



Navy STEM for the Classroom Virtual Field Trip Educator Companion Guide

Overview

Kick off the school year by engaging your students in a Navy STEM for the Classroom Virtual Field Trip (VFT) aboard the USS Nimitz – one of the world’s largest and most elite aircraft carriers. Broadcasting live from Naval Station Mayport near Jacksonville, Florida, your students will get an insider’s look at life in the U.S. Navy, and meet the Sailors who employ STEM skills to launch and recover aircraft on the open seas. In this VFT, students will learn about the most important features of an aircraft carrier, such as the “Ouija Board,” or automated handler systems used to monitor flight deck operations, as well as research technological advancements in modern aircraft carriers. Sailors like the aircraft handler, a fighter pilot, and a team of aviation mechanics will guide students through day-to-day carrier flight operations. Students will also identify naval STEM careers that match their own skills, interests, and experiences. The companion guide contains pre-field trip activities that will introduce students to topics discussed in the VFT, in addition to post-VFT exercises designed to connect and extend student learning to classroom concepts.

Students will:

- identify and justify important features of an aircraft carrier.
- research technological advancements in modern aircraft carriers.
- identify naval STEM careers that match their skills, interests, and experiences.
- generate solutions to unexpected challenges experienced on an aircraft carrier.

Correlating Standards:

Next Generation Science Standards (NGSS)

- HS-PS3-3. Cross-cutting concept - Influence of Science, Engineering, and Technology on Society and the Natural World - Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.

Standards for Technological Literacy (STL) - ITEEA

- 5.H. Design – The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints,



exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating processed and results.

- 10.L. Design - Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving – Benchmark - Many technological problems require a multidisciplinary approach.

Common Core State Standards:

- CCSS. ELA-LITERACY. WHST.9-12.7 - Conduct short, as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Materials:

Access to the Internet

Flip chart paper

Markers

Copies of Teched-Up Aircraft Carrier Capture Sheet

Copies of Gathering the Intelligence to Succeed Student Handout

Before the Virtual Field Trip

Myth vs. Reality

Before you set sail, determine what students already know about aircraft carriers. On opposite sides of the classroom, post a “Myth” sign and a “Reality” sign. Explain to students that a series of statements will be read aloud. After each statement is read, invite students to move to the sign that corresponds with their response. Students should then form small groups to discuss and explain their responses. Invite students to share their thinking on both sides before revealing the correct answer. (*Answers are in italic. You can share the responses before or after the field trip.*)



- Myth or Reality: The flight operations team can launch and recover a jet from an aircraft carrier every 60 seconds. (*Reality: The launch and recovery of each individual aircraft typically takes less than 1 minute to accomplish.*)
- Myth or Reality: Nimitz Class aircraft carriers, using nuclear power, can operate for about two years without refueling. (*Myth: While these carriers do utilize two A4W nuclear reactors for power, they can actually operate for about 20 years without refueling and they have a projected service life of 50 years!)*)
- Myth or Reality: The average age of Sailors on an aircraft carrier is usually younger than 20 years old. (*The average crew member is just 19 years old.*)
- Myth or Reality: Jets use about 1/10 of the space they would normally need to take off from an aircraft carrier. (*Reality: Normally these planes need 3,000 ft. of runway for takeoff, but only use 300 feet of airstrip on a carrier.*)
- Myth or Reality: It's best for planes to take off from the carrier during very low wind conditions. (*Myth: During flight operations, the aircraft carrier must keep a speed of 30 knots – or 34 mph – of wind across the deck to help airplanes get the lift they need for takeoff.*)

Key Vocabulary and Discussion Questions

- **Displacement** - the amount of water that is moved by an object when it is placed in water (the Nimitz Class carriers have a 100,000t displacement)
 - **Recovery** – the return of the aircraft to the carrier (the launch and recovery cycles of an aircraft make up the carrier's flight deck operations)
 - **Propulsion** - the force that moves something forward
1. Nuclear marine propulsion -- first utilized for submarines, then aircraft carriers -- dates back to the 1950s. Nimitz Class aircraft carriers utilize two A4W nuclear reactors for power, and the new Ford Class carriers use two A1B nuclear reactors. What are some of the benefits and risks of using nuclear power for marine propulsion?
 2. To design the new Ford Class aircraft carriers, a full-scale 3D model of each part was created using a Rapid Operational Virtual Reality (ROVR) system before the actual part was manufactured. Can you think of other uses for 3-D printing/modeling in the design, construction, and maintenance of aircraft carriers?



