

A Novel Storage and Reward System for the Morton Arboretum's Peter Rabbit Garden

Prepared for:

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Executive Summary

The Morton Arboretum presented the challenge of creating a Peter Rabbit themed writing station as a part of a new Peter Rabbit's Garden section they are creating in the Children's Garden. The purpose of this project is to design structures that will encourage children to practice their literacy skills by writing letters, as well as making the space easily maintainable for Arboretum staff. In the development of our solution, several interviews were conducted with various staff members of the Arboretum to gain a deeper understanding of the current practices and core principles of the Children's Garden. The major need of this challenge was to engage the kids with the station and to provide effective storage solutions for the stationery and letters to facilitate their experience. The proposed solution consists of two parts: a center console storage system, and a tree-stumped themed mailbox.

The center console storage system, called the *Twist n' Burrow*, is a vertical shelf that seamlessly slides into the table when not in use, and is equipped with two handles on top to be easily pulled out when access to materials is needed. This integrated system is spacious, weatherproof, user-friendly, and modular.

The tree-stumped themed mailbox, named the *Hop n' Hear*, provides audio feedback when a letter is delivered. The mailbox is also weatherproof and user friendly, but highlights child accessibility and engagement. Additionally, the audio feedback is powered by an electrical system, allowing the Arboretum to add any features they want in the future.

In future implementation, the vertical storage system should utilize 3 studs and 3 guide rails should be used instead of the 2 demonstrated in our prototype for stability. Additionally, further testing with the flap length of the mailbox slots is encouraged to make sure children cannot get their hands stuck in the slots.

Introduction

The Morton Arboretum is opening a new area in their children's garden with a Peter Rabbit aesthetic. Some activities that they are planning to add include:

- A hand pump with watering cans
- A little free library with a bench
- Potentially a costume station
- A writing station to write letters to Peter Rabbit

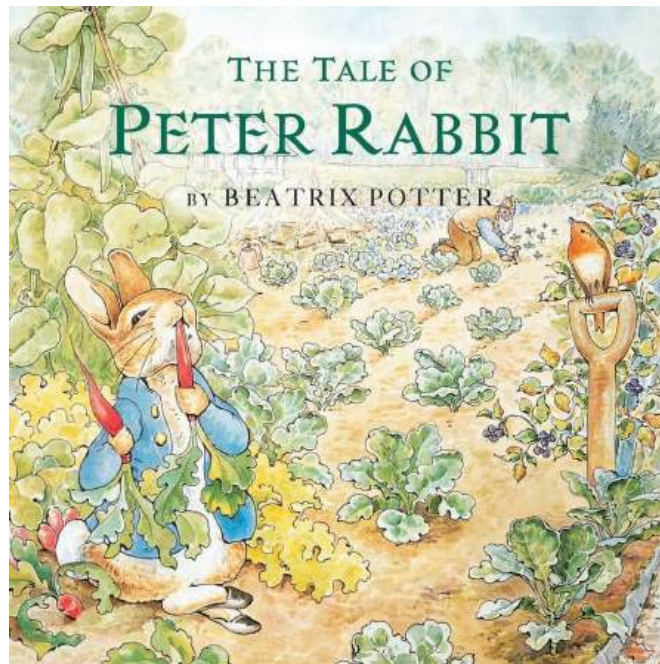


Figure 1. Cover of the Tale of Peter Rabbit

Currently, there is no existing writing station for this area, and we are tasked with designing a prototype that will inspire the final product. We propose a writing station that includes an efficient and aesthetic storage system, as well as a reward system to encourage children to write letters. Through this report, we highlight a potential solution to securely store materials for letter writing away from weather effects and a mailbox system for easy letter retrieval and a reward mechanism to encourage further letter writing.

This report consists of the design concept and rationale, future developments, a conclusion, and an appendix. Refer to Appendix A: Project Definition for more detail.

