Sea Sensors Project

High School Engineering and Computer Science



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# Curriculum Overview

| Stage 1: Desired Results |
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| Essential Questions* What is the purpose of underwater sensors, and how do they contribute to our understanding of the underwater environment?
* How can we design sensors that are sensitive to underwater conditions?
* What principles of physics and biology need to be considered when designing sensors for underwater vehicles?
* How can the engineering design process be applied to create effective and reliable underwater vehicle sensors?
* How might advancements in sensor technology contribute to further exploration and understanding of underwater environments in the future?
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| Enduring Understandings* Students will understand the iterative nature of the engineering design process, including the importance of defining problems, generating solutions, and testing prototypes.
* Students will develop an awareness of the impact of human activities on underwater ecosystems and the importance of designing sensors that minimize negative effects on the environment.
* Students will recognize the interdisciplinary nature of engineering by integrating principles from physics, biology, and technology to create effective underwater sensors.
* Students will appreciate the role of technology in addressing real-world challenges, such as monitoring and collecting data in underwater environments, and how innovation can contribute to scientific exploration.
* Students will value effective communication and collaboration skills as they work in teams to design, build, and test underwater vehicle sensors.
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| Transfer *At the end of this unit, students will be able to…** Students will demonstrate a comprehensive understanding of the engineering design process and its application in creating underwater vehicle sensors.
* Students will engage in innovative problem-solving, adapting their designs based on testing outcomes and refining prototypes to enhance the functionality and reliability of their underwater vehicle sensors.
* Students will develop and demonstrate effective presentation and communication skills, articulating their design process, decisions, and the scientific principles behind their underwater sensors to their peers.
* Students will engage in critical reflection on the successes and challenges encountered during the project, fostering a deeper understanding of the engineering design process and their individual and collective contributions.
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| Stage 2: Evidence |
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| Formative Assessment ideas:* Throughout the design process, students will test their designs for fit and functionality
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| Summative Assessment ideas: * Students will test their sensors on a SeaPerch or similar ROV, present their designs in class, and reflect on their experience with the design process.
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| Stage 3: Learning Plan |
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| Lesson Number  | Lesson Name | Brief description |
| 1 | **Iterative design process** | Students will gain some familiarity with the design process, including an overview and use of the steps of design.  |
| 2 | **Design for 3D printing** | Students will create 3D model with CAD software that includes exterior geometry and interior geometry and the object’s that they design can be interfaced with existing object. |
| 3 | **Pull Up Resistor** | Students will build a circuit that uses a pull up resistor to allow a push button switch to be used in electric circuit and recognized by microcontroller. |
| 4 | **Voltage Divider** | Students will build a circuit that can be used with resistance sensors to gather analog data. When resistance sensor gives data, it can be stored or visualized. |

# Lesson 1: Iterative Design Process

| Lesson 1: Overview |
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| Lesson Overview:Students will gain some familiarity with the design process, including an overview and use of the steps of design.  | Lesson Objectives: *At the end of the unit, students will be able to…** Explain the design process and its usefulness
* Share a plan design process to make a 3D object that meets certain criteria
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| Lesson 1: Overview and Structure |
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| 1. Engaging Opener:* Begin with a thought-provoking question or a brief video related to the importance of underwater vehicles and sensor technology
* Facilitate a class discussion on the challenges of solving problems and introduce the concept of design thinking.

2. Overview of the Iterative Design Process:* Provide a clear and concise overview of the iterative design process, breaking down the key steps: problem definition, ideation, prototyping, testing, and iteration.
* Share a graphic illustrating the design process (quick google search should work here).

3. Discussion on Design Challenges:* Share the design challenge for the sea sensors project.
* Ask students to brain storm types of information an underwater ROV may need to collect.
* Let students know that their designs will include a pull-up resistor and voltage divider and that their designs should incorporate these aspects.
* Emphasize the importance of clearly defining the problem before jumping into solutions.

 4. Group Activity: Applying Design Steps:* Divide students into small groups.
* Guide them through applying the design steps to the sea sensors problem: problem definition, ideation (brainstorming solutions), and initial prototyping.
* Students should define their own problem including what kind of information they will want their sensor to collect.

5. Team Collaboration* In their small groups, students collaborate to develop their initial designs, fostering teamwork and communication skills.
* Circulate among groups to offer guidance and facilitate discussions.

6. Reflection and Discussion (15 minutes):* Bring the class back together for a reflection on their initial design choices.
* Discuss the challenges encountered, decisions made, and potential areas for improvement.
* Facilitate a group discussion on the concept of iteration, highlighting its importance in refining designs based on testing and feedback.
* Encourage students to share their thoughts on the iterative process and its role in continuous improvement.

7. Introduction to Prototyping Tools* Briefly introduce basic prototyping tools and materials that will be used in the project: CAD, pull-up resistor and voltage divider.

 8. Setting Expectations * Conclude the lesson by setting expectations for the project.
* Emphasize that this is just the beginning of the design process and that continuous improvement is a key aspect of successful engineering.
* Ask groups to set team norms.
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| Lesson 1: Tips, Strategies, and Suggestions |
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# Lesson 2: **Design for 3D printing**

| Lesson 2: Overview |
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| Lesson Overview:Students will create a 3D model with CAD software that includes exterior geometry and interior geometry and the object’s that they design can be interfaced with existing object. | Lesson Objectives: *At the end of the lesson, students will be able to…** Explain 3D printing basics, including terminology, processes, and material considerations.
* Apply design thinking principles to develop a detailed 3D printing design for the underwater vehicle sensor component
* Collaborate within teams to create innovative and detailed 3D printing designs, incorporating iterative design processes, attention to detail, and reflecting on choices to enhance overall project goals.
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| Lesson 2: Structure |
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| 1. Introduction to CAD Software* Depending on student experience with the software, students may need an overview of Computer-Aided Design (CAD) software and highlighting the specific features they can use in their design.

