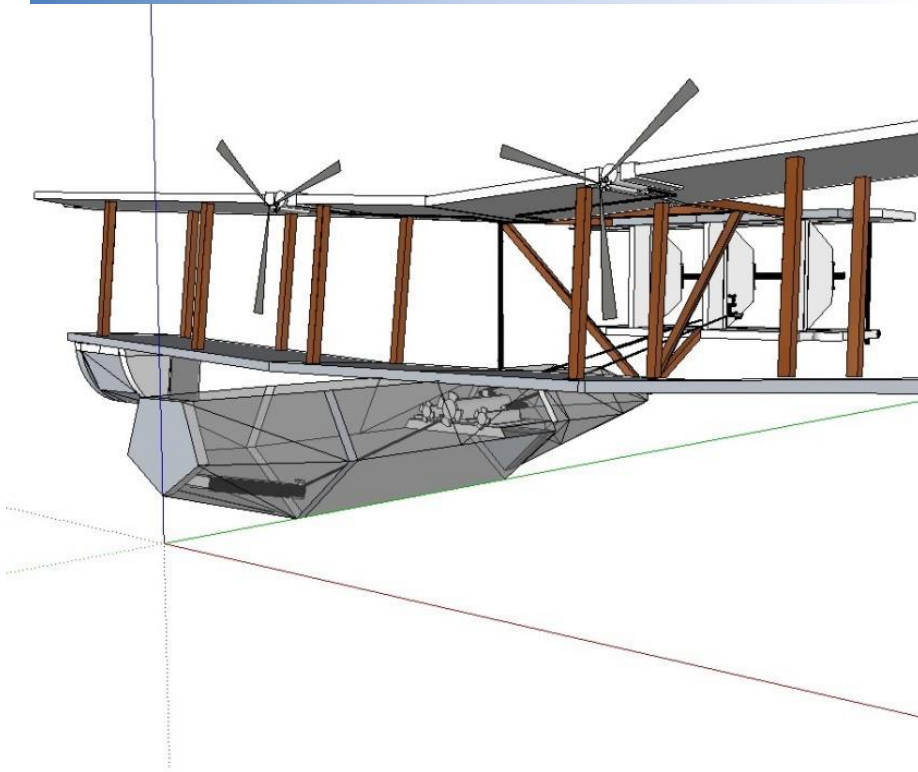


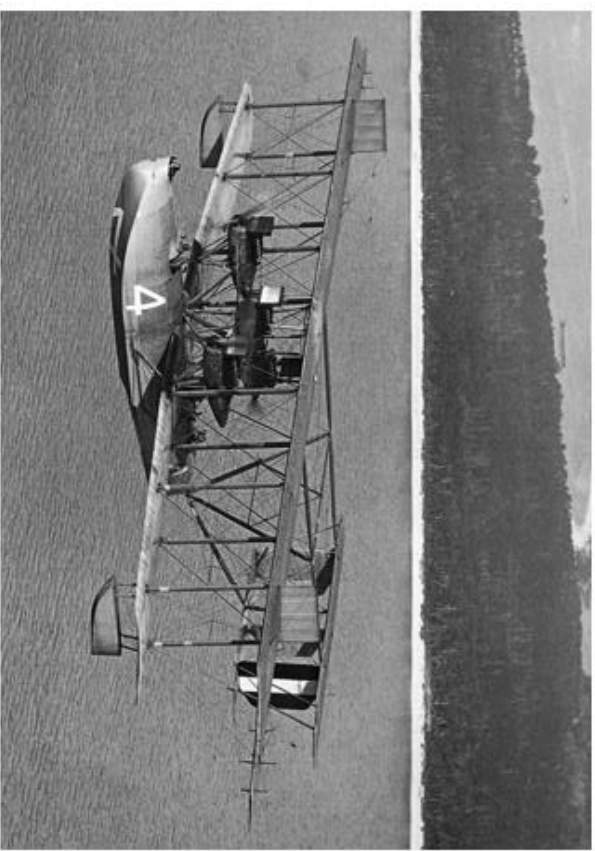
SEAPLANE CHALLENGE BUILD INSTRUCTIONS





Why the NC-4?