Users and Requirements

Users and Stakeholders:

- The Morton Arboretum:
 - Our project partner, who is responsible for installing, maintaining, and producing the final product.
- Children:
 - Main users of our product, who will use the station to write letters for Peter Rabbit, learning writing and literacy skills in the process
 - Our target age range is 8 months to 8 years old, but could vary as other children use the writing station
- Parents/Guardians:
 - Beneficiaries of children learning to write, who are responsible for managing their children
 - We imagine parents/guardians assisting their children in writing letters

Illustrative User Scenario

Jennifer is a park volunteer in charge of maintaining the Peter Rabbit Writing Station. It is 6:00 AM, and staff are setting up and maintaining the Children's Garden ahead of the 7:00 AM opening. Jennifer walks up to the writing station, a large round table with a center storage console. She leans over the table, grabbing both handles of the storage console (*Twist n' Burrow*), and pulls upwards. Once she feels the storage console hit the maximum height, she twists it counterclockwise until it maxes out, and she lets it down slowly. Now the storage console is at the appropriate height, where children can reach and grab paper, pencils, and crayons. The paper is stored in a paper container at the lowest level, while the pencils and pens are stored in pen holders on the second level. As children come by throughout the day, they grab the utensils and write letters to Peter Rabbit, and once finished they put it into the treestump mailbox (*Hop n' Hear*) next to the writing table. When a letter is deposited into the mailbox, it rings a bell that signals it has received the letter. At the end of the day, the *Twist n' Burrow* can be returned to its original close state by lifting, turning clockwise, then lowering until the *Twist n' Burrow* is completely level with the rest of the table. Letters can be extracted from the Treestump Mailbox through a door on the back, locked by a lock that Jennifer has the code for. After unlocking and opening the door, Jennifer takes out the box of letters and passes them off to other park staff to be read or responded to. After replacing the box, she locks the mailbox again and can leave until tomorrow morning, when the writing station is to be set up again.

Project Requirements

Our design must include:

- A storage solution for writing utensils and paper
 - Since the station will stay out in the cold, withstanding snow, sun, rain, and more, the writing utensils and paper must be stored in a way that will protect from weathering. The paper and utensils will stay in the storage when not in use, and must be easily accessible by staff and volunteers.
- An accessible and weatherproof way of storing letters
 - The letters written by children must be kept safe in a safe and secure environment that can be later collected by staff to be responded to or kept. The letters must stay dry and clean after they are submitted, and they must not be damaged during the submission process.
- An audio feedback when letters are submitted
 - When the letters are submitted, there must be a sound alert to create an audio feedback and response for the children. The audio playback plays into the Children's Garden's focus on interactivity and tactile learning.
- An area for children to write letters
 - There must be a dedicated area and writing surface for children to write their letters. It should be accessible by children from ages 8 months to 8 years, as well as being ADA compliant.
- A Peter Rabbit aesthetic
 - The new section of the Children's Garden is in the theme of Peter Rabbit, therefore our design must match the theme and aesthetic. Natural materials are much preferred (e.g. wood) as they match a natural aesthetic. Manufactured materials (e.g. plastic) are not as they do not match the natural aesthetic.

Refer to Appendix B: User Interview/Observation summary: for detail about observations from interviews and site visits.

