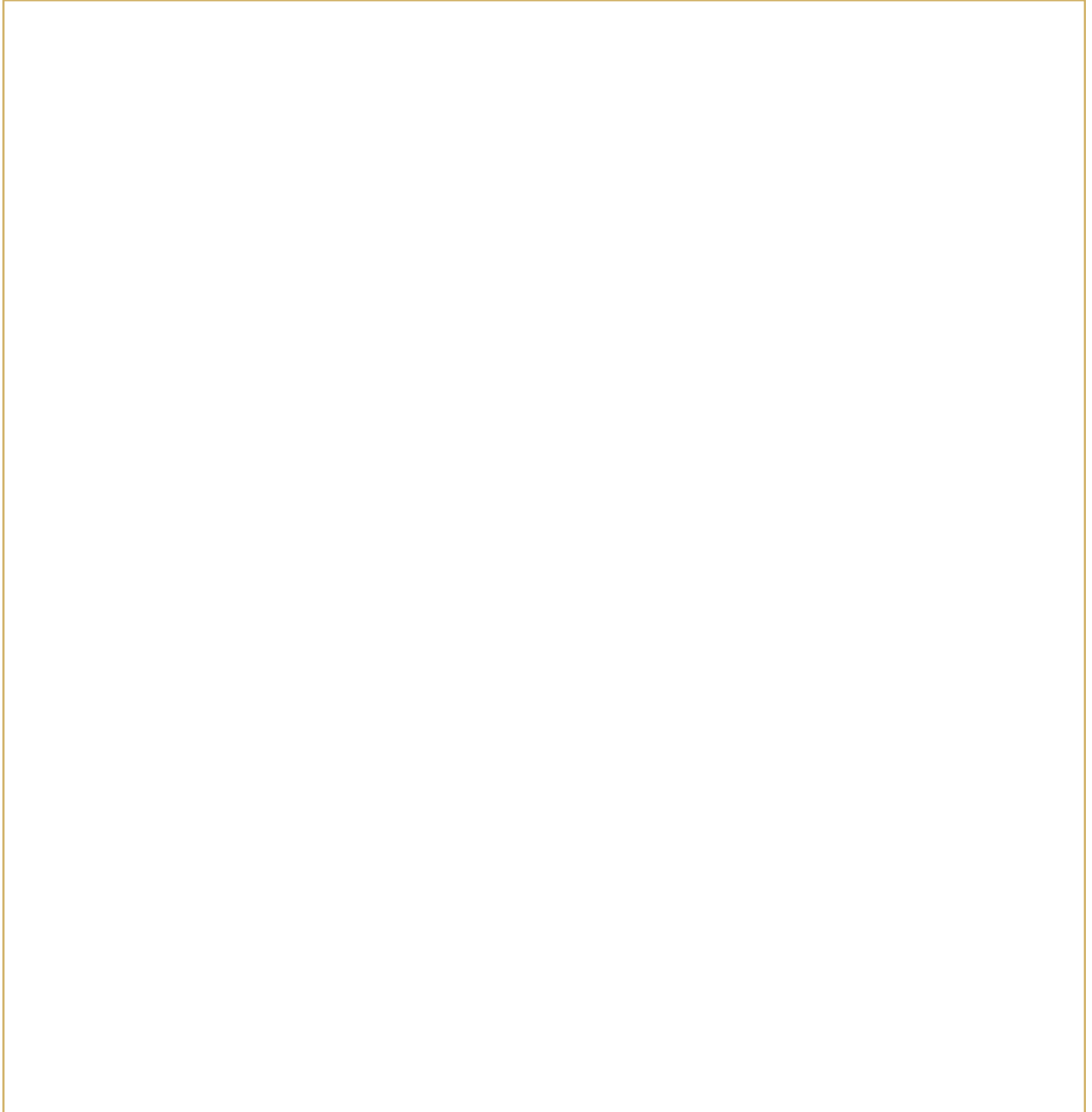
What do you notice about these new buildings?

