



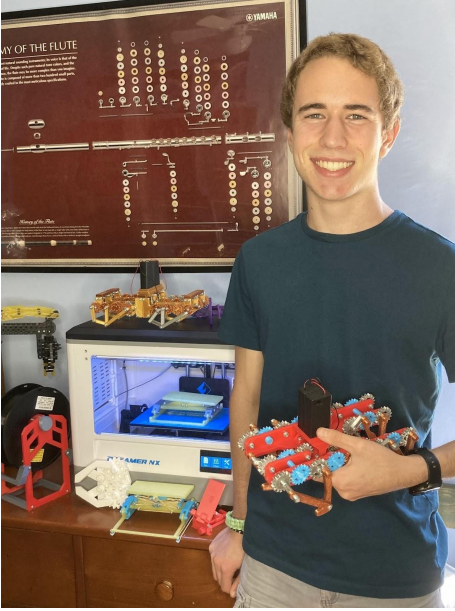


Package Pirating Prevention (PPP)

MJ Anselmo, Theo Juteau, Kim Hansen, Ethan Hopkins

About the Authors

Name & Picture	Bio
 <p data-bbox="241 1018 488 1052">Mr. Ethan Hopkins</p> <p data-bbox="180 1094 552 1157"> https://pltw-website.vercel.app/ www.samohiengineering.com </p>	<p data-bbox="673 422 1500 667">Mr. Ethan Hopkins is a student at Santa Monica High School who attended Lincoln Middle School and Roosevelt Elementary School. He had always had interests in science and math, but became particularly interested in software engineering during sophomore year. He has since won top placements at regional hackathons, been employed at a dental clinic as a software developer, and more. He also has a strong interest in politics, with a focus on election predictions.</p>
 <p data-bbox="258 1766 472 1799">Ms. Kim Hansen</p> <p data-bbox="157 1839 574 1940"> kimhasen2004@gmail.com https://kimhansen2004.wixsite.com www.samohiengineering.com </p>	<p data-bbox="673 1266 1500 1793">Ms. Kim Hansen started taking PLTW classes in seventh grade at her middle school, SMASH (Santa Monica Alternative School House). There, Ms. Hansen learned the basics of 3D modeling and design. In eighth grade, she continued these studies and graduated in the class of 2018. Then, she moved on to high school at Samohi (Santa Monica High School) and continued participating in the PLTW program. Her freshman year, Ms. Hansen took Introduction to Digital Design and expanded on her 3D modeling abilities. Sophomore year, she enrolled in Computer Science and successfully passed the AP Computer Science Exam. Junior year, Ms. Hansen doubled PLTW classes and took both Aerospace engineering and Digital Electronics. Finally, in senior year of high school Ms. Hansen is enrolled in PLTW Engineering Design and Development where she is working on a final capstone project. Past high school, Ms. Hansen plans to study Chemical Engineering and expand her love for engineering.</p>



Mr. Theo Juteau graduated from Edison Elementary School and John Adams Middle School. Maintaining a high interest in music and engineering, Mr. Juteau was eager to join an engineering club and the band at Santa Monica High School. In his junior year, he became the leader of the Novice Engineering Club his junior year and has allowed it to skyrocket in popularity. Continuing to exceed in music excellence and engineering perfection Mr. Juteau hopes to provide service with Exosuits to the world.

Mr. Hansen, Kim. “Pirate Package Prevention Product.” 6 Jan. 2022

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Michael Anselmo learned the basics of engineering in middle school in a program called AVID in which design competitions were held every 6 months. He displayed an innate interest in these competitions and when he graduated from Lincoln Middle School in 2016 he decided to continue his interest in engineering in the 4-year PLTW course at SAMO. In this course, he learned the basics of coding, 3D modeling, Aerospace, and design and development. In the summer he works for a flight simulator company where he gathers real work experience. He enjoys graphic design and has experience as a freelance artist. He also has a passion for flying and is currently working toward his license. In the future, Mr. Anselmo hopes to pursue a degree and a career in Aerospace engineering and use clever engineering to fix the world one solution at a time.

Mr. MJ Anselmo

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Component 1: Research

Element A: Identification and Justification of the Problem

Problem Statement: Over 1.7 million packages are stolen from homeowners and renters daily²¹, costing sellers \$9 billion USD each year⁵. This loss additionally has other costs, as many stolen items include medicine, home accessories, food²², and other important items.

Becoming an Expert:

- Project Title: Package Pirating Prevention
- Images:



Photo descriptions from left to right; man stealing package off front porch in Byron, courtesy of Houston County Sheriff's Office (Source 1), man stealing amazon package from front porch (Source 8).

