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# THE EMPIRE STATE BUILDING

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## EDUCATIONAL MATERIALS

TECHNOLOGY:  
GRADES 9-12





# OTIS ELEVATORS: SMALL INVENTIONS THAT CHANGED THE WORLD—HOW ELEVATOR TECHNOLOGY IMPACTS BUILDINGS AND CITIES

## Exhibit Connections: Lobby Design, Otis Elevator

### OVERVIEW OF LESSON PLAN

This project is a series of lessons before and after the trip to the Empire State Building. Students will research and write about the technological and societal revolution that was facilitated by the invention of a seemingly simple device: the high-speed electric elevator. Students will complete a three-part assignment in which they research and write about:

- One specific aspect of the technology in the elevators created in the 1920s,
- The impact they had on the height of buildings and population migration to cities all around the world, and
- One new technology that has been included in the new Otis Gen2 elevator system during the recent renovation.

There are many “famous” inventions in modern history—electricity, the lightbulb, airplanes, television, computers, and the internet. The elevator is seemingly a simple use of electric motors that we think little about. But consider that from 1900 to 1930, the population of New York City doubled from 3.5 million to 7 million! And after growing by 3.5 million people in only 30 years, the population of New York barely increased over the next 90 years (from 1930 to today) by another 1 million (to 8 million total). The Empire State Building was built in 1930, at the end of this period of massive urbanization in the United States, and it became the most iconic example of our ability to build vertically. This trend in demographics and the growth of dense urban areas throughout the world could not have occurred without the incredibly rapid construction of buildings much taller than previously possible.

In this project, students will carefully observe the exhibit at the Empire State Building about the newest (at the time) Otis Elevators and how they work. They will conduct research, choosing one aspect of the technology used in elevators. And finally, they will write a short essay about the technology they researched and how elevators impacted demographics and history in the United States.

## **OBJECTIVES**

Students will deepen their understanding of:

- One aspect of the technology used in elevators and how the science impacts the design.
- The demographic shifts that happened in New York City and around the world in the first few decades of the 20th Century—from the Industrial Revolution forward, including the shift from agrarian to industrial employment and the subsequent urbanization of the population.
- How technology played a key role in these demographic shifts.
- How the Empire State Building continues to innovate with the recent renovation of the Otis elevators and how environmental sustainability plays a role in new technology.
- Research and writing skills necessary to complete the assignment.

## **SUGGESTED TIME ALLOWANCE:**

4 hours

Time can vary significantly at the discretion of the teacher. Four hours is a suggested approximation: Teachers could provide one hour of (pre-trip) research on how modern elevators work in order to provide perspective for the Empire State Building trip; then, devote approximately three additional hours after the trip for students to conduct research into a specific part of elevator technology, the demographic shifts that occurred from 1900 to 1930, the newest technology included in the recent renovation of the Otis elevators, and to write about their learning.



# RESOURCES/ MATERIALS:



- Information provided in the Empire State Building exhibits, particularly the history of the building's construction and the Otis Elevator exhibit.
- Video from The B1M:

Inside the Empire State Building's 21st Century Upgrade

- Video:

Impossible Science on Location

- Paper or notebook for taking notes at the Empire State Building.
- Additional research and writing will be done on a computer.
- Provided worksheets

# ACTIVITIES/ PROCEDURES:

## PRE-TRIP ACTIVITY

Students will conduct preliminary research into how elevators work from a technology perspective. Although the mechanics of an electric motor are not complicated, teachers can encourage students to choose one specific technology that they want to learn more about. For example, students (working independently or in groups) could choose one of the following topics for preliminary research:

