Lesson Title:	"Race Day!" STEM and the Iditarod Air Force
Background Information	
Created By:	Kate Newmyer, Seabrook, TX, 2024 Teacher on the Trail™
Grade Level/ Subject:	K-12 STEM
Background Information:	The Iditarod Air Force is a vital component of making the Iditarod work year after year. The IAF is a group of private and commercial pilots who volunteer their time and their aircraft to fly up and down the trail. They carry race officials, drop bags for mushers, returned dogs, volunteers, veterinarians, and other cargo. Many of the pilots have been, or still are, commercial pilots, and they volunteer their aircraft, expertise, and love of flying to the Iditarod. The first part of this lesson will engage students in the design-engineering process. This will allow students to understand how to design, build, test, collect data, and redesign their airplane for their intended use. For more on this subset of the Scientific Method, visit the __ web site. Students will use the inspiration of Iditarod Air Force aircraft to design and build their paper airplane. In groups of four, students will form a group that consists of an engineer, manufacturer, test pilot, and communications officer. You can impose more or fewer parameters on the groups as best fits your class; for example, you can give students a budget, a deadline, or materials specifications. Aircraft must be able to get from checkpoint to checkpoint and carry various types of cargo such as drop bags, people, luggage, and dogs. The second part of this lesson will give students a glimpse into the logistics of getting supplies to different places. For more information about the Iditarod Air Force: Iditarod Air Force – Iditarod Zuma, Canine Journalist, for kids Iditarod Air Force – The Trail Above the Trail – Iditarod Iditarod.com article Iditarod from the Air… Up There. Wonder what the connection is between… | by Federal Aviation Administration | Cleared for Takeoff | Medium Medium.com news article Podcast Sn 4 Ep 1: Iditarod from the Air (youtube.com) (audio only)
Learning Objectives/ Essential Questions:	Content Learning Objectives • Students can apply the design-engineering process to design, build, test, and redesign an object for an intended purpose. • Students can manage a budget and time. (optional) Language Objectives • Students use listening, speaking, and reading to develop their ideas and to communicate with each other and with the teacher. SEL Objectives • Students collaborate to design, build, test, and redesign an aircraft that best

	suits the needs of the project. • Students share ideas, use good communication skills, and solve disagreements using core values.
Standards Addressed	Texas Essential Knowledge and Skills (TEKS) for Career and Technical Education (3) The student participates in team projects in various roles. (4) The student develops skills for managing a project. (7) The student uses engineering design methodologies. (8) The student applies concepts of engineering to specific problems. (9) The student designs products using appropriate design processes and techniques. (10) The student builds a prototype using the appropriate tools, materials, and techniques.
Materials Needed:	1. Plain printer paper 2. Data recording sheets—included 3. Logistics scenarios—included 4. Builder's measuring tape for measuring testing area 5. Painter's tape for marking distance 6. Coins or other items to use as "cargo" such as game pieces, paperclips, small pieces of hardware such as washers or nuts 7. Scotch tape 8. Student notebooks, pencils 9. Timer/stopwatch 10. Alaska Aviation Museum web site: Alaska Aviation Museum (alaskaairmuseum.org) 11. Fold'n'Fly or other paper airplane site for inspiration. https://www.foldnfly.com/#/1-1-1-1-1-1-1-1-2 12. History and articles about the Iditarod Air Force: The History of the Early Iditarod Air Force – Iditarod Iditarod Air Force: lifeblood of the race – Iditarod 13. Cessna article: Flying the Iditarod | Cessna Owner Organization 14. Race map, included. 15. "Pilot Licenses"—included. Print the number of sheets needed for your class on cardstock and then have students select at random. Students can then create a six-digit tail number consisting of numbers and letters.
Procedure	
Engagement:	Ask students if they've ever built a paper airplane. Discuss the types of planes and the merits and success of these aircraft. Ask students what they think learning about aircraft and aviation has to do with the Iditarod—make a list of possible responses. Share information about the Iditarod Air Force with your students. Depending on the grade level, you can show images, tell stories, have students read the articles at the included links, or listen to all or part of "The Air Up There" podcast episode. You can assign all or parts of the articles linked above as a pre-reading activity to build background knowledge.