- Personal Information:
 - Santa Monica High School, (310) 395-3204
 - Ms. Breanna Snyder, bsnyder@smmusd.org
 - Ms. Kim Hansen, (323) 283-2540, kimhansen2004@gmail.com
 - Mr. Ethan Hopkins, (310) 634-2465, ethan.e.hopkins@gmail.com
 - Mr. Theo Juteau, (424) 384-3460, theophilejuteau@gmail.com
 - Mr. MJ Anselmo, (424) 384-9480, thinkinawink@icloud.com
- 5 Associations
 - Homeowners and renters
 - Buyers
 - Sellers
 - Amazon
 - Target
 - Walmart
 - Delivery services
 - USPS
 - UPS
 - FedEx
 - Thieves
 - Porch pirates

- ❑ List of Experts
 - ❑ Workers/Engineers at Ring doorbells²
 - ❑ Phone Number: (310) 929-7085/ (800) 656-1918
 - ❑ Email: Email Ring.Com
 - ❑ DoorBox¹⁷
 - ❑ California: 47000 Warm Springs Boulevard, Suite 355, Fremont, California 94539
 - ❑ Phone:(650) 422 2232
 - ❑ Email: info@doorbox.co
 - ❑ Vsons design¹⁸
 - ❑ Email: info@vsons.com
 - ❑ 1130 Charest O Suite 108, Quebec, QC, Canada G1N2E2, Vsons inc.
 - ❑ Neil Paton
 - ❑ Email: neilpaton71@gmail.com

Conducting Market Research:

Designing the Market Research Plan:

- ❑ Personal Observations:
 - ❑ We have noticed that most existing products on the market aimed at package theft prevention are too expensive for the general public making it clear that a majority of the population does not benefit from them.
- ❑ Informational Interviews:
 - ❑ After interviewing Ms. Snyder, she thinks Package theft is a real problem.
 - ❑ She's had three packages stolen so far including a giant oatmeal package, which was very cumbersome to carry. Even packages from upstairs got stolen, proving that "porch pirates" are watching continually to see when the amazon van drives by.
- ❑ Survey: (shown below)

Initial Market Research Survey:

We conducted a market survey that received 65 responses. We asked various preliminary questions relating to package theft. Our responses are listed below.

Figure 1: Question 1 from Initial Market Research Survey²⁰.

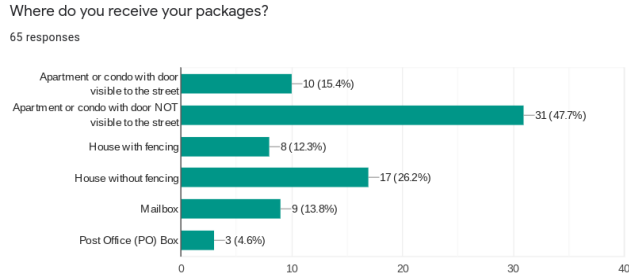


Figure 2: Question 2 from Initial Market Research Survey²⁰.

How many packages have been stolen from you or your household?
65 responses

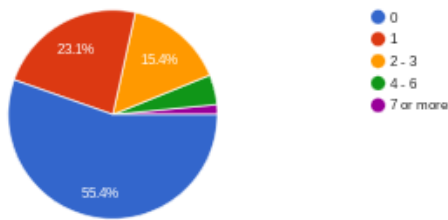


Figure 3: Question 3 from Initial Market Research Survey²⁰.

If you have had packages stolen, were you reimbursed for your stolen goods?
64 responses

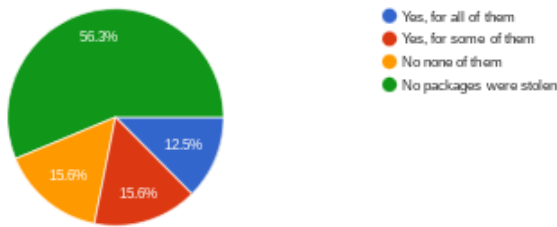


Figure 4: Question 4 from Initial Market Research Survey²⁰.

If you have had packages stolen, what is the TOTAL approximate value that has been stolen from you?

30 responses

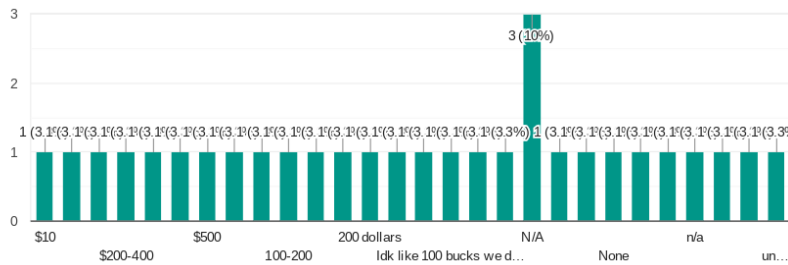


Figure 5: Question 5 from Initial Market Research Survey²⁰.



