Core Knowledge Science Program—Domain Map

Science Content	

• A biography of Wilbur and Orville Wright (engineers who solved the problem of powered flight)
• Engineers use the design process to solve problems:
  ○ Defining the problem
  ○ Possible Solutions
  ○ Plans & Models
 	
Foreshadowed for future learning:
  ○ *Engineering investigations and testing*
  ○ *Comparing multiple solutions*
  ○ *Revisions and optimizing the design solution*	

This unit contributes to meeting or exceeding the following Next Generation Science Standards: *Standards noted with an asterisk (*) are those that incorporate engineering and design*	
K-2-ETS1-1. *Ask questions, make observations, and gather information about a situation people want to change to define a simple **problem that can be solved through the development of a new or improved object or tool.****	***Rationale:*** This unit will introduce the core idea central to this standard, ETS1.A (Defining Engineering Problems), through the study of two brothers and their creation of the Wright Flyer, the first airplane to sustain powered flight.
This unit offers the opportunity to foreshadow learning that will support the following Next Generation Science Standards:	
K-2-ETS1-2. *Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.**	***Rationale:*** The core idea, ETS1.B (Designing Possible Solutions), was introduced during earlier units in Kindergarten (e.g., Unit 6 *Pushes & Pulls*) and will be applied again during design challenges in later grades, such as in Grade 1 Unit 6 *Introduction to Electricity* and Grade 2 Unit 5 *Simple Machines*.
K-2-ETS1-3. *Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.**	ETS1.C (Optimizing the Design Solution) will be introduced and explicitly modeled during Grade 1 units so that students can begin to independently apply this idea during Grade 2 learning.Teachers may foreshadow this idea if/when they summarize different solutions to a single design problem.

Potential Skills & Cross-Curricular Integrations

The connections listed below are intended as ideas for possible integration across this unit. Finding connections in math, in language arts, and in works of poetry, art, and music, may help you as you create meaningful learning experiences for your students. Connections such as these can help your students make links between various disciplines and deepen their understanding of this domain.

POTENTIAL CCSS Math Connections *(all apply to NGSS K-2-ETS1-1)*

MP.2 Reason abstractly and quantitatively.

MP.4 Model with mathematics.

MP.5 Use appropriate tools strategically.

K.MD.A Describe and compare measurable attributes.

K.MD.B Classify objects and count the number of objects in each category.

POTENTIAL CCSS ELA Connections *(all apply to NGSS K-2-ETS1-1)*

RI.K.1 With prompting and support, ask and answer questions about key details in a text.

W.K.6 With guidance and support from adults, explore a variety of digital tools to produce and publish writing, including in collaboration with peers.

W.K.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.

Prior Knowledge

Core Knowledge Preschool Sequence
Scientific Reasoning and the Physical World

Goals: *Select and use tools; and Demonstrate use of the scientific reasoning cycle.*

Level II

- Select and use an appropriate tool to complete a task (e.g., to join paper, dig a hole, water a plant, etc.).
- Demonstrate use of the scientific reasoning cycle.

Core Knowledge Science (Previously taught Kindergarten units)
Unit 3 *Plants & Farms*

- Describe how George Washington Carver used plants to meet people's needs.

Unit 4 *Seasons & Weather*

- Describe why weather forecasts are important when the weather is expected to be severe.
- Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.

Unit 6 *Pushes, Pulls, and an Introduction to Magnets*

- Identify whether the force between two objects is a push or a pull.
- Describe the direction of a push or pull (using terms such as “left,” “right,” “up,” and “down”).
- Describe different ways magnets are used in everyday life (for example, in toys, in cabinet locks, in “refrigerator magnets,” etc.).

What Students Will Learn in Future Grades

Core Knowledge Sequence

Grade 2 Simple Machines

- Types of simple machines (e.g., wheel-and-axle, gears: wheels with teeth and notches, how gears work, and familiar uses such as bicycles)
- Friction, and ways to reduce friction (lubricants, rollers, etc.)

