Losing Protection

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Grading Rubric Found Here

About the Authors

Name & Picture	Bio
 **Ms. Breanna Snyder** bsnyder@smmusd.org www.breannasnyder.com www.samohiengineering.com	Ms. Snyder graduated from Royal High School in 2008, as valedictorian, and then attended the University of California, Santa Barbara from 2008-2012. In 2012 Ms. Snyder graduated UCSB with a BS Biochemistry, and a double minor in Education and Mathematics. Ms. Snyder then worked as an Outreach Coordinator for a program called SciTrek for a year before entering Graduate School at UCSB. From 2013-2014 Ms. Snyder was a graduate student working on her masters degree in chemistry while teaching general chemistry classes at the university while also doing research in chemical education. In 2014 Ms. Snyder earned her MA degree in chemistry, as well as an award for "Outstanding Teaching" in the Chemistry Department. From 2014-2015 Ms. Snyder was in the Teacher Education Program (TEP) at UCSB while also student teaching at Santa Barbara High School. In the summer of 2015 Ms. Snyder taught at Santa Barbara City College (SBCC). Since fall of 2015 Ms. Snyder has been a teacher at Santa Monica High School teaching classes such as HP Chemistry, Chemistry P, AP Chemistry, PLTW Digital Electronics, and PLTW Engineering Design and Development.

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Component 1: Research

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Component 3: Prototype and Test

Component 1: Research

Element A: Identification and Justification of the Problem

Problem Statement:

Insert your problem statement here. Make sure your problem statements include who the problem affects, how many people are affected, how long the problem has existed, and why the problem is important to solve.

Initial Research:

In order to become an expert please complete the following section.

- **List of Experts:** Find a potential pool of candidates that will be your mentor throughout the rest of the capstone project. Make sure to include their credentials and contact information. Insert a list of potential mentors and their contact information below.
    - ***Once you are ready to reach out to your mentor please include a copy of your original email to the appendix. (See appendix for more information)***
- **Initial Thoughts :** As a group answer the following questions in complete sentences. Make sure to restate the question in your answer!
    1. What do you need to know to design and develop a solution to your chosen problem? Be specific, this will guide your future research.
    2. What customers will be interested or served by a solution to the problem?
    3. Do products exist that already serve as a solution? If so, list products that are already in the market. Further research will be conducted later on current products in Element B (make sure this list matches the list in element B)

4. What competitors or factors affect your solution options?

5. What solution characteristics and features are most important to your group's initial ideas for a solution?

6. How much do you think people would be willing to pay for a solution?

☐ **Market Research**: In order to further justify the problem you will need to analyze the current consumer market. Complete the following:

- ❏ **Personal Observations**: What have you noticed about the current problem? Describe how this problem affects your group, or why you are interested in it. Make sure to restate the question in your answer!

- ❏ **Informational Interviews:** Conduct at least 3 interviews where you ask questions to further justify your problems. Insert testimonials from these interviews below. Make sure to quote the person and state their full name and date of interview.

- ❏ **Surveys-** Create an initial survey to send out to your peers and the greater community (Your teacher will help with distribution). This survey should ask questions that further justify that you have a problem worthy of developing a solution. Before you send out this survey you must get instructor approval.
  - ❏ HyperLink a copy of your survey below.
  - ❏ Once you have at least 50 submissions submit images of the results below.
  - ❏ Summarize what these results mean.

Element B: Documentation and Analysis of Prior Solution Attempts

Secondary Research

☐ **Current Solutions**: Complete the following graphic organizer with at least 7 commercial solutions, and 2-3 patent solutions)

- Patent Office:

Solution *(include description and Image)*	**Source** *(hyperlink with name)*	**Pros** *(list 2-3)*	**Cons** *(list 2-3)*	**Evaluation** *(What from this solution will you use in your design, and what from this solution will you make better in your design?*

☐ **Summary of Current Solutions:** In 2-3 paragraphs summarize the current solutions and their common pros and cons. Explain what design specifications will be necessary for your prototype solution to solve the problem and be better than the current solutions.