Figure 6: Question 6 from Initial Market Research Survey²⁰.



Figure 7: Question 7 from Initial Market Research Survey²⁰.

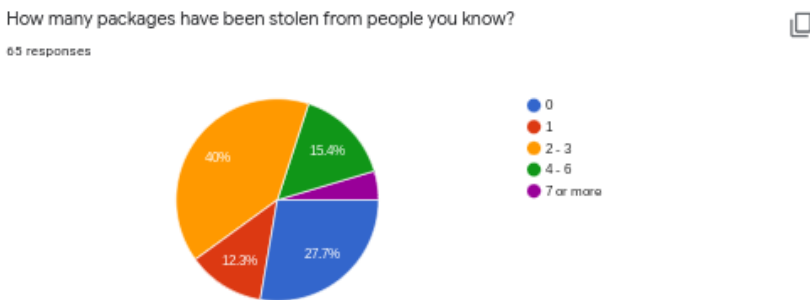


Figure 8: Question 8 from Initial Market Research Survey²⁰.

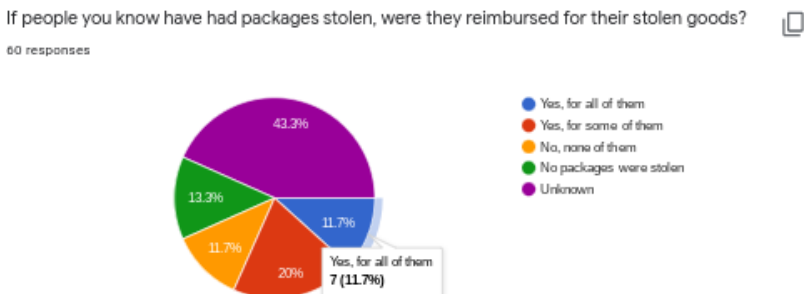
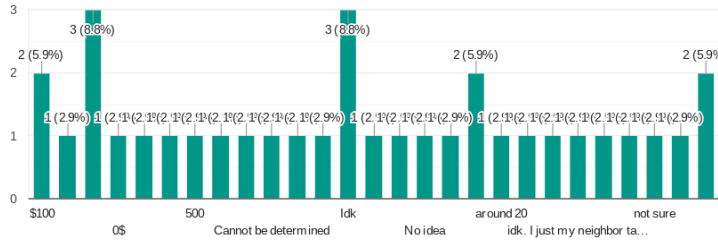


Figure 9: Question 9 from Initial Market Research Survey²⁰.

If people you know had packages stolen, what is the TOTAL approximate value that has been stolen from them?

34 responses



Graphs (Arranged Data):

Figure 10: New Graph from Question 4 from Initial Market Research Survey²⁰.

If you have had packages stolen, what is the TOTAL approximate value that has been stolen from you?

Custom Google Sheet Chart

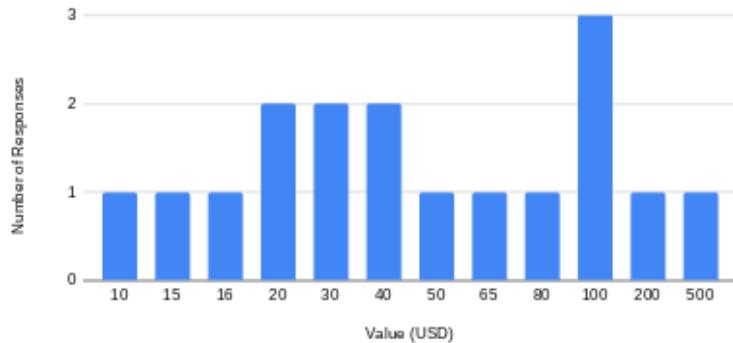
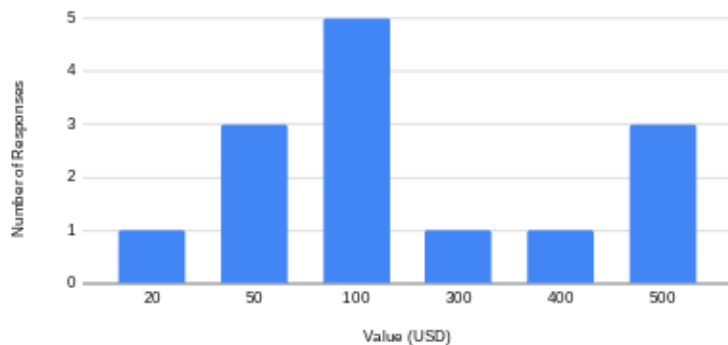


Figure 11: New Graph from Question 9 from Initial Market Research Survey²⁰.