Lesson Procedure:	Part 1—Engineering-Design Process Divide your students into teams of four. Depending on the needs of your class, you can assign the roles or let students decide. Give students the sheet of instructions that explains the roles—see resources at end of lesson. Engineer: researches and determines the best design for the aircraft, then communicates with the Manufacturer on how to build it. The engineer may not touch the materials used to build the aircraft. Helps collect data during testing. Manufacturer: Follows the directions of the Engineer to build the aircraft. Can give feedback on how materials perform during manufacturing but may not implement design ideas of their own. Helps collect data. Test Pilot: Test flies the completed aircraft, helps collect data, and gives feedback to the Engineer and Manufacturer. May not touch the aircraft during the manufacturing process. Communications Officer: This person functions as a CEO, helping the Engineer, Manufacturer, and Test Pilot communicate, and also relays questions and problems to the teacher. Communications officers also help manage budget and time if applicable. Step 1 Explain to students that their groups of four will be designing, building, and testing an Iditarod Airforce craft. All students will visit the Alaska Aviation Museum web site to look at images and specs of the different types of Iditarod aircraft, including Cessna 170, 180, 185, 206, and 207s along with Piper Super Cubs, Pacers, Cherokee Six, Maule, Stinson 108s, and an Aeronica Sedan on skis and wheels. Give students an appropriate amount of time for this depending on grade level and the needs of your class. Step 2 Have students work in their teams to design and build the aircraft, using the roles they have been given. During this step, only the communications officer may talk to the teacher. You, as the teacher, can decide on the parameters of the project. You can give students a budget for paper, you can give them two sheets of paper to start, or any other time or materials constraints you wish. During the design and build phase of the lesson, students should be discussing in their teams all aspects of their aircraft's design and purpose, but only the Designer gets to make final decisions about the design, and only the Manufacturer can touch the materials. Step 3 Set up a flight testing area. You will need to measure out distances, such as yards or meters, in a hallway near your classroom. You might consider putting up signs warning visitors that there will be flight testing happening in this area at a certain time. During the test phase of the process, you can have one team at a time, as they are ready, enter the flight test facility. Each throw of the airplane will be considered one tank of fuel. In the first phase of testing, the aircraft needs to go a certain distance and be stable when "empty." In the second phase, students will add various types of "cargo" to their airplane to continue the test.

	Note: Depending on the grade level of your class, you might want to gather the Designers and Test Pilots or all the team members together to determine the criteria for testing. How many tests will you do? What criteria will you look for? For younger grades, start with distance and stability. You might also want to build in test flights for the Test Pilot to learn how to fly the plane before the plane itself is tested. Depending on the number of teams you have, you will want to schedule test flights, or build time for them in between other content or learning you are doing. For test flight data collection, Stability means the plane flies the intended distance upright before coming to the ground. Step 4 Once the test flight data is collected, teams can return to any point in the design-build process, perfecting their plane and making sure it is tested again. When the final tests are finished, your aircraft is ready to fly for the Iditarod Air Force! Note: As an extra step for higher grades, students can work together to create instructions for building their team's aircraft. Students can write down the steps for a writing exercise, create a video, or any other product that fits their needs and the time that you have for this activity. Part 2—Flying Iditarod Missions The Iditarod Air Force flies a hub and spoke pattern—see map. Supplies and drop bags are flown to the hubs by cargo aircraft, then delivered to individual checkpoints by IAF pilots. All drop bags, Heet, and straw are flown out prior to the start of the race. All students are pilots. Four of the pilots have a license for large cargo aircraft that can fly larger aircraft from Anchorage to any of the other hubs. The rest are rated for single-engine, Visual Flight Rating (VFR) conditions only. (Note: The IAF small aircraft only fly with good visibility, not in low visibility conditions.) Step 1—Pre-Race Missions Cargo pilot team: Determine the total weight of drop bags, straw, and Heet. Then divide according to the checkpoints (count the hub too) for that hub. Cargo pilots must divide the load into weights that will fit in their aircraft and be going to the correct hub. The hubs are Anchorage (also where the staging location for drop bags is), McGrath, Unalakleet, and Nome. Each drop bag is 50 pounds. Each musher is allowed 3 drop bags per checkpoint, excluding Yentna and Finger Lake. The Safety checkpoint is optional. The total weight of drop bags is the number of mushers in this year's race x 1,800 lbs. Each musher gets a fresh bale of straw at every checkpoint to use as dog bedding. The straw bales weigh 50 lbs. The IAF flies 400 cases of Heet, or cooking fuel for hot water for the dogs, out to the checkpoints. Each case of Heet weights 18 lbs. Divide the Heet between all the checkpoints as equally as you can.