☐ **Justification**: Justify the effort and expense that will be required to design a solution to your team's problem by discussing the relative size of the target market and your preliminary plan to reach the target.

Element C: Presentation and Justification of Solution Requirements

Design Specifications

- ❑ **Initial Thoughts :** As a group answer the following questions in complete sentences. Make sure to restate the question in your answer!
  1. Who is the target **consumer**?

     Those with mental disability such as ADHD or dementia

  2. **Customer Needs**. What does the customer want/need?

     A way to not lose things

  3. **Performance**. What must the product be able to do? Be specific.

     To be able to find lost items

  4. **Target Cost.** What is the anticipated cost to the consumer for this product?

     30$

  5. **Size and Weight.** What size should the product be, or what restrictions to size exist? What are the weight restrictions on the product?

     10 g

  6. **Aesthetics.** Are there preferences in the appearance features of the product (color, surface treatment, shape, material)? If so, describe them.

     black

  7. **Materials**. Is there a specific material or materials that must be used? If so, describe it.

     glass

  8. **Safety and Legal Issues**. Identify potential safety and legal issues that may arise from the use of this product.

     Ultraviolet, stalker, health,

9. **Ergonomics**. Identify considerations for the ergonomics of the product.

10. **Operating Environment**. Identify the environmental conditions relevant to the manufacture and use of the product (temperature, corrosion potential, dust or dirt, pressure, humidity, vibration, noise, degree of abuse, other).

11. **Global Environment**. Will the product include any toxic or dangerous substances? What is the plan for disposal of the product at the end of its useful life?

12. **Service Life**. What is the required service life of the product?

Depends on battery life

13. **Product Life**. What is the anticipated length of time that the product will be produced before it is replaced by a newer version or alternate product?

Several years

14. **Durability and Maintenance.** Will the product require routine maintenance during its service life? If so, answer the following:
    - ❏ What specific parts of the product must have easy access for maintenance?
    - ❏ What is the anticipated maintenance schedule?
    - ❏ Are special tools required? How will they be acquired?
    - ❏ Will replacement parts be required? How will they be acquired?

battery

Design Criteria

As a team, prioritize your list of criteria from most important to least important. Insert a list of your most important design criteria below and explain why this criteria is the most important (make sure to reference the pros and cons of the competitor list in Element B.

Design Constraints

As a team, list applicable constraints that the designer must work within. Be specific. In other words, listing "time" as a constraint is not acceptable; you must state specifically how much time is available for the design process.

Design Specifications Survey

Create a survey to send out to at least 50 target consumers for your project. Your survey should include the overall problem, and your intended solutions that include your design specifications. Before you send out your survey you must get instructor approval.

- ❑ HyperLink a copy of your survey below.

- ❑ Once you have at least 50 submissions submit images of the results below.

- ❑ Summarize what these results mean.

Mentor Feedback:

Reach out to your mentor to get their feedback on your design requirements and constraints. Insert your exact correspondence on the appendix document, and summarize their feedback below.

Component 2: Design

Element D: Design Concepts Generation, Analysis, and Selection

Brainstorming Potential Solutions

Have each person in your group come up with an initial design to solve the problem stated above. Insert an image of each of the initial designs that each group member comes up with below. Initial Drawings should be labeled and need to include a description of each part and how this idea will solve the problem.

Initial Design Concept:

Compare all of the initial design ideas and combine all of the potential solutions into one idea. Create a new image of this initial design concept. Make sure this initial design concept is labeled and includes a description of each part and how this idea will solve the problem.

Initial Peer Feedback

You will share your initial design concept with the class and get feedback from your peers. Create a survey to send out to your peers to get initial feedback about your design. You only need to collect "open ended" feedback, you do not need to create questions about your design. Give your peers an opportunity to critique and give feedback that they think will help your initial design process.

Insert the responses that your group received from your peers below. Organize the responses into categories.

Reflect on the responses and summarize in one paragraph about how this informs your initial design concept. Insert your response below.