If people you know had packages stolen, what is the TOTAL approximate value that has been stolen from them?

Custom Google Sheet Chart



Our initial survey strongly indicated that package theft is at least a widespread problem for students, teachers, and residents of Santa Monica, California, with nearly half of respondents reporting personal package theft and three-quarters reporting knowing someone who has experienced package theft.

Questions:

- What do you need to know to design and develop a solution to your chosen problem?

We need to know the main reasons for package theft, and what deters porch pirates.

- What is the need or want in your problem statement that is causing a problem?

The need is to prevent thieves from easily stealing packages that are delivered to doors.

- What customers will be interested or served by a solution to the problem?

Everyone who orders products online will benefit as there will be next to no risk of package theft.

- Is the assumed **target market** correct, smaller, larger?

The target market is correct.

- Do products exist that already serve as a solution?

They do, but they aren't very elegant and sometimes pose a theft risk themselves.

- What competitors affect your solution options?

Competitors such as Amazon, and Vsons may affect our solution options.

- What solution characteristics and features are most important?

Important characteristics include affordability, and reliability ensure the design is not made vulnerable to thieves.

- How much would people pay for a solution?

It is intended that people do not pay much for the solution, it aims to cost around \$50.

- Is the problem definition adequate or is the problem broader or narrower than the original problem statement indicates?

The problem is adequate as everybody who lives in high-theft neighborhoods would benefit from a solution.

Justification: Currently, according to José Holguín-Veras, an engineering professor and director at the Rensselaer Polytechnic Institute Center of Excellence for Sustainable Urban Freight Systems, more than 1.7 million packages are stolen each day which totals \$25 millions dollars in stolen goods⁵. To prevent this, people could purchase a package theft prevention device to stop people from taking the goods they buy. By purchasing this, the idea is that the cost of the packages you keep from being stolen will outweigh the cost of the package theft prevention device. This way, the device is justified.





Brief Summary of Existing Solutions:


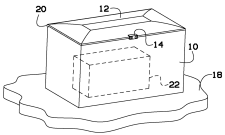
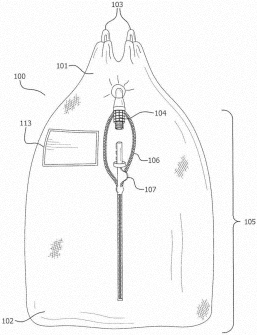
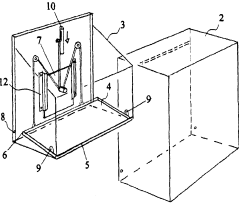
The DoorBox is an existing solution to protect package theft. Although it's easy to set up, it is aesthetically unappealing and requires a wired connection for power. The Vsons Box has a strong metal layer for physical protection; however, it is both extremely expensive (upwards of \$300) and can only fit a single package at a time. The Keter Delivery box, although large enough to hold multiple packages, is large/obtrusive and made of fake wood, providing very little physical protection. Some other solutions exist with benefits and drawbacks, and are also analyzed below in more detail.

Element B: Documentation and Analysis of Prior Solution Attempts

For Element B, we researched other solutions to prevent package theft. This included both products on the market and patents of possible products. By utilizing websites, online store information, and patents, we learned what criteria we should fulfill such as looks and size. From the mistakes and flaws presented in other products, we understand what to avoid for our product solution. Mr. MJ Anselmo conducted a majority of the research and analysis of these solutions.

Knowledge of the Marketplace:

Solution (include description and Image)	Source (hyperlink)	Pros	Cons	Target Market (Users and Buyers)
 <p><i>DoorBOX on front porch⁹</i></p>	DoorBOX	<ul style="list-style-type: none"> - Secure Packages - Easy to Install - Multiple Deliveries Anti Theft Alarm 	<ul style="list-style-type: none"> -Large -Ugly -Bulky -Website had false information and scarcely credible 	<ul style="list-style-type: none"> -Homeowners -People in high theft areas
 <p><i>The Vsons BOX Locking parcel drop box¹⁰</i></p>	Vsons Box	<ul style="list-style-type: none"> -Looks good -Simple -Easy to Use 	<ul style="list-style-type: none"> -Can't do multiple deliveries Expensive 	<ul style="list-style-type: none"> -Wealthy Homeowners -People in high theft areas
 <p><i>Keter Delivery Box in the color brown¹¹</i></p>	Keter Delivery Box	<ul style="list-style-type: none"> -Very Simple -Multiple Deliveries 	<ul style="list-style-type: none"> -Ugly -Fake Wood 	<ul style="list-style-type: none"> -Homeowners that get multiple packages delivered daily. -People in high theft areas
 <p><i>Mail Boss 7506 Mail Manager Package collector mailbox¹²</i></p>	Mail Boss 7506 Mail Manager	<ul style="list-style-type: none"> - Simple - Small 	<ul style="list-style-type: none"> -Ugly -Small -Cheap -Used for mail and small packages 	<ul style="list-style-type: none"> -Homeowners that only receive small packages