### Watch: Impossible Science on Location

- Before the use of electric elevators, some buildings used steam-powered elevators, which were also invented by Elisha Otis in New York City. Students could research how steam-powered elevators worked.
- Why do modern elevators use “counterweights”? What is their purpose and how do they work?
- Modern elevators have automatic braking systems, so that they will not fall to the ground even if they lost power or the cable snapped. How do they work?
- How fast do elevators go? Is there a limit to their speed or acceleration to guarantee that the ride is not harmful or uncomfortable for passengers?
- One of the limitations on the height we can build modern buildings is due to the need for elevator space. In other words, as a building is made taller, we need more elevators (for a larger number of people entering and exiting); and therefore, as buildings get taller, a larger percentage of the square footage must be devoted to elevators, which limits the height that is practical for use. What new technologies allow for taller buildings without losing too much space to elevators? How do engineers address this problem? Consider researching “multi-directional elevators.”
- Students will also consider the environmental impact of elevators and the energy that is consumed to move visitors up and down inside buildings—and research the recent renovations at the Empire State Building and the new Otis elevators that utilize new technology. Students will watch the video by B1M, “Inside the Empire State Building’s 21st Century Upgrade” and read the Washington Post article, “Empire State of Green.”

Students will choose one of these topics or another topic about the technology of elevators that is approved by their teacher. They will conduct research into the topic they choose, take notes, and share their learning with their classmates before the trip to the Empire State Building.

## ON-SITE ACTIVITIES (One hour)

**EXHIBIT: MODERN MARVEL** (15-30 minutes)

Have students view the information in one of these exhibits to learn about how the Empire State Building is still utilizing cutting-edge technology. How have engineers increased the energy efficiency of the building?

**EXHIBIT: OTIS ELEVATORS AND ELEVATOR TO THE 86TH FLOOR OBSERVATION DECK**

(15-20 minutes; 5 minutes)

Next, at the observatory, students should pay particular attention to the Otis Elevator exhibit. They will review and take notes on the information provided in the exhibit—facts about the elevators, the timeline of the construction, and the video simulation of the internal workings of the elevator. Again, they should pay particular attention to anything relevant to the topic they chose to research.

**EXHIBIT: SECOND FLOOR ELEVATORS** (10 minutes)

Before getting on the elevators after the Kong exhibit and Celebrity Walk, students will carefully observe and take notes about their observations before they get on the elevator and about what they see when they take the elevator from the second floor to the 80th floor. How much of the second-floor space do you estimate is taken up by elevators? How fast does the elevator feel like it's moving as it ascends to the 80th floor? They should note anything relevant to their own research on elevators.

**HOMEWORK/FURTHER DISCUSSION**

After each student (or group) in the class has shared the results of their research, students will use various technological ideas and design their own “elevator of the future.” Students will diagram the specifications and describe the technology that they would include in their own elevator design—including the speed, user interface, interior design, and any other elements of their design. This activity will require students to design an elevator that solves a specific problem, addresses a modern societal need, or represents the students' own creative thinking.

**POST-TRIP ACTIVITY**

After the trip, students will use the information they gathered at the Empire State Building and their own independent research before and after the trip to write an essay about one aspect of elevator technology and how that technology impacted urbanization in the United States in the first part of the 20th Century. For a technology class, students are expected to write a clear explanation (with diagrams where necessary) to explain in detail one part of the functioning of the Otis elevator. The next part of the essay will link the technology they studied to its historical and societal impact. Student essays should also consider the environmental impact of elevators, including a discussion of the recent innovations at the Empire State Building that significantly reduce the carbon footprint of the building. After watching the [Inside the Empire State Building's 21st Century Upgrade](#) about the recently installed Otis elevators, students can conduct further research into similar innovations in elevator technology.

## **EVALUATION AND ASSESSMENT**

Teachers can review and assess the final essays written by each student according to the standards and grade levels appropriate for their class. Students should be able to write about technology using appropriate terminology and with connections to the material addressed in the course.

Teachers can adjust the details of the assessment as they see fit. Moreover, depending on the grade level, accommodations for students with disabilities or students learning English could be provided by sharing specific links for research or a template for the essay.





# CONNECTIONS TO THE STANDARDS

## **NEXTGEN SCIENCE STANDARDS**

### **HS-PS3-3 ENERGY**

Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

### **HS-ETS1-1 ENGINEERING DESIGN**

Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

### **HS-ETS1-2 ENGINEERING DESIGN**

Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

### **HS-ETS1-3 ENGINEERING DESIGN**

Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.