Biographies of Other Engineers

- Grade 1—Thomas Edison (invented an electric light bulb)
- Grade 2—Anton van Leeuwenhoek (invented a microscope) and Elijah McCoy (invented an automatic lubricator)
- Grade 3—Alexander Graham Bell (invented a telephone)
- Grade 4—Michael Faraday (chemist and physicist whose work led to the development of the electric motor and electric generator)
- Grade 6—Lewis Howard Latimer ((worked with Alexander Graham Bell on drawings of Bell’s invention, the telephone; and improved Thomas Edison’s light bulb)
- Grade 8—Charles Steinmetz (scientist who made key advances in electric power)

Engineering Design

- Students will also learn more about and apply additional steps of the engineering design process in future grades, such as:
    - Engineering investigations/testing
    - Comparing multiple solutions
    - Revisions to and optimizing the design solution

Core Vocabulary

The following list contains the Core Vocabulary words suggested for purposeful integration across this Kindergarten unit. ***Boldfaced*** *terms can be introduced and/or reviewed with students using a Word Work activity, as modeled by the [Core Knowledge Language Arts program](#) (CKLA). The inclusion of the words on this list does not mean that students are immediately expected to be able to use all of these words on their own. However, through repeated exposure across the lessons, students should acquire a good understanding of most of these words and begin to use some in conversation.*

The Wright Brothers

bicycle, bike, shop, store, rent, sell, glide, wind, tunnel, kite, **glider**, idea, power, **engine**, motion, fly, **flight**, **design**, study, create, develop, build, machine, tool, invention, **mechanical**, manufacture, improve, fix, important, newspaper, example

Engineering and Design

engineer, **problem**, question, ask, define, science, apply, knowledge, **research**, study, **investigate**, experiment, solve, solution, tinker, try, design, improve, optimize, **model**, draw, sketch, **communicate**, demonstrate, criteria, goal, target, success

Airplanes

plane, **airplane**, jet, **lift**, **force**, push, pull, travel, structure, **function**, front, back, sides, wing, tail, **rudder**, **propeller**, blade, flap, cockpit, pilot, buckle, window, **control**, steer, wheel, landing, skid, drag, stop

Potential Misconceptions

Students have been shown to learn significantly more science when their teachers demonstrate strong knowledge of potential student errors, and when the teacher plans accordingly (Sadler & Sonnert, 2016). The following incorrect statements serve as a sampling of the "intuitive theories" or "alternative conceptions" that students and teachers may actively use to describe their thinking, and which might interfere with the process of learning. The details following each statement are not intended to imply the scope of instruction for this grade, but instead provide a clearer sense of what students (of all ages) often misunderstand and/or overgeneralize when investigating and describing scientific ideas.

Misconception: "Air is weightless."	**Key points for instruction:**
Understanding that air is a material that surrounds us and takes up space is a target for upper elementary students (AAAS, Vol.2, 2007). However, even high school students have been shown to have difficulty recognizing that air has weight and mass (Sere, 1985; Krnel, Watson, & Glazar, 1998). Students of all ages may describe that air only exerts force or pressure when it is moving and only in a downward direction (Driver et. al., 1994; Henricks, 2002).	Lift, the force that allows an aircraft to fly, is more complex than most people realize. Many diagrams—even in encyclopedias, textbooks, and websites—are overgeneralized and misleading because they focus on only one of the many factors that produce the force of lift (NASA, 2015). Teachers should be sure to plan their instructional language carefully, with a clear understanding of the grade-level objectives for their students. For example, this Kindergarten unit intentionally focuses on the basic parts of an airplane and the history of the Wright brothers, and does not attempt to answer the question, "What makes an airplane fly?"

Potential Objectives for this Kindergarten Unit

The organization of the following objectives reflects the order in which they are expected to be addressed.The proposed timing within the unit ("beginning" or "end") and aligned NGSS are also noted. In addition to daily lessons focused on each objective, days have been built into the unit for review and assessment.