 <p>Ring Doorbell on front door frame¹³</p>	<p>Ring Doorbell</p>	<ul style="list-style-type: none"> -Pretty -High Tech -Multipurpose 	<ul style="list-style-type: none"> -Expensive -Doesn't stop thieves -Requires smartphones 	<ul style="list-style-type: none"> -Homeowners who want security around their home, possibly because they live in an unsafe neighborhood
 <p>Lock box for package delivery patent technical drawing¹⁴</p>	<p>Lock box for package delivery</p>	<ul style="list-style-type: none"> -Simple -Easy to use 	<ul style="list-style-type: none"> -Unfathomably ugly -If it's too big, it'll draw too much attention -If it's too small, it won't hold any packages 	<ul style="list-style-type: none"> -Homeowners in high
 <p>FIG. 1 Package Receptacle and Theft Deterrent Device and System patent technical drawing¹⁵</p>	<p>Package Receptacle and Theft Deterrent Device and System</p>	<ul style="list-style-type: none"> -Malleable -Compact -Can fit multiple type and sizes of packages 	<ul style="list-style-type: none"> -Can be cut open -Too big/ draws too much attention 	<ul style="list-style-type: none"> -Homeowners or apartment owners in high income areas.
 <p>Parcel box for receiving and keeping parcels in a theft proof manner patent technical drawing¹⁶</p>	<p>Parcel box for receiving and keeping parcels in a theft proof manner</p>	<ul style="list-style-type: none"> -Has a door. -Multiple package deliveries 	<ul style="list-style-type: none"> -Expensive -No tie down 	<ul style="list-style-type: none"> -Homeowners who have a limited amount of space.

Prior Solution Attempts: [Similar Solutions Matrix Google Sheet](#)

Element C: Presentation and Justification of Solution Requirements

To acquire some data for what is important factor in the design process we conducted a second survey which asked about what percentage of the population would benefit from a package pirate prevention device and what are the important features they would want incorporated into it.

Design Specifications:

Target Consumer

The target consumers are customers who have packages delivered to them, especially in areas with higher theft.

Customer Needs.

The customer does not want their packages stolen from their door before they acquire the product.

Performance.

The product must be able to secure packages that are delivered to someone's home. This could be accomplished via a lock mechanism or alarm system.

Target Cost.

The anticipated cost to the consumer would be around \$50 to \$200, however the amount saved will likely be more, considering the target consumer is likely in an area where a similar amount or greater might be stolen.

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

The product should fit multiple packages, and/or the weight should be significant enough to the point where thieves (or potential porch pirates) would not be able to easily run away with the consumer's item(s).

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

The product should have a sleek, simplistic, and aesthetically pleasing design, so consumers are more likely to both purchase our product and to use it on their front porch. Considering the front porch is one of the first things visitors see when they approach a house, the design of a box that contains packages in front of it must not appear bulky, ugly, or otherwise unappealing.

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

The product will likely be made out of a durable material such as metal that can resist any attempts for forceful opening.

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

There would be little to no safety or legal issues relating to our product, unless the product does not work as intended. Although the consumer might have legal issues with a thief or porch pirate who attempts to steal from their front porch, our company itself would not be involved.

Ergonomics. Identify considerations for the ergonomics of the product.

The product should be somewhat cumbersome (not easy to carry), so that thieves cannot pick up the product and run away with it. However, this design specification should not negatively affect the aesthetics of our product.

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).

The product's operating environment likely does not impact any functionality or process relating to our project.

- 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?

The product will not contain any toxic or dangerous substances. After its useful life, its materials should be recycled.
- Service Life.** What is the required service life of the product?

Hopefully our product will last 5-10 years. This depends on the technology we use, the material involved (metal, wood, etc.).
- 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?

If we use some sort of biometric device (fingerprint reader or Face ID), part of it would probably be replaced in less than 5 years. However, if we use a simple passcode or no lock, it might last a lot longer and would not need replacement any time soon.
- Durability and Maintenance.**

The interior of the box or location the package will be placed should be cleaned, especially if you're purchasing food or anything perishable.