	Samples: Drop bags: 38 mushers x 1,800 lbs = 68,400 lbs of drop bags. Straw: 38 mushers x 20 bales of hay = 760 bales, x 50 lbs = 38,000 lbs. Heet: 400 cases x 18 lbs = 7,200 lbs Once the Anchorage spokes are complete and the drop bags, straw bales, and Heet are in place, the IAF will move to McGrath and fly those missions, then to Unalakleet, and then to Nome. Students can work out the weights and logistics on paper, cut paper into pieces representing the loads, or use tokens or coins to represent each load. Do what works for your students! Step 2 – During the Race Students work in teams to determine in what order they will fly missions. A list of missions is included. Determine which pilots and their aircraft are best suited to flying those missions, and have students sort the list into the most logical order. Using background knowledge, students can determine which missions are priority, which loads can be combined, and work out a plan for getting supplies, people, and dogs safely to their destinations.
Conclusion & Reflection:	Conduct a discussion with your class about what they learned about the Iditarod through studying the aircraft, pilots, and logistics that are used to support the race. Answers could refer to setting up checkpoints or logistics and personnel it takes to provide support for the race. Other responses could include the nature of flying in Alaska, and how some villages are so remote that the only way to get supplies and food is by barge or air. Ask questions and help spark your students' interest in learning more about aviation or what it takes to become a private pilot, and other questions.
Assessment:	1. Have students come up with a list of connections this lesson could have to other content areas, such as science, technology, engineering, and math, geography, communication, history, and language arts. How would the concepts they learned in this lesson apply? 2. Let students write a reflection of their experience working in teams with specific roles to build their aircraft. What social skills were easy or hard? What did they learn about this kind of teamwork?
Notes	
Enrichment/ Reinforcement Suggestions:	1. Give students another design-engineering project related to the Iditarod and have them work in groups in the same way as they built their aircraft. Students could build sleds, bridges, insulating gear, or water-resistant boots. 2. Students can extend the logistics missions, writing additional scenarios and keeping lists of supplies and items needed for each checkpoint for mushers and volunteers. 3. Students can calculate the food needs for a checkpoint of volunteers and mushers for a certain number of days. They can research nutrition needs, design menus, and order supplies, then divide those needs between flights. 3. Let students create another list of missions for the hubs of McGrath and Unalakleet.

Iditarod Air Force Design-Engineering Roles

Engineer

Job: Researches and designs the aircraft.

What they do:
- Research the best aircraft design.
- Instruct the manufacturer on how to build the aircraft.
- Help collect data during testing.
- Ask questions on how their design works to build and fly.
- Receive feedback from the Test Pilot, Manufacturer, and Communications Officer on how best to improve the design.

What they DON'T do:
- Touch the airplane during manufacturing or testing.
- Communicate with the teacher or other groups.

Good for someone who:
- Can visualize ideas and then communicate them appropriately.
- Is open to feedback and can problem-solve mentally.

Test Pilot

Job: Test flies the finished aircraft.

What they do:
- Flies the finished aircraft during the testing phase.
- Ask questions about the testing process and what data to collect.
- Helps collect data about the testing.
- Communicates and gives feedback to the Engineer, Manufacturer, and Communications Officer.