Beginning

- Identify the problem that the Wright brothers wanted to solve
- Identify the basic parts of an airplane
- Describe the purpose of an airplane's tail and rudder
- Describe the purpose of an airplane's propeller
- Compare and contrast the actions of gliding and flying
- Draw a model of a new airplane using what you know about parts of an airplane (foreshadowing (K-2-ETS1-2)
- Describe why engineers use models and drawings

End

- Describe how scientists ask questions and solve problems (K-2-ETS1-1)
- Identify problems that can be solved by engineers (K-2-ETS1-1)
- Describe a new problem that could be solved by engineers (K-2-ETS1-1)
- Identify possible solutions to a selected problem
- Develop a model that illustrates a solution to a selected problem (K-2-ETS1-2)
- Using a model, describe a solution to a selected problem

Potential Big Guiding Questions

Essential Questions:

- **How do the inventions of the Wright brothers affect our lives today?**
- **How do engineers solve problems?**
- **How do engineers know when they have solved a problem?**

Other possible questions:

- What is the difference between gliding and flying?
- Why did the Wright Flyer need a propellor?
- What is the purpose of the rudder on an airplane?
- Why do engineers use drawings and models?
- What other problems could be solved through engineering?

Potential Assessment Opportunities

The following assessment tasks serve as a sampling of how students can demonstrate mastery of lesson objectives. Each aligned objective and NGSS are noted in parentheses. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate approximately when the assessment should take place.

Example #1: (Beginning of Unit 7)

{Evaluates Student Mastery of Objective: *Draw a model of a new airplane using what you know about parts of an airplane.***}**

Invite your students to design and draw a new airplane using what they have learned about the parts of all planes. To provide up-front support, consider asking students to name the parts of an airplane that help it to fly (e.g., wings, engine, propeller, rudder, steering wheel/stick, etc.). Ask your students to draw a model of a new airplane, using their knowledge *and* imagination. Circulate throughout the room in order to annotate their drawn models with keywords or phrases as they identify the critical parts. To challenge students, consider asking them to recall what specific parts the Wright brothers improved/created to enable flight (i.e., engine, propeller, and rudder). For added support/scaffolding, consider reading or rereading key sections of the biography of the Wright Brothers found in *What Your Kindergartener Needs to Know* (page 379) or using one of the supplemental trade books found on page 9 of this unit map. Ask students to describe how their new planes will be "powered" and which characteristics of their planes will help to control the plane during flight, continuing to annotate their drawings as they respond. Student-drawn pictures of their designs will provide an experience to which students can connect as they discuss the importance of models and designs during the engineering process *(foreshadowing K-2-ETS1-2)*.

Culminating Performance Assessment: Engineering Design Challenge (End of Unit 7)

{Evaluates Student Mastery of Objectives:

- Describe a new problem that could be solved by engineers. (K-2-ETS1-1)
- Identify possible solutions to a selected problem.
- Develop a model that illustrates a solution to a selected problem. (K-2-ETS1-2)
- Using a model, describe a solution to a selected problem.}

Task Assessment: Challenge your students to be engineers in this culminating performance task. This task assessment will be completed over the course of four days. On Day 1, students are presented with a series of problems (e.g., "How can we make sure our classroom plants receive enough water and sunlight while indoors?" "How can we reduce the amount of trash we create?", etc.) that directly relate to content presented in previous units. Students select the problem they wish to solve, and on Day 2, identify possible solutions. On Day 3, students develop models that illustrate how the problem can be solved, and on Day 4, students describe their models to the class.

Potential Activities & Procedures

The following activities or procedures serve as a sampling of what instruction could look like in this unit. Each example was specifically designed to contribute to one or more of the aforementioned objectives. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate approximately when the activity should be conducted during this unit. Aligned NGSS are noted in parentheses.

Example #1: (Beginning of Unit 7)

{**Contributes to the Objective:** *Identify the problem that the Wright brothers wanted to solve.*}

As an introduction to the accomplishments of the Wright Brothers, discuss what your students already know about airplanes and flight. Invite them to think about how people traveled before airplanes were invented. Explain that it could take weeks by train or ship to travel the distances that people today can travel in just a few hours. Encourage your students to imagine what a long trip across the ocean or across the entire United States might have been like.