 - What is the anticipated maintenance schedule?

The consumer would likely want to clean their device every month or two.
 - Special Tools**

No special tools will be required.
 - Replacement Parts**

A passcode system might need to be replaced, however this is only necessary if the original broke or otherwise degraded. We can provide extra parts for sale.
- Additional Criteria :
 - Design Priorities**

Physical theft prevention ← Cost-effectiveness ← Mental theft prevention ← Aesthetics ← Durability
 - Work Constraints**

We have a limited budget: likely less than \$200; 6-month time constraint; limited expert availability; limited accessibility to power tools and other tools to work with metal and other components/materials.

Justification Survey:

Survey Results: Justification of the problem & Design Specification

Survey Questions: "What is your age?" "How would you describe your residence?" "Where do you receive your packages?" "How many packages have been stolen from your household?" "What's the average value of your stolen goods?" "Would you benefit from a product aimed at package theft?" "If you DO NOT think you would benefit from a theft prevention product, why not?" "If you DO think you would benefit from a theft prevention product, what is the highest price you would be willing to pay?" "We are attempting to build a device to prevent package theft. Which of the following ideas would be important in a package theft prevention device?"

Number of Respondents and Results:

As of December 15 at 9:51am, 77 People have taken our second survey.

We hoped to analyze how consumers and individuals who experience package theft may respond to potential solutions, and to determine what the most effective solutions may be in preventing porch pirating.

Figure 12: Question 1 from Justification Survey¹⁹.

What is your age?
77 responses

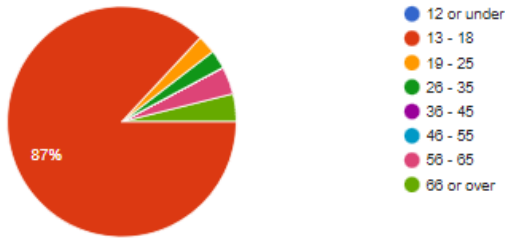


Figure 13: Question 2 from Justification Survey¹⁹.

How would you describe your residence(s)?
77 responses

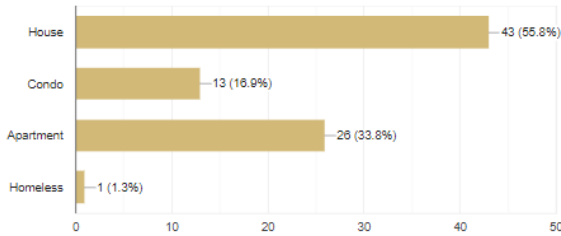


Figure 14: Question 3 from Justification Survey¹⁹.

Where do you receive your packages? (select all that apply)
77 responses

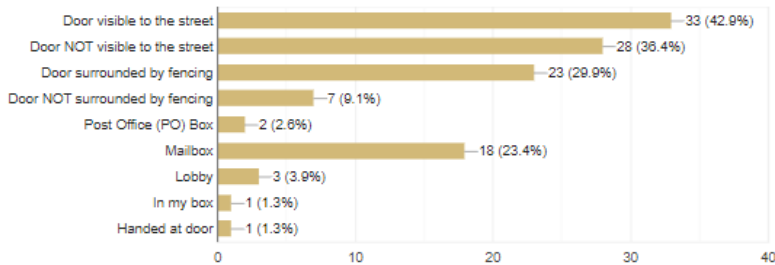


Figure 15: Question 4 from Justification Survey¹⁹

How many packages have been stolen from your household?

77 responses

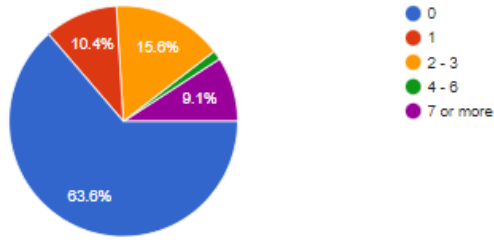


Figure 16: Question 5 from Justification Survey¹⁹

What's the average value of your stolen good? (in USD)

77 responses

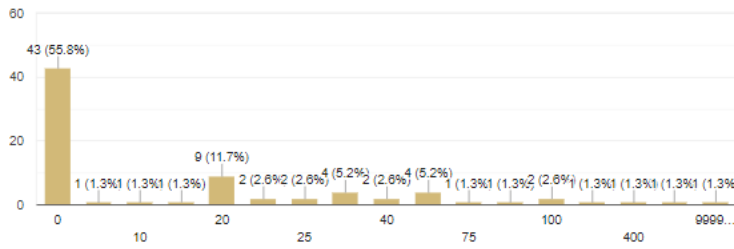


Figure 17: Question 6 from Justification Survey¹⁹

Would you benefit from a product aimed at preventing package theft?