- It's a funny looking plane, different than anything most students have seen
- The story of the development of the plane and flight has many facets that can be explored
- Important but not well known aeronautic achievement by the US Navy



WHY THE NC-4?

BACKGROUND FOR EDUCATORS

The **Seaplane Challenge** is a STEM outreach program for students that was created at Naval Surface Warfare Center-Carderock Division. This program is designed to teach and excite students about aviation, aerodynamics, hydrodynamics, engineering, history, and design. The program draws inspiration from the Navy's NC flying boats, one of which was the first aircraft to cross the Atlantic Ocean. It is an exciting study in both exploration and engineering, and provides a great story from which to build. Additional content and material has been added to this guide in order to create a truly interdisciplinary learning experience for students across multiple disciplines.

Next Generation Science Standards: Grades 3-5

Engineering Design

- **3-5-ETS1-1** Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- **3-5-ETS1-2** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- **3-5-ETS1-3** Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Common Core State Standards

ELA/Literacy

- **RI.5.1** Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. (3-5-ETS1-2)
- **RI.5.1** Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (3-5-ETS1-2)
- **RI.5.9** Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (3-5-ETS1-2)
- **W.5.7** Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (3-5-ETS1-1),(3-5-ETS1-3)
- **W.5.8** Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. (3-5-ETS1-1),(3-5-ETS1-3)
- **W.5.9** Draw evidence from literary or informational texts to support analysis, reflection, and research. (3-5-ETS1-1),(3-5-ETS1-3)

Mathematics

- **MP.2** Reason abstractly and quantitatively. (3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)
- **MP.4** Model with mathematics. (3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)
- **MP.5** Use appropriate tools strategically. (3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)

Next Generation Science Standards: Grades 6-8

Engineering Design

- **MS-ETS1-1.** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account 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.

Common Core State Standards Connections:

ELA/Literacy

- **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts. (MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3)
- **RST.6-8.7** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ETS1-3)
- **RST.6-8.9** Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-ETS1-2),(MS-ETS1-3)
- **WHST.6-8.7** Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-ETS1-2)
- **WHST.6-8.8** Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.(MS-ETS1-1)
- **WHST.6-8.9** Draw evidence from informational texts to support analysis, reflection, and research. (MS-ETS1-2)

Mathematics -

- **MP.2** Reason abstractly and quantitatively. (MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3)(MS-ETS1-4)
- **7.EE.3** Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using

EDUCATIONAL LINKS

History of the Navy-Curtiss NC-4 Flying Boat

<http://www.aviation-history.com/navy/nc4.html>

<https://www.navalaviationmuseum.org/aircraft/nc-4/>

<https://www.historynet.com/aviation-history-three-us-flying-boats-were-the-first-to-fly-across-the-atlantic-in-1919.htm>

<https://airandspace.si.edu/collection-objects/curtiss-nc-4>

INTERDISCIPLINARY CONTENT

ELA or Social Studies

Students can research Primary Sources through the Library of Congress. Using the Primary Source Reflection Tool (included) or <http://www.loc.gov/teachers/primary-source-analysis-tool/>, students can make observations, reflections and create additional questions or points of research as they analyze historic documents, articles and pictures relevant to the NC-4. Students can further research aviation history, or how the development of the NC Curtiss changed the shape of World War I

<https://www.loc.gov/search/?in=&q=Navy+Curtiss+NC-4&new=true&st=>

Science, STEM or Engineering Classes

<https://www.faa.gov/education/educators/curriculum/k12/>

<https://www.nasa.gov/sites/default/files/files/Living-in-the-age-of-airplanes-resource-guide.pdf>

https://www.faa.gov/education/educators/curriculum/k12/media/K-12_One_Hundred_Years_of_Sustained_Flight.pdf
<https://www.aiaa.org/get-involved/students-educators/k-12-teacher-resources>