What they DON'T do:
- Touch the aircraft during manufacturing.
- Communicate with the teacher or other groups.

Good for someone who:
- Can problem-solve mentally.
- Can suggest specific data to collect and give appropriate feedback to the Engineer and Manufacturer.
- Is good at flying paper airplanes.

Manufacturer

Job: Manufactures the aircraft.

What they do:
- Follow the instructions of the Engineer during the building process.
- Give feedback on the manufacturing process to the Engineer.
- Ask questions on how the aircraft is performing.
- Help collect data during testing.
- Receive feedback from the Test Pilot and Engineer on how to change the design.

What they DON'T do:
- Implement design ideas that the Engineer has not instructed them to do.
- Touch the airplane during testing.
- Communicate with the teacher or other groups.

Good for someone who:
- Can follow verbal instructions to build a design.
- Is good with building things.

Communications Officer

Job: Communicates with other teammates and the teacher, and records data.

What they do:
- Monitor and regulate communication between the Engineer, Manufacturer, and Test Pilot.
- Ask questions on how the design works to build and fly.
- Record data during testing.
- Bring questions and comments to the teacher and carry the information back to their team.
- Share ideas with Communications Officers from other teams.

What they DON'T do:
- Touch the airplane.

Good for someone who:
- Is a leader who can manage different roles and personalities.
- Can communicate ideas.

Suggested Test Flight Data Collection

Team:

Test	Distance	Stability	Cargo
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Team:

Test	Distance	Stability	Cargo
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Team:

Test	Distance	Stability	Cargo
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Iditarod Air Force Pilot License

Name:

Aircraft: Cessna 180

Capacity: 2 passengers and120 lbs. cargo

Range: 500 mi

Tail Number:

Iditarod Air Force Pilot License

Name:

Aircraft: Cessna 185

Capacity: 6 passengers and 200 lbs. cargo

Range: 600 mi

Tail Number:

Iditarod Air Force Pilot License

Name:

Aircraft: Cessna 2007

Capacity: 1,100 lbs. and 7 passengers

Range: 610 mi

Tail Number:

Iditarod Air Force Pilot License

Name:

Aircraft: Piper Super Cub

Capacity: 1 passenger or 850 lbs cargo

Range: 360 mi

Tail Number:

Iditarod Air Force Pilot License

Name:

Aircraft: Piper Cherokee 6

Capacity: 1700 lbs. or 3 passengers

Range: 840

Tail Number:

Iditarod Air Force Pilot License

Name:

Aircraft: Aeronica Sedan

Capacity: 1 passenger and 640 lbs.

Range: 456 mi

Tail Number:

Iditarod Air Force Pilot License

Name:

Aircraft: Stinson 108

Capacity: 3 passengers

Range: 500 mi.

Tail Number:

Twin Turbine Pilot License

Name:

Aircraft: CASA 212-200

Capacity: 5,000 lbs.

Range: 1600 mi.

Tail Number:

List of missions from Anchorage and race map.

Missions from Anchorage are good to go; flights to Anchorage require that an aircraft be at that checkpoint first. Pilots try not to fly "empty" meaning no passengers/cargo. Refer to the passenger and cargo capacity of each aircraft as you plan your missions. Some missions will need more than 1 aircraft.

1. Teacher on the Trail to Willow.
2. Six trail crew personnel to Skwentna.
3. Five vets, race judge, and photographer to Skwentna.
4. TOTT from Willow to Skwentna.
5. One return dog and a vet from Skwentna to Anchorage.
6. Six boxes of supplies and three vet boxes to Finger Lake, six boxes of food/supplies to Rainy Pass.
7. Three returned dogs from Rainy Pass and one from Finger Lake to Anchorage.
8. Photographer and TOTT from Skwentna back to Anchorage.
9. Three trail crew personnel from Anchorage to Rainy Pass.
10. Ten boxes of food and supplies from Anchorage to Rainy Pass.
11. Veterinarian and 3 vet boxes from Skwentna to Finger Lake.
12. TOTT, six vets, ten vet boxes, and twenty-four boxes of food/supplies to McGrath, commercial