Design concept and rationale

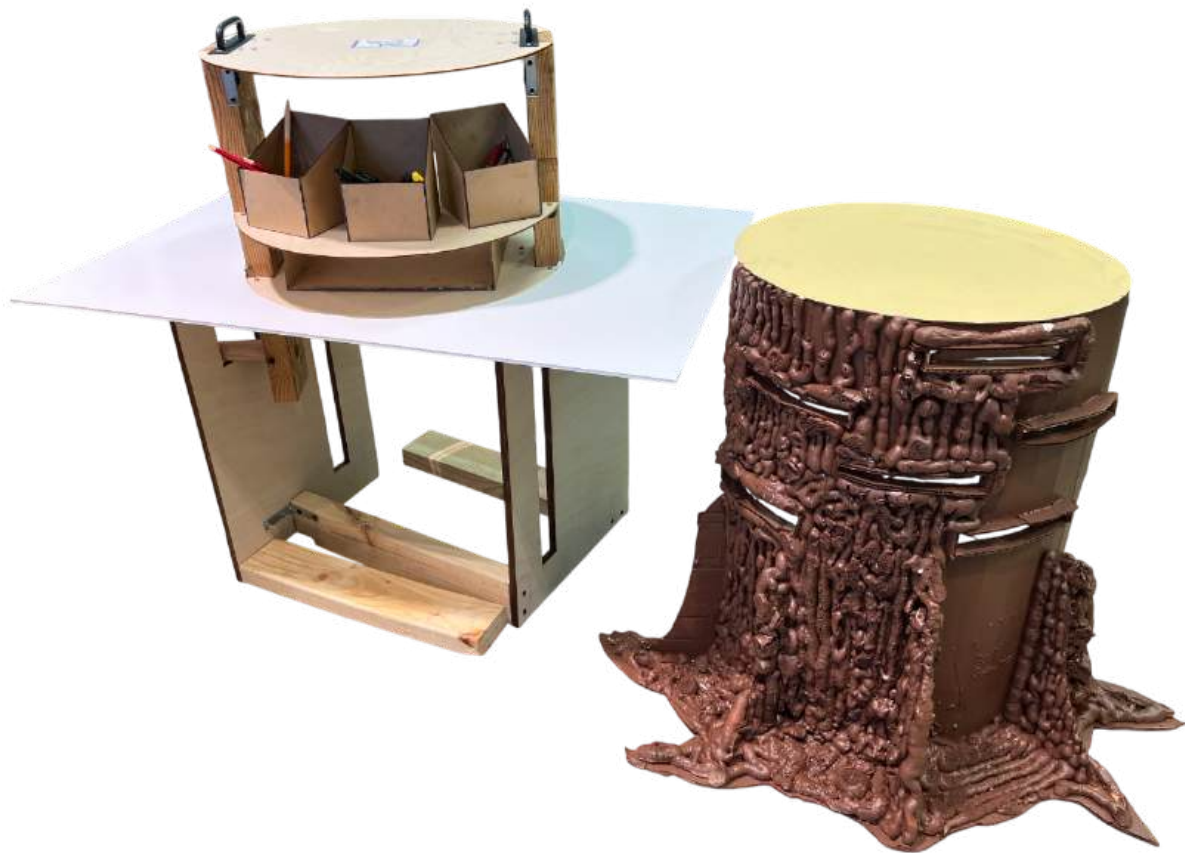


Figure 2. Prototype designs for our solutions to the design challenge

The Peter Rabbit Writing Station is a letter writing station for children aged between 18 months to 8 years consisting of a circular table with a central pull-out storage system and a tree-stump styled mailbox. At the center of the table, there is a cylindrical shaped storage unit (Figure 2) to store pens, pencils, papers, and other essential items for the children called the *Twist n' Burrow*. It can be pulled up using the two handles and locked by turning it clockwise. Once used, it can slide back in by simply unlocking it by turning it anti-clockwise and pushing it back inside. On the other hand, the mailbox (Figure 2) is designed carefully to include various entry points for the letter submission. As a letter is dropped, it will go through a funnel and then using a laser beam with sensors, a bell will ring, making it more interactive and fun.

See Appendix C: Mockup Testing and Appendix D: Design Review Summary for full detail of mockups and early prototype designs.

Twist n' Burrow: Center Storage Console

To properly store and maintain writing utensils and paper for the Peter Rabbit writing station, we designed a center storage console. Our first design consideration was weatherproofing the design. The table will sit outdoors for the whole year, experiencing weather conditions such as harsh sun, winter snow, hail, etc. Our design solves this by storing the pens and pencils within the table itself, protecting the writing utensils from the outdoor weather conditions as it sits flush with the table surface (see figure 1). The storage can be accessed by pulling upwards on both handles, and once at the top, twisting counterclockwise until rotation stops, and setting down the storage slowly (see figure 2).



Figure 3. Closed and Open State of Storage

Twist n' Burrow Specifications

- **Material**

- The storage console is constructed from plywood sheets and spruce wood 2x4 planks. These were chosen due to their relative weather resistance along with their appearance. Wood is the preferred material due to its natural look to fit into the Peter Rabbit aesthetic of the Children's Garden. Our estimates also suggested wood was the best material to reach our weight target of 10 pounds.