77 responses

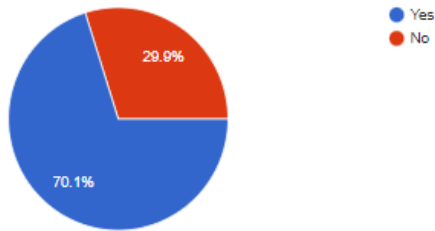


Figure 18: Question 7 from Justification Survey¹⁹

If you DO NOT think you would benefit from a theft prevention product, why not?

27 responses

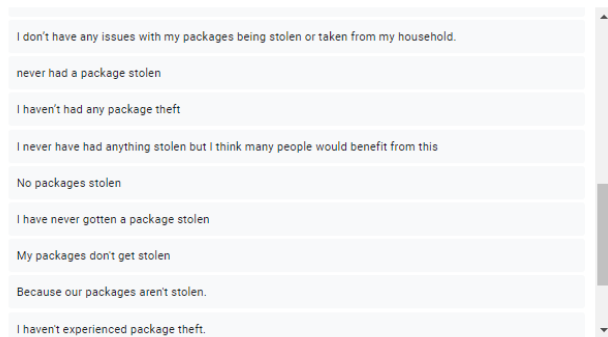


Figure 19: Question 8 from Justification Survey¹⁹

If you DO think you would benefit from a theft prevention product, what is the highest price you would be willing to pay?

63 responses

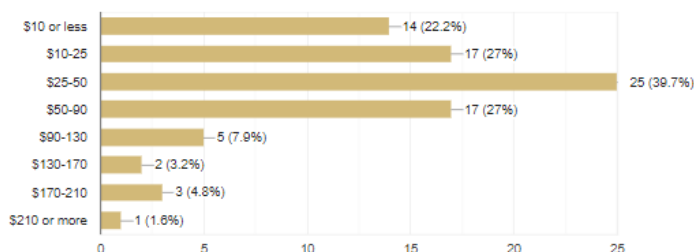
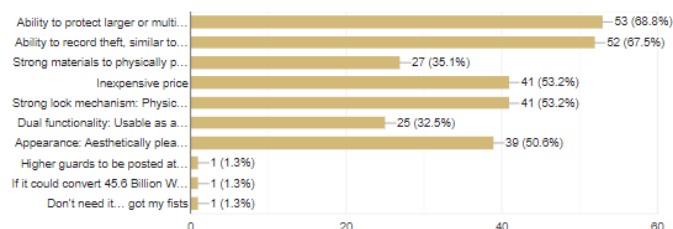


Figure 20: Question 9 from Justification Survey¹⁹

We are attempting to build a device to prevent package theft. Which of the following ideas would be important in a package theft prevention device?

77 responses



How we will modify our research and/or design specifications:

After receiving these results, we have concluded that although most of our respondents did not report any packages stolen, the majority (70%) of them indicated that they would benefit from a product that prevented package theft. This indicates that there is an overall need for package theft prevention no matter the location at which people receive their packages from. Additionally, regarding which factors should be included, the majority of respondents indicated that they wanted the ability to protect multiple packages, a recording device to capture attempted thefts, a strong lock mechanism, and affordability to be prioritized when creating our product. From this we have summarized that the most important factor is capacity to hold multiple packages as top priority, an embedded recording device as next priority, a strong lock mechanism as third priority, affordability as the third priority, and aesthetics as the fourth priority.

Mentor Information:

