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| **Lesson Title :**  **The Challenge and the Engineering Design Process** | **Unit #: 1** | **Lesson #:**  **2** | **Activity #:**  **3** |
| **Activity Title: Design a Plan** |

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| **Estimated Lesson Duration:** | **11 days** |
| **Estimated Activity Duration:** | **3 class periods (45-50 minutes)** |

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| **Setting:** | **9th Grade Integrated Science Classroom** |

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| **Activity Objectives:** |

Design a plan to optimize the use of UAVs in a disaster relief situation.

-Work through the steps of the Engineering Design Process: Identify challenge, gather information, identify/select/test alternatives, revise and continue, communicate.

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| **Activity Guiding Questions:** |

Guiding Questions:

How far and how fast can a UAV travel?

What types of supplies can a UAV carry?

How much distance can the UAV travel in 24 hours? How many locations can it reach?

How can we minimize travel time and travel distance?

Which supplies should be delivered first? Why?

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| **Next Generation Science Standards (NGSS)** | |
| **Science and Engineering Practices (Check all that apply)** | **Crosscutting Concepts (Check all that apply)** |
| ☐ Asking questions (for science) and defining problems (for engineering) | ☐ Patterns |
| X☐ Developing and using models | X☐ Cause and effect |
| X☐ Planning and carrying out investigations | X☐ Scale, proportion, and quantity |
| X☐ Analyzing and interpreting data | X☐ Systems and system models |
| X☐ Using mathematics and computational thinking | ☐ Energy and matter: Flows, cycles, and conservation |
| X☐ Constructing explanations (for science) and designing solutions (for engineering) | ☐ Structure and function. |
| X☐ Engaging in argument from evidence | ☐ Stability and change. |
| X☐ Obtaining, evaluating, and communicating information |  |

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| **Ohio’s New Learning Standards for Science (ONLS)** |
| **Expectations for Learning - Cognitive Demands (Check all that apply)** |
| X☐ Designing Technological/Engineering Solutions Using Science concepts **(T)** |
| ☐ Demonstrating Science Knowledge **(D)** |
| ☐ Interpreting and Communicating Science Concepts **(C)** |
| ☐ Recalling Accurate Science **(R)** |

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| **Common Core State Standards -- Mathematics (CCSS)** | |
| **Standards for Mathematical Practice (Check all that apply)** | |
| X☐ Make sense of problems and persevere in solving them | X☐ Useappropriate tools strategically |
| ☐ Reason abstractly and quantitatively | X☐ Attendto precision |
| ☐ Construct viable arguments and critique the reasoning of others | ☐ Look for and make use of structure |
| X☐ Model with mathematics | ☐ Look for and express regularity in repeated reasoning |

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| **Unit Academic Standards (NGSS, ONLS and/or CCSS):** |

HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

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| **Materials**: (Link Handouts, Power Points, Resources, Websites, Supplies) |

1.2.3e. PPT slides: Disaster Specs, tables, map, constraints

1.2.3f. UAVs Engineering Design Process

Probability spinners for testing

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| **Teacher Advance Preparation:** |

Set up the PowerPoint; make copies for students

Copy the Handouts.

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| **Activity Procedures:** |

**Day 1: The Challenge / the Engineering Design Process**

Explain the challenge to students, using the PowerPoint;

There has been an earthquake. We have a map of where people are stranded without supplies. Your group will need to create a plan for what supplies will be delivered to each location by UAV, in what order. How can you provide the most effective aid?

**For Activity 2, your group will program a robot to simulate these tasks.**

Explain the challenge. Pass out the map worksheet with the disaster specifications. Assign students to groups of 4 and assign roles (recorder, manager, timekeeper, fact checker).

Refer to the poster (or PowerPoint Slide) of the Engineering Design Process. Explain the steps to the students.

Pass out the “Design a Plan” (EDP) Handout. Have students follow the process in steps 1 and 2.

Step 1: 5 minutes - identify the challenge in your own words. Students can list some of the constraints; others will be provided later.

During Step 2 (gather information), have students review the disaster specifications to brainstorm some guiding questions. (10 minutes)

List examples on the board (5 minutes)

Examples of Guiding Questions:

How far and how fast can the UAV travel?

What types of supplies can the UAV carry?

How much distance can the UAV travel in 24 hours? How many locations can it reach?

How can we minimize travel time and travel distance?

Which supplies should be delivered first? Why?

Check with the teacher (use cups or flag signal) when you have completed these steps. As groups are checked by the teacher:

Pass out the handout of the Power Point with information about the needs of the people at each location, distances between locations, speed and carrying capacity of UAVs. Students should use this information to complete the “constraints” section of Step 1.

Instruct students to begin Step 3 (Design Solutions) by brainstorming strategies for delivering supplies. Brainstorming means ideas are not judged, only recorded. (5-15 minutes)

For Step 4 (Select Solutions), groups should choose three of their best ideas and write about pros and cons of each strategy. (15 minutes)

Check with the teacher (use cups or flag signal) when you have completed these steps. If time still remains, groups may begin to calculate the distance, supplies delivered, people saved by their plan.

DAY 2: Testing and Communicating

For Step 5, students will write out their best plan on the whiteboards and test it by calculating distance traveled, time spent, supplies delivered, and people helped. (15-30 minutes) Talk with the students about how probability spinners can assist with determining “how many people helped” based on the probabilities of medical help / finding survivors as listed in the PowerPoint slides. It may also be necessary to review distance –rate –time calculations, since distance and rate data is given but time information must be computed.

After each group has tested their plan, groups will report back to the whole class. They will explain why their strategy was chosen, advantages, and the outcomes. (15 minutes)

After walking around to hear about all the plans, groups will return to their tables and have the opportunity to revise their plans based on their own data and reports from their classmates.

DAY 3: (if needed)

Student groups may continue their work on creating, testing, describing, and revising their plans.



FORMATIVE ASSESSMENTS:

Presentation to class of Design and Results of intitial testing

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| **Formative Assessments:** |

Presentation to class of Design, results of initial testing

**Summative Assessments:**

1.2.3f Design A Plan (EDP) Handout

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| **Differentiation** |

As students work in small groups, teacher will walk around to provide scaffolding for groups who are struggling with brainstorming or testing. Students who complete the tasks early and who show an interest /aptitude in excel may be encouraged to use an excel spreadsheet to organize their testing data and even construct probability simulation using random number generators.

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| **Reflection:** |

This lesson took longer than I expected, which is why the third day is built into the activity plan. However, I was pleased with the level of student engagement. One difficulty the students had was in brainstorming multiple alternative approaches – the groups sometimes wanted to stick with the first approach they considered instead of writing about multiple options. There was a lot of discussion about varied approaches to the challenge, such as leaving one UAV at the base for support vs keeping both UAVs in the field to provide maximum relief. This was also a good opportunity to review distance – rate – time calculations as the students tested their plan. Taking an extra day which allowed for review of math concepts such as rate and probability was a worthwhile tradeoff for me.