Engineering Class-

Build a model from balsa wood and blocks

https://outerzone.co.uk/plan_details.asp?ID=8099

TIPS FOR TEACHERS

- Unit measurements – There are different units used throughout the build to encourage students to practice conversions and think critically.
- 3D printed parts are different shapes for different wings.
- Pay attention to the LEADING EDGE. Both leading edges should be facing to the front during assembly.
- The heavier the paper, the better it looks, but the worse it will fly. Midweight cardstock seems to work best but you could even use that as a challenge and have students calculate which paper which best. Additionally, you can combine mediums to get a better plane – lighter weight cardstock for wings and heavier cardstock for hull.
- Part of the idea of the SeaPlane build is to have students “figure things out” or discover the best approach by using trial and error with the Engineering Design Process. Some of the directions are intentionally left vague so that students will work together to solve the problem.
- *In lieu of 3D printed parts use 24 - ¼ inch diameter x ½ inch length brad fasteners or standard sized paper clips and tape. Glue or hot glue also works well.*
- YouTube video showing how to build SeaPlane: <https://youtu.be/4NioQwn6cF4>

PREPARATION

Teachers should prepare all materials ahead of time. This activity and build will take several hours, so it should be completed over several class periods. Students can work in pairs or groups of threes to cut out and assemble the different parts of the plane.

Materials

- Templates (6 pages) – printed on medium weight cardstock
- 3D printed parts, regular size paper clips, or ¼ inch diameter x ½ inch length brad fasteners
- 13-15 Clear, regular drinking straws
- Pencil
- Scissors
- Ruler
- Hole punch
- Tape (clear, preferred)
- (Optional) Hot glue gun or white glue for use with brads or paper clips

Key

- Solid Line: Cut here
- Dotted Line: Fold here
- (2x): two time

VOCABULARY: Can assign as part of the lesson or use when reviewing directions.
Can also be used to label the NC-4

Aft – Back part of a hull

Boom – A stiff rod or bar that acts like both a spar and a strut.

Bow – Front part of a hull

Dihedral – The angle between the left wing and the right wing. Dihedral can help to make an airplane stable. On this model, the lower wing has dihedral.

Elevators - The hinged part of the horizontal stabilizer; it is used to deflect the tail up and down.

Hull – Part of a boat that sits in the water. On this seaplane, it is the “body” of the airplane. On other kinds of airplanes, the body is called a *fuselage*.

Leading Edge – Front edge of a wing

Rudder - The hinged part of the vertical stabilizer; it is used to deflect the tail to the left and right as viewed from the front of the hull.

Spar – A stiff rod or bar that keeps parts from bending. This models uses drinking straws to make spars.

Strut – A stiff rod or bar that holds other parts together. This model uses drinking straws to make struts.