# PRE-TRIP WORKSHEET

## PREPARING FOR YOUR TRIP TO THE EMPIRE STATE BUILDING

In order to prepare for your trip to the Empire State Building, we will do research to learn about the technology of elevators. Elevators may seem like simple or “old” technology, but there are many interesting and important technological innovations—and many other new ideas that are used in modern-day elevators.

For this introductory assignment, choose one aspect of elevator technology that interests you and research how it works. Take notes and write a summary of your findings. These are some possible ideas (or ask your teacher if you have another topic you would like to research):

- Before the use of electric elevators, some buildings used steam-powered elevators, which were invented by Elisha Otis in New York City (the same company that built the elevators in the Empire State Building). Investigate how steam-powered elevators worked and how they differed from electric elevators.
- Investigate why elevators use “counterweights”. What are they? What is their purpose and how do they work?
- Modern elevators have automatic braking systems so that they will not fall to the ground even if they lose power or if the cable snapped. Investigate how they work.
- How fast do elevators go? Is there a limit to their speed or acceleration to guarantee that the ride is not harmful or uncomfortable for passengers? Investigate everything you can about the speed of elevators.
- One of the limitations on the height we can build modern buildings is due to the need for elevator space. In other words, as a building is made taller, we need more elevators (for a larger number of people entering and exiting); and therefore, as buildings get taller, a larger percentage of the square footage must be devoted to elevators, which limits the height that is practical for use. What new technologies allow taller buildings without losing too much space to elevators? How do engineers address this problem? Consider researching “multi-directional elevators.” Investigate these issues about limiting the amount of space in a high rise that is required to be used for elevators.

Watch [Inside the Empire State Building’s 21st Century Upgrade](#) by B1M to get further background information about the elevators in the Empire State Building and the recent renovation and replacement with newer (and more environmentally friendly) elevators. Students should also read the Washington Post article, “Empire State of Green.” Additional research can be conducted into other “green” innovations introduced at the Empire State Building to reduce the carbon footprint of the building and improve its sustainability. This research might inspire some students to write their final essays on issues related to sustainability.





# POST-TRIP WORKSHEET

NAME \_\_\_\_\_

DATE \_\_\_\_\_

## EMPIRE STATE BUILDING ASSIGNMENT

You have completed your visit to the Empire State Building and learned about one of the most famous examples of elevator technology in the world! To wrap up this experience, consider how an invention—even one that seems simple and commonplace like the elevator—could help revolutionize how we live.

Elevators changed history in the early 1900s. During this time, the entire world experienced a massive transformation—from working on farms to factories and from living in small towns to living in large cities. As a result, buildings began to be constructed much taller.

For this assignment, you will conduct research and write about the impact that elevator technology had on the world in the early 20th Century. Investigate the answers to some of these questions (or review them from your notes from the visit). Then write an essay about how the technology in elevators changed our society.

- When was the Empire State Building built? Who owned and built it?
- What happened in the world's economy in the 1920s? What was the nickname for the 1920s? Why?
- What are some technological advances that occurred during the Industrial Revolution, and generally from 1880 to 1920? Identify some important inventions. Which inventions allowed us to create taller buildings?
- What happened to the population in the United States as a result of the Industrial Revolution? What percentage of the country lived in rural areas and worked on farms (compare 1880 to 1930)? What percentage lived in cities and worked in factories?
- How did the change in people's jobs impact the size of American cities? Does this explain why we needed to build taller buildings?
- How tall were most buildings built around 1900 in New York City? How tall were most buildings built in 1950? What differences do you see?
- What is the environmental impact of elevators? Are tall buildings more efficient because they are easier to heat and cool than hundreds of smaller structures? Or are they less efficient because of the need for elevators and difficult construction processes? How has the Empire State Building recently made its structure more sustainable by dramatically reducing its energy use? How are the new Otis elevators contributing to that change?

