**Fearless FOD Detectives**

**Target Grade Level(s):** 4-5th

**Subject(s):** Science & Engineering, ELA

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**Problem Statement:**

**How can we improve our production process so that we have less debris (foreign object debris or FOD) left on the airplane during the build stage and can deliver a clean, safe airplane? What turns an object into FOD?**

***What changes to the process could be made that would eliminate FOD in other applications?***

**Storyline:** Clankless in Seattle

Even though it was going to be a hectic day, Jyoti was excited to get to work today. She would be flying on one of Pacific Airlines new airplanes, the Hercules 2200. She had heard so much about the sleek new design of this larger aircraft. She checked-in with security and headed down the jetway to the plane. As she was getting the passengers settled into their seats, she could hear the happy murmur of the people around her discussing their business and leisure plans with one another. The captain finally came on the intercom to inform the passengers and crew that it was time to shut the cabin doors and do the final cabin checks before take-off. The flight attendants dutifully went over the safety protocol, and they took their jump-seats ready for the plane to ascend gracefully into the sky. Once the pilot was cleared for take-off, the plane gained speed and Jyoti could feel that familiar lift of the plane as the airport drifted out of view. Suddenly, there was a strange, dull ‘clank’ that she had never heard before during take-off. A few of the passengers in the rear of the plane heard it as well, and they gave her a quizzical, concerned look. Nothing seemed amiss with the take-off and the plane was still gaining altitude. Jyoti knew she would have to do some investigating once they got to their cruising speed.

***Dear Mechanical Engineers,***

***You have been hired by the Pacific Airlines to help them figure-out where the strange noise is coming from in one of their newest airplanes. Furthermore, we would like you to come up with a system by which we could examine all new aircraft for any possible bit of debris. We will be asked to send a final report to the production team about your findings. In this report, you will be asked to come up with your own system for organizing and keeping track of all tools and other possible smaller, individual items that could be potential FOD debris.***

***We look forward to reading your report soon!***

***Kind regards,***

***Malcolm T. Eagle***

***CFO of Pacific Airlines***

**Real-world Connection:**

On rare occasions, airplanes have been documented as being delivered with accidental debris left in them. For example, the Air Force expressed concern a few years ago about loose tools and bits of debris found in various locations inside a few completed airplanes.

“We have USAF pilots here for flight training and they will not fly due to the FOD (foreign object debris) issues”. These types of incidents are rare, but they can be very costly to all parties concerned (the airplane manufacturer as well as the customer) in terms of not just money to find & fix the problem, but also the time involved.

Students will learn the importance of having certain ‘systems’ in place (such as FOD detection or FOD avoidance systems). They will learn how all of the production teams (engineers, mechanics, …) must work together using these systems to create a final product that meets all of the safety and performance requirements of a high-quality, well-built aircraft.

**How is this related to their lives?**

Everyone has had the experience of something being out of place that later causes a problem. Stepped on a LEGO piece that hasn’t been put away? Packaged up a box only to realize you forgot to take out something you needed? Heard a weird sound coming from inside an appliance? These could all be examples of everyday problems with foreign object debris or FOD! The students of Washington State are familiar with one of our region's largest companies; Boeing and that they are known for building airplanes. “The total economic impact of the aerospace industry in Washington state in 2017 included 226,130 jobs, $19.7 billion in labor income, and $89.6 billion in business revenues.” - [Washington Aerospace Economic Impacts 2018 Update](http://nma.choosewashingtonstate.com/wp-content/uploads/2018/12/CAI-AFA-2018-Aerospace-Update.pdf). Many of our students will become a part of this industry. Even so, students will develop the soft skills that will help them in any workplace that they encounter. They will learn the importance of task efficiency and how even small decisions and actions can affect the end result.

**Unit Overview and Table of Contents**

A unit overview is the "story" of the unit. It includes a description of the ideas, concepts, and practices that students will develop in this unit, how they relate to each other, and how they will build on each other chronologically. It should also include a table that shows the sequence of the lessons and learning outcomes. It helps the teacher think through the logical process or storyline of the learning that needs to take place.