2. Provide examples of interior / exterior geometry.* Discuss the concepts of exterior and interior geometry in 3D modeling.
* Provide examples to illustrate the difference between the outer surface (exterior) and internal components (interior) within a 3D model.
* Emphasize features such as hollowing, adding internal structures, or creating spaces within the 3D model.

4. Practice* Allow students to practice creating the exterior geometry of a simple object using the CAD software.
* Circulate to provide guidance, answer questions, and ensure that students grasp fundamental concepts.

5. During this lesson (or another), provide examples of interfacing 3D models with existing objects or systems. * Discuss the importance of compatibility and seamless integration in design projects.

6. Peer Review and Feedback: * Conduct a peer review session where students share their 3D models and provide constructive feedback to their peers.
* Encourage discussions on challenges faced and innovative solutions.
* Ask students to set individual goals for further improvement in 3D modeling skills.

This lesson sequence will vary depending on student experience with CAD and previous coursework.  |

| Lesson 2: Tips, Strategies, and Suggestions |
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| [*https://warwick.ac.uk/fac/sci/wmg/about/outreach/resources/tinkercad/getting\_started\_with\_cad\_lesson\_plan.pdf*](https://warwick.ac.uk/fac/sci/wmg/about/outreach/resources/tinkercad/getting_started_with_cad_lesson_plan.pdf) |

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# Lesson 3: **Pull Up Resistor**

| Lesson 3: Overview |
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| Lesson Overview:Students will build a circuit that uses a pull up resistor to allow a push button switch to be used in an electric circuit and recognized by microcontroller. | Lesson Objectives: *By the end of this lesson, students will be able to:** Build a circuit integrating a pull-up resistor, push button switch, and microcontroller, demonstrating proficiency in wiring and understanding the fundamental components.
* Explain how pull-up resistors ensure stable voltage levels in a circuit, enabling recognition of push button switch states by the microcontroller.
* Share explanation of how to incorporate a pull-up resistor into design.
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| Lesson 3: Activites |
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| 1. Overview and introduction
* Briefly introduce the components: pull-up resistors, push button switches, and microcontrollers. Discuss their individual functions and the significance of their interaction in electronic circuits.
* Provide a concise explanation of how pull-up resistors function in circuits, emphasizing their role in maintaining a stable voltage and facilitating microcontroller recognition of push button states.
1. Hands-on building time
* Students will need time to practice with the resistors, switches, and microcontrollers as well as time to incorporate into their design.
1. Feedback and reflection
* Provide students an opportunity to reflect on the challenges with this aspect of the project, as well as opportunities for how they can incorporate into their sensor design.
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| Lesson 3: Tips, Strategies, and Suggestions |
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| **Voltage Pull Up - Button**Build a circuit that allows the Microbit to sense the press of a button. <https://www.teachwithict.com/pushbtton.html> Programming the Microbit to sense<https://makecode.microbit.org/> Button Test Code - <https://makecode.microbit.org/S99617-71369-26903-92764>  |

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# Lesson 4: Voltage Divider

| Lesson 4: Overview |
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| Lesson Overview:Students will build a circuit that can be used with resistance sensors to gather analog data. When a resistance sensor gives data, it can be stored or visualized. | Lesson Objectives: *At the end of the lesson, students will be able to…** Build a circuit that can be used with resistance sensors to gather analog data
* Reflect on design process and teamwork collaboration
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| Lesson 3: Activites |
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| 1. Overview and introduction
* Briefly introduce the voltage divider
	+ <https://www.youtube.com/watch?v=JGXdi7XcQi8>
* Provide students with an example they can test out, as well as examples of various pieces of information students will want to test for
1. Hands-on building time
* Students will need time to develop their own voltage dividers, incorporating into the project.
1. Feedback and reflection
* Provide students an opportunity to reflect on the challenges with this aspect of the project, as well as opportunities for how they can incorporate into their sensor design.
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| Lesson 4: Tips, Strategies, and Suggestions |
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| Make a circuit that uses the voltage divider technique to allow resistive sensors to give feedback to a microbit microcontroller. CardBinder clipsJumper wiresAluminum/copper tapeMicrobit/programming cableMakecode - <https://makecode.microbit.org/S64829-36076-29555-21355> Expansion board for Microbit [https://wiki.keyestudio.com/Ks0360\_Keyestudio\_Sensor\_Shield\_V2\_for\_BBC\_micro:bit](https://wiki.keyestudio.com/Ks0360_Keyestudio_Sensor_Shield_V2_for_BBC_micro%3Abit) <https://quadstore.in/2020/10/03/microbit-lesson-11-photoresistor-light-sensor/> <https://cdn.sparkfun.com/assets/resources/4/4/input_photoresister.pdf> <https://learn.adafruit.com/micro-bit-lesson-4-sensing-light-and-temperature?view=all> Voltage Divider explained - <https://www.youtube.com/watch?v=JGXdi7XcQi8> Voltage Divider testing code - <https://makecode.microbit.org/S64829-36076-29555-21355>  |

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