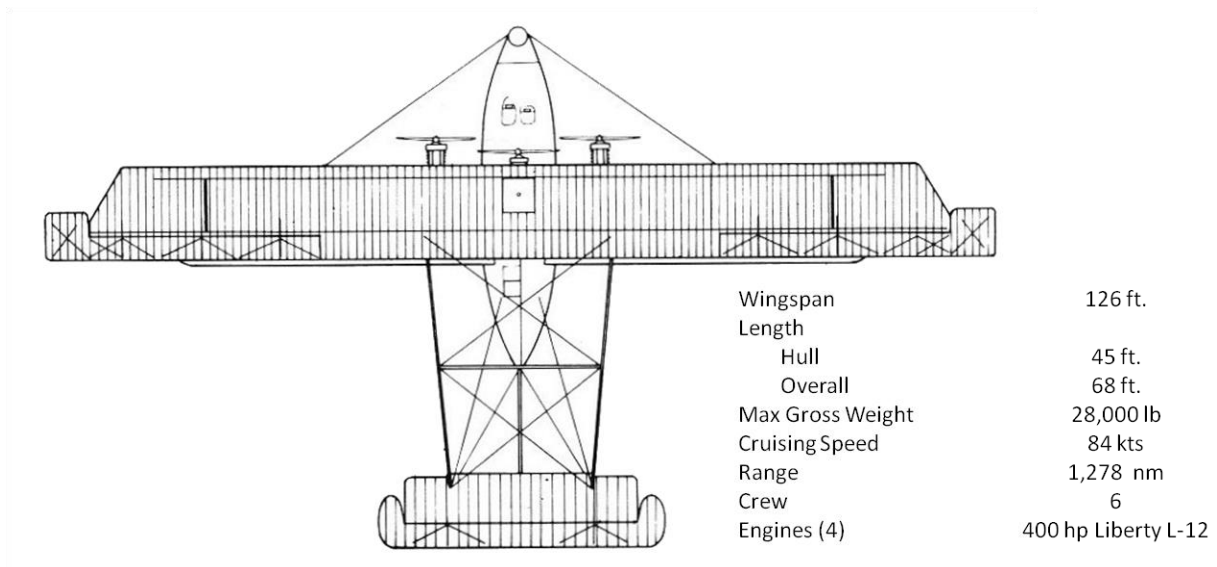
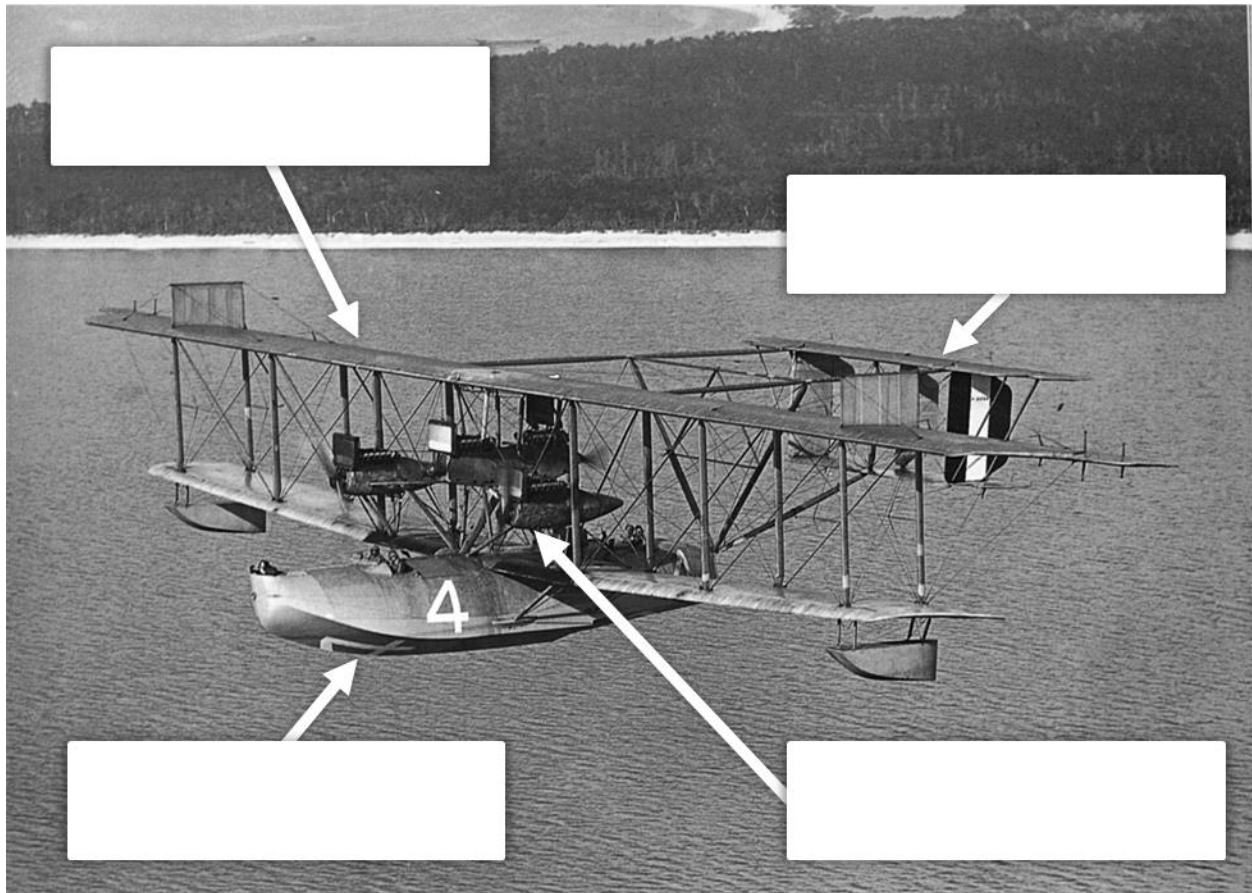
Rivet – A kind of fastener, like a screw or a nail.

Trailing Edge – Back edge of a wing

Truss – A bunch of struts connected together.