After the Virtual Field Trip

Activity 1: Go, No Go for Takeoff

The VFT discussed the importance of the Air Boss and flight deck crew onboard the USS Nimitz. Challenge students to imagine themselves as Sailors assisting the pilot on whether their takeoff is a go or no go. To complete their mission, students will determine the airspeed by inputting the speed of the USS Nimitz, the velocity of the steam-powered catapult, and the speed of the wind moving across the flight deck into the formula below. The minimum takeoff speed is 170 mph. The maximum speed of the USS Nimitz is 30 knots, which is equivalent to 34.5 mph. Encourage your students to make their calculations, decide on “go or no go” with justification, and offer adjustments.

Discover more examples of this scenario in the [Ocean Landing Digital Lesson Educator Guide](#).

$$\text{Airspeed} = V_{\text{Nimitz}} + V_{\text{catapult}} - V_{\text{wind}}$$

(Note: Assume positive wind velocity is in the direction of the USS Nimitz’s motion)

Examples of adjustments include:

Increasing the speed of the USS Nimitz, increasing jet engine throttle to maximize forward thrust, turning the ship to the wind to maximize lift

Scenario #1: The USS Nimitz is travelling at 30 mph. The wind on the flight deck is blowing at 35 mph, in the opposite direction of the ship’s course. The catapult is set to launch the jet with a velocity of 120 mph. Given these values, determine whether the flight will be a “go” or “no go”. Explain the steps in your decision-making process. If it is a “no go”, what adjustments need to be made to ensure that the minimum airspeed is reached?

Solution:

$$\text{Airspeed} = 30 \text{ mph} + 120 \text{ mph} - (-35 \text{ mph})$$

$$150 \text{ mph} + 35 \text{ mph} = 185 \text{ mph.}$$

“Go” because 185 mph is greater than the desired minimum airspeed of 170 mph.



Activity 2: Teched-Up Aircraft Carrier

In May, 2017 the Gerald R. Ford (CVN 78) became the first new design for an aircraft carrier since USS Nimitz (CVN 68). The ship comes equipped with two newly-designed reactors and has 250 percent more electrical capacity than previous carriers. The improvements will allow the ship to load weapons and launch aircraft faster than ever before. Building such an aircraft carrier takes generations of experience, hundreds of thousands of man-hours, years of planning and steady determination. From conceptualization in 2005, to its delivery to the Navy in 2017, the USS Gerald R. Ford (CVN 78) took 12 years to become a naval aircraft carrier.

Invite students to research the following question: *What makes the newly commissioned USS Gerald R. Ford the most advanced aircraft carrier?*

Provide students with the **Teched-Up Aircraft Carrier capture sheet** and encourage them to research the ship's specific technological upgrades on the [Ford Class Aircraft Carriers: Building Giants](#) web site, and list and describe each in the space provided.

Examples of the advancements students may list include:

- New dual-band radar
- Power supply redesign
- Advanced Arresting Gear (AAG) System
- Electromagnetic Aircraft Launch System (EMALS)

Activity 3: All Aboard for STEM Jobs!

The STEM experts you met are hard at work managing the “beautifully orchestrated chaos” that is daily life aboard an aircraft carrier. Before today's VFT, you might have known something about one high-profile career: an F-18 jet pilot. However, did you realize that there are thousands of other Sailors working tirelessly to help successfully launch and recover those pilots?