Revised Design Concept

Taking the peer feedback into consideration, revise your initial design concept and create an image or description of the idea and insert an image below. This should be a REVISION of your initial design, take into consideration the feedback and make changes as appropriate. Insert an image of your revised design with labeled components.

Product Improvement and Design Documentation

The following is a list of some factors that may affect the commercial success of your product. Keep these factors in mind as you finalize your design to solve the problem.

Answer the following questions in your document

1. **Function**. Can you simplify the operation of the product? Will the product function properly every time it is used?

2. **Aesthetics**. Can you improve the visual appeal of the product? Keep your target market in mind.

3. **Cost**. Can you reduce cost by using alternate materials or reducing the amount of materials in the design? Can you change the design to simplify the manufacturing or assembly process of the product?

4. **Durability.** Will the product function properly for the duration of its design life with minimal maintenance? Can the product be designed such that all components wear out simultaneously as it reaches the end of its design life?

5. **Environment.** Consider the life cycle of your product. Is the manufacturing process harmful to the environment or employees involved in the manufacturing process? Does the manufacturing process produce excess waste or hazardous material? Will disposal of the product emit toxins? Can the product or components of the product be reused or recycled? Can you reduce the overall impact of the product on the environment?

Final Design

Create a 3D computer model of your proposed design. Create a set of CAD working drawings to document your team's proposed design as described above.. The drawing set should include dimensioned part drawings and assembly drawings as necessary. Include all necessary dimensions, material callouts, notes, a parts list, and details necessary to construct a prototype of the product. Insert your CAD image below. In addition, in your appendix section link your CAD files.

Cost to Produce Device

Estimate the cost to produce one prototype of your proposed design according to the drawings. The cost should include the cost of materials (including raw materials, fasteners, and purchased components or subassemblies) and labor needed to build the prototype. Although a thorough cost **analysis** would consider other costs related to taking the product to market (such as manufacturing equipment, distribution, marketing, overhead, and selling the product), we will restrict our analysis to material and manufacturing labor costs.

Research and document the cost of each component of your design. Revise the parts list within your working drawings to include a column for cost. Input an estimated cost for each part. Make sure to appropriately cite your sources! Insert a cost analysis for materials below.

Estimate the time necessary to construct your prototype and an hourly wage for a person to assemble the product. Use these estimates to approximate a total cost of labor to build the prototype. Make sure to appropriately cite your sources! Insert a cost analysis for time to make your device below.

Approximate the production cost for your product by summing the material cost and labor cost. Insert this value below.

Element E: Applications of STEM Principles and Practices

Scientific and Engineering Principles to Investigate

Research at least 5 engineering and scientific principles that support or explain your capstone project. Explain and cite each scientific principle and state how you will need to solve this problem in order to develop your prototype. Make sure to include for each principle how each possible concept will affect the structure and function of your prototype design. This should be a VERY detailed section of your research document!

Validation of Investigation and Concepts: Mentor Feedback

Have your mentor approve the scientific principles that you will need to investigate to build your prototype, and add their feedback to your mentor feedback document, and to this section in the research document below.

Equipment and Technology

Explain the equipment and technology that is going to be needed to build your prototype. This is NOT a description of the physical materials needed to build your prototype but rather HOW you will build it and what tools or programs will be needed.

Element F: Consideration of Design Viability

Introduction:

State how you will compare your prototype design to the top three competitors to your design. What factors will you specifically compare to see if your device is successful?

Market Analysis:

Fill out the following table to compare your prototype design product with the top three current competitor solutions. Make sure to cite any sources that you use in the works cited!

Products Include picture and link	Manufacturer Price	Consumer Price	Pros & Cons
Competitor 1:			
Competitor 2:			
Competitor 3:			
Our Product:			

Summary

Summarize the table above and explain what you can conclude from the above information. Also included what demand there will be for your product based on the information presented in the table.

Distribution

Describe how your product will be distributed.