THE NAVY-CURTISS NC-4 FLYING BOAT

Name the Parts of the Real NC-4!





Story of Adventure, Achievement, and Failure

NC-4 arrives in Portugal to a hero's welcome



NC-3 survived high winds and large waves, "sailing" to port safely, if not bruised and battered



NC-1 was lost at sea after sustaining damage landing



- The crews of the transatlantic mission were explorers in the same vein as the Apollo 11 astronauts
- They accomplished what many believed to be impossible
- 2 of the 3 aircraft on the transatlantic mission failed to complete the journey, but succeeded in other ways (no crew member was lost on the mission)

NC-4 HISTORY



Great Innovators



Glenn Curtiss



CDR G. C. Wetters



CDR H. C. Richardson



LT J. C. Hunsaker



RADM David W. Taylor (center)



Curtiss America
1914



B&W Seaplane
1914



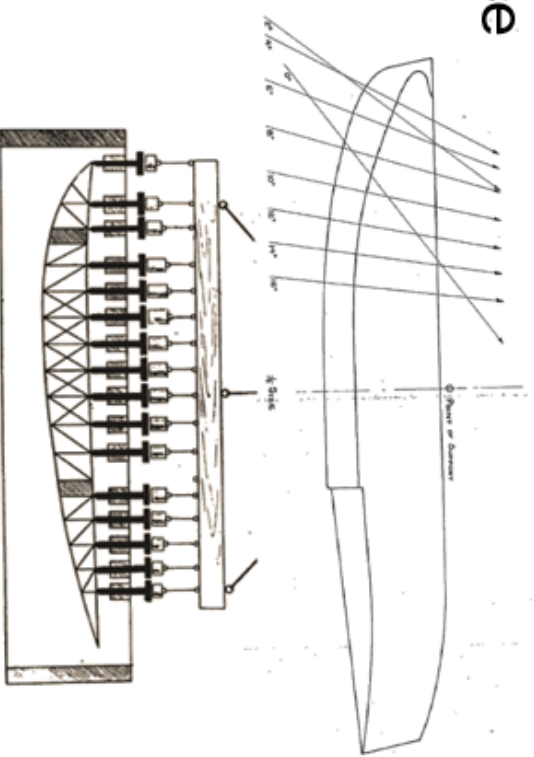
82-A
1916

Leaders in aeronautics for the
Navy and industry



Focus on the Engineering Process

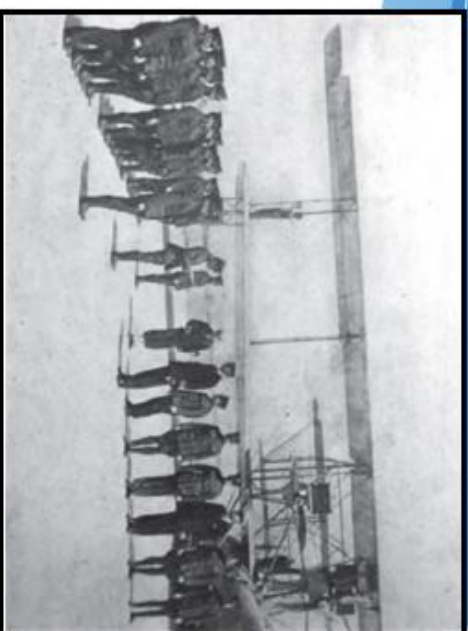
- The NC flying boats were designed and built using modern engineering practice
 - Model testing and experimentation
 - Component engineering
 - Advanced materials
 - Design for manufacture
- Advanced technology used where needed
- Proven concepts used where possible





Connection to the Navy

- World's first transatlantic flight was a US Navy mission
- Compared to Columbus' voyage to America
- Well planned and executed – not a daredevil stunt
- Original NC-4 on display at the National Museum of Naval Aviation at NAS Pensacola, Florida





Connection to Today and the Future



“... anyone in the present age of new and startling inventions who says positively that we will never attain an altitude of 60,000 feet, will never fly at 500 miles an hour, or will never be able to cross to Europe in the forenoon and return in the afternoon is a most courageous person”

*Albert Read, 1919
Commanding Officer, NC-4*