Remind students that there are about 2,500 Sailors who work within the air wing (those who fly or maintain the aircraft) and another 3,000 who work for the ship's company (everyone from dentists to chefs to navigators and meteorologists).



Several jobs discussed during the VFT and others that are available on naval aircraft carriers are listed below. List each on a separate piece of chart paper and place them around the classroom. Individually, or in small groups, ask students to engage in a Gallery Walk activity to list what they remember, if anything, about these jobs:

- Aviation Mechanic
- Handler
- F-18 Pilot
- Air Boss
- Information Systems Technician
- Machinist's Mate
- Meteorologist

The Navy will continue to need STEM professionals to maintain and further advance the state of the art technology that powers these “floating cities.” Challenge students to choose one of the careers listed above to learn more. Invite students to research the following information about the career they have chosen:

- Brief overview of job description
- Required education and skills
- Potential salary
- Relative demand for this career
- High school classes that will help to prepare for this career
- Personal level of interest in this career and explanation

Instruct students to add information from their research to the sheet that corresponds to the career they chose from the class Gallery Walk and to share what they've learned with their classmates. Discuss which careers are most interesting to students and why.

Activity 4: The Intelligence to Succeed; Assess, Decide, and Respond

As students learned in the Navy STEM VFT, launching and recovering aircraft from a carrier requires thousands of people all working together in some of the most challenging situations imaginable. The unexpected and multi-faceted challenges an aircraft carrier may face include everything from high seas to combustible materials blowing up on deck. To help them complete their missions, service members rely on a steady flow of information from satellite technology, radar, navigation sensors, and GPS.



Instruct students to read the following resources: [CNN – How Do Navy Ships Operate](#) and **Gathering the Intelligence to Succeed student handout**. Then, invite students to choose a challenge described in the articles. (Other examples students could explore include: mechanical failure and natural disasters.) Once students have chosen their specific challenge, ask them to assume the role of a crew member on the ship, such as an Air Boss, helmsman, quartermaster, etc. Then, choose one piece of technology, like the GPS system, radar system, navigation sensors, radio communication, electromagnetic catapult, among others, and explain how the crew member would use the chosen technology enhance the safety operations of the aircraft carrier. Encourage students to refer back to their notes and knowledge from the VFT and other activities to help them solve the problem.



Name _____

**Teched-Up Aircraft Carrier
Capture Sheet**

Key Question:

What makes the newly commissioned USS Gerald R. Ford the most advanced aircraft carrier?

Example #1: _____

Description

Example #2: _____

Example #3: _____



Gathering the Intelligence to Succeed

<p>Aircraft carriers are always moving</p> <p>Motions of an aircraft carrier are defined by the six degrees of freedom that a ship can experience. It can move up and down (heave), move side to side (sway), or move front to back (surge). It can also rotate along each axis. An up/down rotation is called a pitch. A roll tilts the ship front to back, and yaw changes the direction the ship is pointing.</p>	<p>They are loaded with combustible substances</p> <p>Onboard is a nuclear power plant and propulsion system to move the boat and generate electricity for the entire ship. The nuclear reactors are located in a restricted area that is heavily-armored. Fuel, and metals used in munitions, like magnesium and phosphorus, are highly combustible. Takeoff and recovery operations can also be a cause of fire.</p>
<p>It's all about precision</p> <p>Launching and landing jets successfully in a limited amount of space takes a tremendous amount of resources and ingenuity. To compensate for the relatively short runways of an aircraft carrier, engineers have developed steam-powered catapult systems to launch planes at high speed. Carriers also speed into the wind, in the direction of takeoff, to get additional airflow over the flight deck. This helps lower the plane's minimum takeoff speed.</p>	<p>Staying safe on deck</p> <p>Flight-deck personnel need to stay away from jet engines to avoid the force blowing them overboard. Personnel wear float coats that are self-inflating jackets, and helmets to protect their head and hearing. If they were to come into contact with water, the jacket activates a flashing distress light. There are also safety nets around the side of the flight deck.</p>