Brooke Josephs

**BHAG:** Learners will evaluate a problem and create a structure that rescues a tiger from a moat based on their exploration of simple machines and engineering in order to recognize that they are real engineers who can solve unique problems.

### STAGE 1 – DESIRED RESULTS

<table>
<thead>
<tr>
<th>Unit Title: PLTW Stability and Motion: Forces and Interaction (4th Grade Science)</th>
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<tbody>
<tr>
<td>Established Goals:</td>
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<tr>
<td>• Learners will apply the engineering design process (ask, explore, model, evaluate, explain) to plan and create a complex machine.</td>
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<td>• Standards 3-PS2-1, 3-PS2-2, 3-PS2-3, 3-PS2-4</td>
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| Understandings: |
| Students will understand that... |
| • Engineers have a step by step approach for looking at and solving a problem called the design process. |
| • Engineers and designers create new products and technology to meet a need or want that meets specific criteria for success including constraints on materials, time, and cost. |
| • Engineers 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. |
| • Engineers propose a solution to develop for a design problem after evaluating multiple possible designs. |
| • Prototypes can be evaluated and improved upon by a series of fair and controlled tests to identify a product’s strengths and limitations. |
| • Engineers write down everything they do to document their work, organize their thoughts, and show their steps in an engineering notebook. |
| • Engineers share their work with and get feedback from others at many points throughout the design process. |

| Essential Questions: |
| • How can an engineer use forces and interactions to meet a human need or want? |
| • What questions do engineers ask when solving a design problem? |
| • Why is it important to develop and evaluate a prototype? |
| • Why is it important for engineers to document their work? How can this help you as an engineer? |
| • Why do engineers share their work and get feedback? What can feedback do for you as an engineer and in real life? |

Source: Understanding by Design, Unit Design Planning Template (Wiggins/McTighe 2005)
**Students will know...**
- what happens at each step of the design process.
- how to pose questions that engineers may ask when gathering information about a situation people want to change.
- the differences between invention and innovation.
- how to identify forces acting on an object.
- how to describe the motion and stability of an object with balanced or unbalanced forces.
- key terms - engineering, force, stability, motion, balanced forces, unbalanced forces, push, pull, effort, resistance, friction, work, gravity, energy, simple machine, and compound/complex machine.

**Students will be able to...**
- build simple machines.
- compare the attributes and components of six simple machines.
- identify simple machines and explain how they make work easier.
- explain what happens at each step of the design process.
- state questions that engineers may ask when gathering information about a situation people want to change.
- evaluate a problem.
- create a complex machine.

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**STAGE 2 – ASSESSMENT EVIDENCE**

**Performance Tasks:**
- Building machines – Students create a complex machine to rescue a tiger from a moat after careful planning and following of the design process.
- Create ePortfolio
- Discussion

**Other Evidence:**
- Launch Log – sketches, answers to questions, data, observations
- ePortfolio posts – reflection, presentation
- Self-Assessment/Reflection Rubrics
- Summative Assessment (test)
**STAGE 3 – LEARNING PLAN**

**Summary of Learning Activities:**
(In this PLTW unit, there are 5 main sections of learning. The following summary covers section 5 with the focus of building a complex machine. For the other sections in more detail, please view the lesson plans.)

1. Read the “Introduction to Stability and Motion” story as a class to reintroduce the problem – a tiger is stuck in a moat the zoo, and it is the students’ job as engineers to rescue it. H, W
2. Share the news article with students about the bobcat being rescued from the Gateway Clipper to connect the problem to the real world and help students see the importance of engineering for animal rescue. H, W
3. Teams view the design process video and graphic and discuss how following the process can help solve the problem. E
4. Discussion - Remind students that they will be working with teams to design, sketch, and build a model of an animal rescue device that can rescue a trapped zoo animal. The team will decide how to rescue the animal by lifting and moving it to a safe area.
   - **Criteria** - The group will design, build, and test a device to rescue a trapped zoo animal. The device must safely lift the animal at least 4 inches and set it down in a safe area away from where the animal was trapped. You must include a magnet in your design. Your design must include a compound machine consisting of at least two simple machines. A harness for the animal must be created that safely supports the animal and does not pull on the animal’s tail, legs, or head.
   - **Constraints** - You are limited to the VEX kit and string. W, O
5. Teams work through the engineering design process to create a complex machine to rescue a tiger from a moat.
   - **ASK** - Respond in Launch Log: What is the need or want that we are trying to fulfill? What will make the design solution successful? List the criteria and constraints for the design problem. W, E
   Complete the self-reflection rubric individually. Teacher leaves feedback during conference. E2, R
   - **EXPLORE** - Investigate the problem. Write or sketch how others have tried to solve a similar problem. Brainstorm several ideas that may solve the problem. Create sketches of your ideas. Talk to your team and share ideas. Add any additional ideas by writing or sketching. Add labels to your sketch.
   Complete the self-reflection rubric individually. Teacher leaves feedback during conference. E, R, T
   - **MODEL** - Compare the solutions that your team generated during the Explore step. Work collaboratively to choose the best idea for your model using the Decision Matrix. Build a model of the design. Document the model by sketching the final design and take a picture with the iPad.
   Complete the self-reflection rubric individually. Teacher leaves feedback during conference. E2, R

Source: Understanding by Design, Unit Design Planning Template (Wiggins/McTighe 2005)
EVALUATE - Describe how you will evaluate or test your solution. Conduct and document a controlled test. Record your observations. (Conduct three trials. Use the iPad camera to videotape the trails. Record the results of your test in your Launch Log. Discuss with your team - Was your model able to successfully rescue the tiger?) Use evidence to identify parts of your design solution that can be improved. Complete the self-reflection rubric individually. Teacher leaves feedback during conference.

EXPLAIN - Present your design, evaluation, and suggestions for improvement for your rescue device model on your ePortfolio. Complete the Explain section of your Launch Log by evaluating how the animal rescue device solved (or didn’t solve) the problem. Include the data you collected to support your conclusions. Complete the self-reflection rubric individually. Teacher leaves feedback during conference.

6. Teams present their designs, evaluation, and suggestions for improvement to the class.

7. Discussion - What did the successful models have in common? How did the machine make it easier to rescue the tiger? How would you use the engineering design process in your life to solve problems?

8. Conclusion Questions - Students answer conclusion questions individually in the Launch Log.

9. Students complete a summative assessment (test) – 6 short-answer questions based on real-world application of knowledge and skills.

WHERETO

WHERETO is an acronym that highlights key elements in instructional planning. It is not to be followed in order, but rather ensures that all parts of an effective lesson are involved in the designing process.

W – WHERE is the unit headed and WHY?
H – HOOK students right away and HOLD their attention/interest.
E – EQUIP students with tools, knowledge, and experiences to meet goals.
R – Provide time to RETHINK, REFLECT, and REVISE.
E – EVALUATE and self-assess progress.
T – How will we TAILOR learning to all needs, talents, and interests?
O – How will we ORGANIZE the learning to develop a deep understanding?

Abiding by WHERETO helps establish significant learning in authentic ways.