Name: Neil Paton

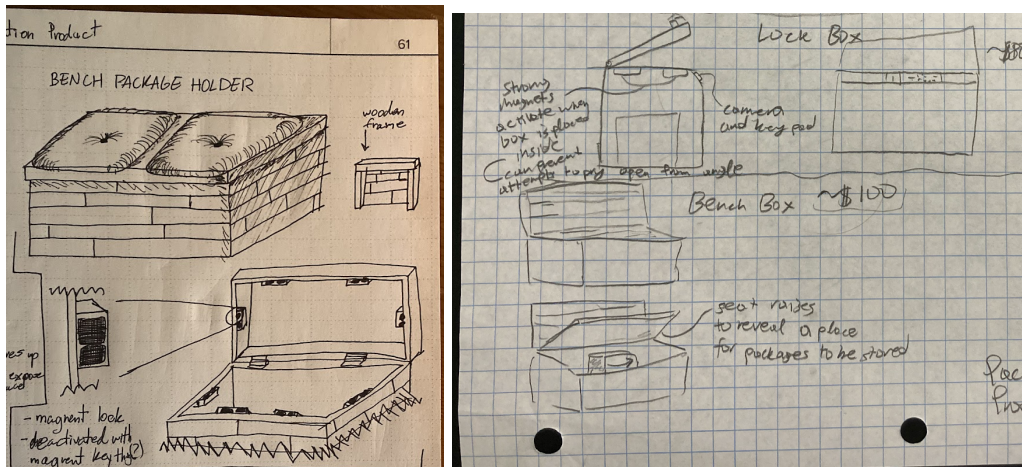
Email: neilpaton71@gmail.com

Expertise: Material / Mechanical Engineering

Contact plan: We originally contacted him through email but he has expressed an interest in talking over the phone or zoom because it is a much faster and more efficient process. Furthermore, he has experience in doing these long-distance mentorships through this median during covid.

[Mentor Feedback Document](#)

Initial Design Concept: (Theo, Kim, MJ, Ethan)



From left to right, Figure 25²⁴, 26²⁵

Initial Peer Feedback (Theo)



Figure 24²⁷

Taking a look at the feedback given, we learned a lot about the important factors that people value in our product. The most repeated piece of feedback asks to make it easy for delivery workers to find the product. We will try to achieve this by instructing customers to make special instructions on the delivery site or have indications on the product itself. One of the second most common guidelines indicates that we need to make a design that can work in multiple different environments. This means that while an outdoor bench works very well in an outdoor porch,

it may not fit so comfortably next to a door in an apartment complex. In response to this we will likely make more than one product that can be purchased depending on the type of front door the consumer has.

Revised Design Concept (version 2): (Kim, Theo)

- Taking the peer feedback into consideration, revise your initial design concept and create an image or description of the idea and add below.

Product Improvement and Design Documentation (Ethan, Kim)

The following is a list of some factors that may affect the commercial success of your product. Keep these factors in mind as you create detailed documentation of your design.

Answer the following questions in your document

- **Function.** Can you simplify the operation of the product? Will the product function properly every time it is used?
 - The operation of our product can be simplified if we use a simple lock and key, not an electronic lock. Plus, if we get rid of an electric lock, the risk of a failure or faulty lock will be reduced justicly.
- **Aesthetics.** Can you improve the visual appeal of the product? Keep your target market in mind.
- **Ergonomics.** Is the product well suited for human use? Is it user friendly? Can you improve the ease of use?
- **Safety.** Is the product safe to use? Are there any components that may pose a hazard?
- **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?
- **Standardization.** Can you use standard tools and parts instead of requiring custom tools or parts?
- **Quality Control.** Are there parts or components of the product that will be difficult to manufacture correctly? Can you alter the design to better **control** the quality of the product in the manufacturing stage?
- **Ease of Maintenance.** Is the product easy to maintain? Can you improve the product to reduce the need for maintenance? Can the cost of maintenance be reduced by altering the design to require less expensive tools or parts to properly maintain the product?
- **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?
- **Environment.** Consider the life cycle (as discussed in Lesson 1.1) 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?

Assign individual responsibilities among team members to complete each of the following tasks:

Prototype Design Documentation (Theo)

[**See Grading Rubric Here](#)

- a. Based on the **concept** sketch of the selected solution, ***create detailed annotated sketches of each part of your design in your notebook***. Each group member should review every part drawing to ensure compatibility with other parts and adherence to the approved design scheme.
- b. Create a 3D computer model of your proposed design.

--or--

- c. Create a set of CAD working drawings to document your team's proposed design. 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.
- d. (MJ) 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 the 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.
 - Estimate the time necessary to construct your prototype and an hourly wage for a person to assemble the product. Use these estimates to approximate the total cost of labor to build the prototype.
 - Approximate the production cost for your product by summing the material cost and labor cost.

Lock Mechanism Ideas:

Electronic Lock: This lock is expensive but it allows for a simple quick way to open the lock that will also be able to be compatible with amazon.



Analog Lock: Having an old school style

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.

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.

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 and highlight the pros and cons of each to justify how your product is better than the competitors in the below Market Analysis Table.

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
<i>The material of the shade must be able to withstand a temperature of 350°F without burning or melting</i>	<i>Temperature at which the lamp shade material burns or melts</i>	<i>Quantitative</i>	<i>+/- 5°F</i>	

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

- o 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.
- o 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?

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29.

Appendix

1. [Patent Office](#)- Use this link to discover patents that are related to prior solutions
2. [Prototype Design Documentation Rubric](#)- Use this rubric to evaluate your initial prototype design