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| **Lesson** | **Title & Short Description:** | **Learning Outcome:** |
| #1 | Introduction to Unit: *Clankless in Seattle*  Pacific Airlines has hired students to figure-out where the ‘odd noise’ is coming from on their new aircraft. | Introduction to FOD – foreign object debris & prevalence in manufacturing of aircraft |
| #2 | Define the vocabulary - F.O.D.  Find Your FOD: Students will be shown a PPT with items that may (or may not) be FOD. They will be asked to analyze the pictures. | Students will use a Mentimeter or other poll option (like Forms) to determine if the pictures are FOD or not.  Students will discuss what damage the FOD could cause. |
| #3 | **Production Process**:  A key part of this lesson is the concepts of ‘systems’ and manufacturing production processes. Students will watch a time-lapsed video of a plane and a Tesla car being made:  [Norwegian Dreamliner](https://www.youtube.com/watch?v=jiH3-rJ-iYc)  [Telsa Model 3 Assembly Line](https://www.youtube.com/watch?v=RQHBR3rjGXM&feature=emb_logo) | Students will learn more about the concepts of ‘systems’ and ‘manufacturing production processes’.  Students will produce a ‘mock assembly’ line for a simple task like making cookies (at home) or constructing a LEGO set or object.  Students will create and refine the production process and learn the importance of being organized & having a system in place. |
| #4 | FODly Yours:  F.O.D. is actually all around us. Students will be introduced to the concept that anything left out-of-place could be considered F.O.D. It can cause damage, hurt someone, or be unsafe. (GIF of mom falling on toys.) | Students will pick a room in their home & identify the potential FOD they find there.  They will create an organizational system to show how the situation might be improved. |
| #5 | Costly Mistakes:  Students will be given a cost-analysis sheet to determine the most cost-effective way to solve the problem.  How would you solve this airline’s problem?  Taking apart parts to find the debris and reinstall the parts. | Students will learn how the change in systems has helped to save money and cause less problems. |
| #6 | Engineering a FOD system ~ Imagine/Plan Stage  Students are introduced to the Engineering Project:  Students will be asked to design a system to organize and store supplies in an area of their classroom. | Students are asked to design an organizational system for keeping the items in an area of their classroom organized. |
| #7 | Engineering a FOD system ~ Build/Create stage  Students will create a prototype of their organizational system with their group. They will test it for a few days to see if it works | Students will create a prototype of their organizational system with their group. They will test it for a few days to see if it works |
| #8 | Engineering a FOD system ~ Test & Evaluate & Improve/Redesign stage  Students will share their design with their classmates, collect data and evaluate the effectiveness of their system. They will then redesign their prototype. | Students will test and evaluate their ‘system’ to see if it meets the criteria. They will redesign and improve their initial system. |
| #9 | The students will be going back to the original scenario problem and they will make recommendations to the CFO of Pacific Airlines, Malcolm Eagle. | The students will write a summary of their findings based on the organizational system that they created. They will write an email or letter to CFO of Pacific Airlines, Malcolm Eagle. |

**Standards (NGSS, CCSS, CTE):**

**5-PS1-3:** Make observations and measurements to identify materials based on their properties.

**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 our controlled and failure points are considered to identify aspects of a model or prototype that can be improved

**Common Core Standards:**

CCSS**.**[ELA-LITERACY.SL.5.1](http://www.corestandards.org/ELA-Literacy/SL/5/1/)

Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 5 topics and texts*, building on others' ideas and expressing their own clearly.

[CCSS.ELA-LITERACY.SL.5.1.A](http://www.corestandards.org/ELA-Literacy/SL/5/1/a/)

Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.

[CCSS.ELA-LITERACY.SL.5.1.A](http://www.corestandards.org/ELA-Literacy/SL/5/1/a/)

Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.

[CCSS.ELA-LITERACY.SL.5.1.C](http://www.corestandards.org/ELA-Literacy/SL/5/1/c/)

Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others.

[CCSS.ELA-LITERACY.SL.5.1.C](http://www.corestandards.org/ELA-Literacy/SL/5/1/c/)

Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others.

**Soft Skills:**

Listening, Critical Thinking, Collaboration, Communication (written and oral), Creativity & Innovation