How many of them are there?

What about their construction looks similar to what you saw in the Construction exhibit downstairs?

What looks different?

Sketch some of the buildings you see and record a few observations about each.



POST-TRIP WORKSHEET

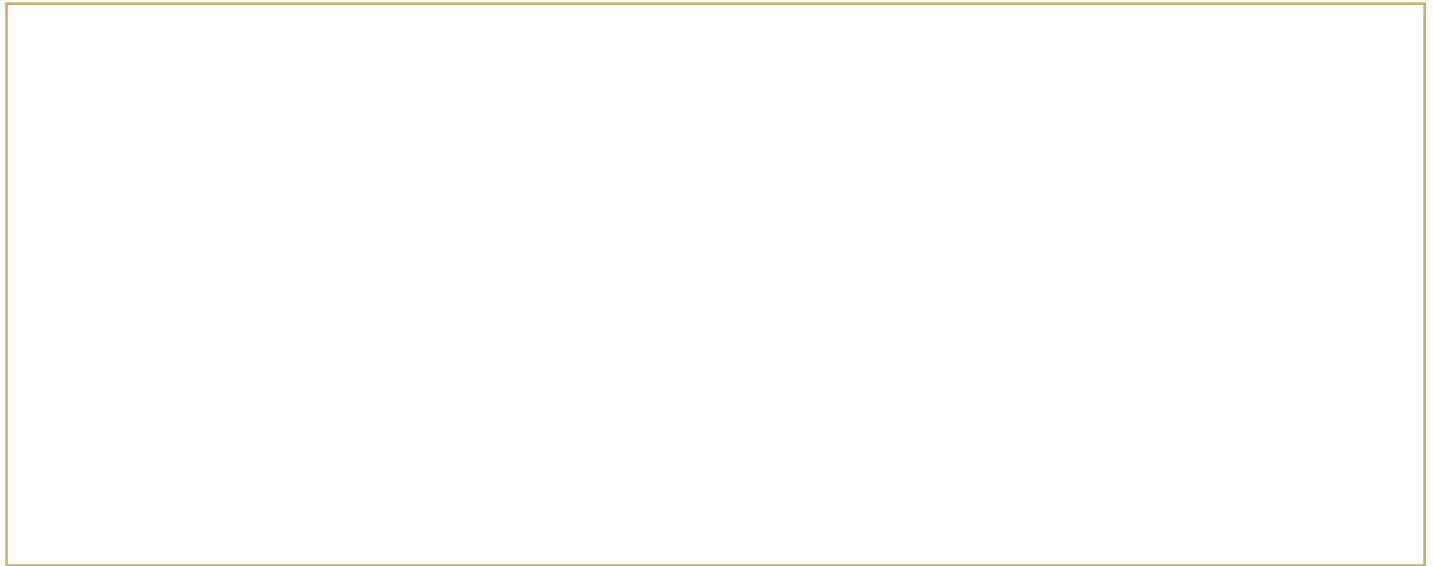
NAME _____

DATE _____

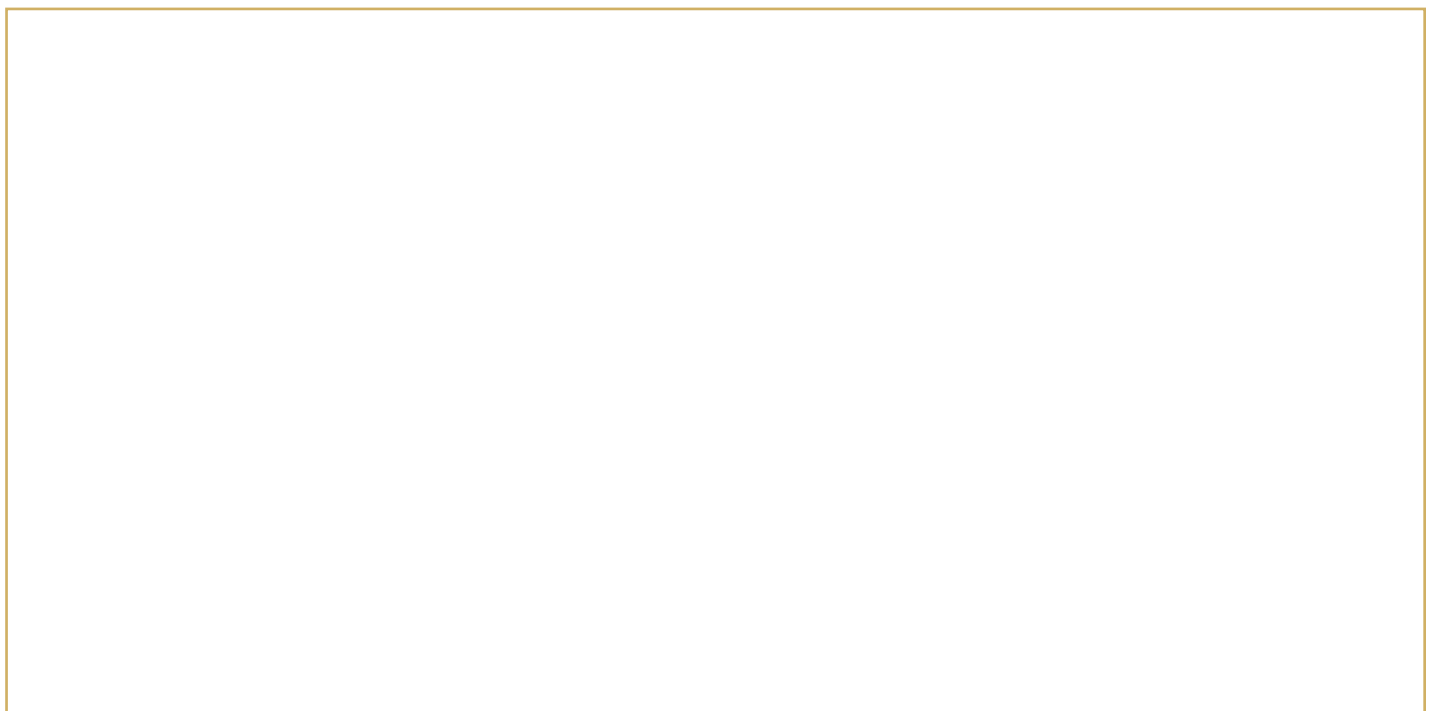
HOW AMAZING WAS YOUR TRIP TO THE EMPIRE STATE BUILDING?

Now that you've been to the top of the Empire State Building, it's time to put your knowledge of skyscrapers to the test. What did you notice about the construction? How did the beams come together to hold up such a tall structure? It's time to use some everyday materials to build your own tower. Try to build one taller than yourself!

Take a moment to sketch a plan to build your "Office Supply-scraper".



Speak with your group and compare plans. What is the same? What is different?



Working with your group, build your tower design. How tall can your tower go?
Sketch your final designs.



TEACHER ANSWER KEY

MODERN MARVEL

The Otis Elevator company created an innovative and new elevator system for the Empire State Building twice—first in 1931, then again in 2011.

The Empire State Building has also made many modern improvements to the building's energy efficiency, design, and environmental impact.

Use the signage and touch panels in the exhibit to answer the questions below.

1931 OTIS ELEVATORS:

How many elevator cars were there?

73

How many trips per day did they make?

85,000

How many miles of rope were used?

120 miles

2011 OTIS ELEVATORS:

How many trips per year?

10 million

How much more efficient (%) are the new elevators during rush hour?

50%

If 20% of NYC's largest buildings follow the Empire State Building's example, the city's total energy consumption could reduce by how much (%)?

25%

How many tower lights were changed to LED fixtures?

400

How many windows were rebuilt with the insulating krypton/argon gas?

6,514