Example #2: (End of Unit 7)

{**Contributes to the Objective:** *Describe how scientists ask questions and solve problems.***}**

Advance Preparation: This activity makes use of Core Knowledge Instructional Master #34, which is available as part of the Kindergarten Teacher Handbook; prepare one copy for each student. The instructional master is used in conjunction with a world map/globe and an extended discussion of the questions/problems that Jane Goodall, George W. Carver, and the Wright brothers answered and/or attempted to solve. Using six large sentence strips or your board/projector, write the following information in two columns for whole-group use later in the lesson:

1) Jane Goodall	a) "Can we build a tool that helps us to fly?"
2) George Washington Carver	b) "How do chimps behave in the wild?"
3) Wilbur and Orville Wright	c) "How many uses are there for peanuts?"

Using a world map or globe, help students make connections among all the individuals studied across the year and where she or he worked (i.e., Jane Goodall in Kenya, George Washington Carver in the southeast United States, and the Wright brothers in Kitty Hawk, North Carolina). With guidance and support, ask your students to recall what each of these individuals did to contribute to science or engineering, noting student ideas on the board or chart paper. As you review each scientist/inventor, note where she or he worked, using sticky notes or pushpins on the map or globe. Ask your students to think about what makes each place important; for example, Carver lived in the southeastern United States, studying agricultural problems in that region; Goodall studied chimpanzees found in Kenya; and the Wright brothers used the windy dunes of Kitty Hawk to test their airplane.

Then, using Instructional Master #34, ask your students to use what they know about these individuals to independently match their images with representations of their contributions. *(You may find it useful to reread short passages from each of the biographies used in Units 2, 3, and 7 in order to transition to and support this task, recalling details such as: the Wright brothers owned a bike shop; and Jane Goodall had a beloved stuffed animal chimp as a child.)* Rotate around the room, probing students' thinking about who each image represents and how they know this. As students finish, ask them to pair with a partner to discuss, "Which of these individuals was an engineer?"

As you rotate around the classroom, or as a final question for the whole group, consider challenging your students with the following question: "Why do scientists ask questions or create tools to solve problems?" As students answer, probe for additional examples of questions and problems that can be addressed through science and engineering.

Websites & Media

Smithsonian National Air & Space Museum—The Wright Flyer:
http://airandspace.si.edu/collections/artifact.cfm?object=nasm_A19610048000

The National Air & Space Museum offers pictures and in-depth descriptions of the world's first airplane. Visit this online exhibit, and learn more about the steering mechanism that Wilbur and Orville designed and about how they established the basic tenets of modern aeronautical engineering.

Library of Congress—Photographs of the Wright Brothers:
https://www.loc.gov/photos/?q=wright+brothers

Browse through more than three hundred negatives of Wilbur and Orville Wright, and of their collaborators, in these archival collections of images.

How Stuff Works:

- **Airplanes—**http://science.howstuffworks.com/transport/flight/modern/airplanes.htm
- **Classic Airplanes—**
http://science.howstuffworks.com/transport/flight/classic/classic-airplanes.htm

Build your background knowledge of modern and classic airplanes as you read websites such as those above. These pages also offer a concise description of how airplanes developed across the twentieth century.

PBS Kids—Sid the Science Kid's "Let's Fly": http://pbskids.org/sid/letsfly.html

Consider using this game as your students review the basic parts of an airplane, including wings, tail/rudder, and propellers.

Supplemental Trade Books

- *50 American Heroes Every Kid Should Meet*, by Dennis Denenberg and Lorraine Roscoe (The Millbrook Press, 2002) ISBN 0761316450 [Contains profiles of Wilbur and Orville Wright, as well as of George Washington Carver]
- *First Flight: The Story of Tom Tate and the Wright Brothers*, by George Shea and Don Bolognese (Scott Foresman, 2003) ISBN 0064442152 [Fictional account of a boy who helped the Wright brothers build their first glider.]
- *The Wright Brothers* (Famous People in Transportation), by Lola Schaefer (Pebble Books, 2000) ISBN 0736805494
- *Airborne: A Photobiography of Wilbur and Orville Wright*, by Mary Collins (National Geographic, 2003) ISBN 0792269578
- *The Wright Brothers: How They Invented the Airplane*, by Russell Freedman (Holiday House, 1994) ISBN 082341082X