Component 3: Prototype and Test

Element G: Construction of a Testable Prototype

Prototype Planning and Documentation

Bill of Materials

a. The first step in materials acquisition is to specifically identify the needed item. You must be very specific. For example, if you need an electric motor, you need to know beforehand the ratings of the motor for your application. What does the motor move? With this information, you can select from available motors. Looking at the list of all the parts of your design solution, brainstorm with your team all the materials you will need to build it.
b. The next step is to determine whether the specific item is unique to your project (in which case it will have to be **fabricated**) or it already exists. If it is unique, it will have to be made from raw materials such as wood, plastic, or metal. You can make the part yourself, or you can have it made by a person or company that your research leads you to. If the part already exists, you may purchase it or try to get it donated by the manufacturing company or by someone who has one. Obviously, donation is preferred since your group has a limited budget. Using your interpersonal communication skills, you may contact an engineer, sales representative, or supervisor from a company with the item you need. Keep it local if possible. Refer to Activity 4.1.4 Professional Correspondence for tips on corresponding with potential donors.
c. Now that you have listed the materials, research the standard sizes, quantities, and cost of the different materials and determine what sizes you will use. Use a catalog or online resources. It may be necessary

for you to draw the parts to scale to more accurately determine the quantities needed. Put the information into a table. Below is one example you may choose to follow.

Tools and Equipment List

a. Based on your bill of materials, determine all of the tools and equipment that will be necessary to assemble the materials into your prototype. Consider **hand tools**, **power tools**, shop tools, and specialized equipment that may not be readily available at your school.
b. Now that you have listed the tools and equipment that you will need, determine whether they are available in your lab. If they are not, identify a source from which you can obtain the tool or equipment and contact the source. Discuss arrangements for using the equipment. Refer to Activity 4.1.4 Professional Correspondence for tips on corresponding with potential donors. Document your conversation and note the important information for each tool and equipment in a table. Below is one example you may choose to follow.

Needed Knowledge

a. Consider the additional knowledge (math, science, and engineering concepts) needed to ensure that your design will meet the specifications. In addition, consider the skills and knowledge needed to correctly and safely assemble your parts using the appropriate tools. List the concept, skill, or information that you will need.
b. Determine whether the necessary knowledge is available from a member of your group. If not, identify a source that can provide assistance with each item listed. Contact the source to ask for help and arrange a transfer of knowledge. Refer to Activity 4.1.4 Professional Correspondence for tips on corresponding with experts. Be sure to document your conversation. Below is a table that may be helpful when recording your findings

Reflection

As you determine resource availability for your team's project, reflect any changes to your design with notes in your engineering notebook and revisions to your final drawings.

Element H: Prototype Testing and Data Collection Plan

Test Criteria

In this project your team will determine the quantitative and qualitative testing criteria for your design solution. Brainstorm as a team and complete the following steps. Document your work below:

1. Revisit your design specifications and list the criteria/benchmarks that should be tested to ensure success of your product.

2. For each criterion that should be tested, determine specifically what you need to know. For example, when testing a lamp shade, you will need to know whether the material of the shade can withstand the heat that the lightbulb produces without burning or melting.

3. In your media center or on the internet, look up the ASTM standards for testing of the materials used in your design solution or devices that are similar to yours, if they exist. You may have to contact a testing facility in your area if you do not have access to ASTM books. A manufacturing company or engineering firm that writes test procedures may have the information you need.

4. As a team, brainstorm the results of your research to determine the parts of your design solution that you will be testing. Your goal is to formulate an appropriate list of test criteria and the method of testing that will objectively measure the effectiveness of your design solution. Consider what type of testing will be performed—qualitative or quantitative? If you have time, it is recommended that you do both. In the case of the lamp shade, if you want to measure the temperature at which the material will burn or melt, you will collect quantitative data, since the temperature is a numeric value. If you want to determine whether the material can withstand a temperature of 350°F for 24 hours without visible signs of burning or combusting, you will collect qualitative data, because the results will be recorded as pass or fail.

5. To ensure successful performance of the design, determine the degree of accuracy that is needed in the data collected during testing. In other words, how close must the measured data value be to the actual value to be acceptable? In the case of the lamp shade, you may be able to accept a deviation of 5 degrees in the measured temperature from the actual temperature at which the material burns or melts. In other words, you have determined that the performance of your product will not be adversely affected if the temperature sensor reads 265 degrees (or 255 degrees) during testing, as long as the actual temperature is 260 degrees.

Create a table similar to the one below to record testing criteria/benchmark information.

Criteria/Benchmark	Description of data needed	Quantitative or qualitative	Degree of accuracy	Link Source
The material of the shade must be able to withstand a temperature of 350°F without burning or melting	*Temperature at which the lamp shade material burns or melts*	*Quantitative*	*+/- 5°F*	

Test Procedure

Insert your testing procedure below.

Element I: Testing Data Collection and Analysis

Insert Pictures of your final prototype design solution and explain each component of the solution and describe how the prototype solves the problem. Summarize the testing procedures from above and include how you will know your prototype is successful at solving the problem.

Test Prototype

Directions: This can only be completed AFTER your prototype has been created.
Part 1:

1. *Perform the testing procedures at least three times and collect data for each test during the testing procedures that you created above.*
    a. *Collect pictures, screenshots, and data throughout the test procedures.*
    b. *Document your test administration , insert copies of your data, and reflect on the test results*
2. *Create a summary of the testing procedure and Submit the data tables and summary to your expert for their input.*

Evaluate Prototype

1. *After receiving input from your experts/stakeholders, determine if your design solution was a success, failure, or somewhere in between. Explain using EVIDENCE (pictures, testing results etc.)*

2. *Answer the following questions and EXPLAIN your "yes" or "no" answer*
    a. *Do the results reflect a problem with the testing procedure?*
    b. *Do the results reflect a problem with the testing criteria?*
    c. *Do the results reflect a problem with the materials used for the prototype?*
    d. *Do the results reflect a problem with the quality of the building process of the prototype?*
    e. *Do the results reflect a problem with the design of the prototype?*

3. *Write a summary of proposed corrections, modifications to the following*
    a. *Prototype Design*
    b. *Testing Procedure*
    c. *Data Collected*

Prototype ReDesign

1. *Implement your recommended changes and outline these changes below*
    a. *design specifications, technical drawings, prototype build procedure, and/or test procedure) as necessary.*
2. *Retest your prototype using the instructions above in this document. Be sure to document the second round of testing as required.*

Element J: Documentation of External Evaluation

Feedback to Evaluate prototype

- Feedback from Stakeholders
  - Create a survey to get feedback from at least 100 different people. In your survey include the following
    - show people your virtual prototype and explain its intended purpose and if possible provide a demonstration of it working.
    - Have stakeholders provide feedback about your prototype and how it could be improved.
    - In this element include a link to your survey, and include a link to the survey in the appendix.
    - In this element, include at least 5 responses (quotes) from people surveyed that would impact the design of your prototype in the future.
- Feedback from Mentor
  - Get written feedback from your mentor and include this in this element.

- Evaluation of Feedback
  - Analyze the Results of the Survey & Mentor feedback
    - Looking back at the additional feedback from stakeholders and your mentor write a one paragraph analysis of the success of your prototype. Make sure you reference your initial problem statement, initial design and your testing results in your analysis.

Element K:Reflection on the Design Process

- In one 2-3 paragraphs answer the following
  - Describe what your team would plan to do next with all of the information that you gathered from the previous element (evaluation of feedback) Be specific and explain each detail.
  - Do you think your prototype could be produced on a mass scale? What changes would need to take place? How could this be implemented?
  - Overall what do you think you (and your group) would need to do in order for your device to be successful?

Works Cited:

1. Citation
2. Citation
3. Citation

Appendix

1. **Mentor Log**: - Create a Log that will serve as a record of communication between you and your mentor.
2. Patent Office- Use this link to discover patents that are related to prior solutions