- **Weight**

- The storage console is designed to be only accessible by adults and park volunteers, weighing at roughly 8.25 pounds. We asked several students to lift dumbbells to approximate the lifting weight, and found a good compromise at 10 pounds. From research, older children are able to lift this much weight, however the angle and position of lifting makes it difficult to do so. Thereby only adults and older volunteers will be able to lift the Twist n' Burrow to set up in the mornings and to close up in the afternoons.

- **Height**

- At standing height, the Twist n' Burrow stands at 17.76 inches (~1.5 ft) above the surface of the table. There are two layers of the console, the bottom layer is at table height, and the upper layer is 3.5 inches above it. These heights were designed to be accessible by older children (5-8 year olds with arm lengths of around 11 inches and above). We conducted testing using a 11 inch stick representing a child's arm and found that the second layer height of 3.5 inches was a good balance of reachability and accessibility to the lower layer.

- **Circular Design**

- The center storage was designed to be a circle to maximise accessibility to each child, as a circle provides equal opportunity for each writing station participant to grab their paper and writing utensil. Our research showed that a circular, roundtable design would encourage the most collaboration between users

- **Handle Design**

- Our choice of handle was an aluminum screw-on handle that could attach directly to the center storage. Aluminum was chosen for its temperature,

moisture, UV, and rust resistance, making it ideal for prolonged use in the open. The design involves two handles on opposite sides of the storage, enabling ergonomic lifting and turning for the mechanism.

- **Layer Design**

- The choice to separate the letter paper and the writing utensils was determined from testing in the prototyping phase. Users found it most easy when paper was at a lower level and the writing utensils were placed above in a separate layer. Our design consists of a bottom layer at tabletop height when fully lifted, as well as a second layer 3.5 inches above to hold writing utensils.



Figure 4. Assembled prototype without foamcore tabletop

For specific dimensions and assembly procedures, refer to Appendix E, the instructions for construction for the central storage console.

Hop n' Hear: Tree Stump Mailbox



Figure 5. Hop n' Hear Prototype

The tree-stump styled mailbox contributes to the writing station both aesthetically and functionally. Children will deliver their completed letters by inserting them into whatever mailslot is more comfortable for them to reach. Once the mail is delivered, a small bell will ring, giving children instant audio feedback and incentivizing them to further interact with the mailbox and the writing station as a whole. A bell was chosen as a reward system, as multiple studies have confirmed that spiritual rewards are an effective form of positive reinforcement [1-4]. For the staff, the mailbox is equipped with a locked door that gives them access to a collection basket, allowing them to easily collect all the letters.

Tree Stump Mailbox Specifications

- **Breakbeam Sensor**
 - We decided to opt for an electrical system to trigger the bell rather than a mechanical system for cost-effective repairs and ensuring scalability of the system. Electrical parts such as sensors, servos, and wires are all inexpensive, and in our visits to the Arboretum we confirmed that staff would be able to fix electrical problems. Additionally, the electrical system gives the Arboretum the option of easily adding more feedback features to the mailbox in the future, such as a digital speaker that could play a voice

clip of Peter Rabbit, or a physical token dispenser for the children to keep as a souvenir. In our conversations with Dr. Gezci, we learned that instant feedback is a key part of engaging younger kids, so we want to give the Arboretum the opportunity to further develop any other feedback systems that they believe could further encourage children to interact with the writing station.

- **Mail Slots**

- As seen in Fig. 3, the tree stump has multiple mail slots at various heights, ensuring the mailbox is accessible to children of different heights, starting at above the funnel (12 inches from the bottom of the stump). For weatherproofing, the mail slots are designed with a small lip around the slots as well as an internal flap, ensuring nothing gets into the mailbox apart from the letters.

- **Material**

- The trunk will be constructed out of concrete and then painted over to look like a tree stump. We are opting for construction of an artificial tree stump over reusing a natural stump as Dr. Gezci informed us that hollowing out a real stump would be too troublesome. We chose concrete as our material because the Arboretum has worked with concrete in the past to create a large tree-themed play space, so we are confident the material can both put up with wear and tear, as well as be modified to fit the aesthetics of the Peter Rabbit Garden.

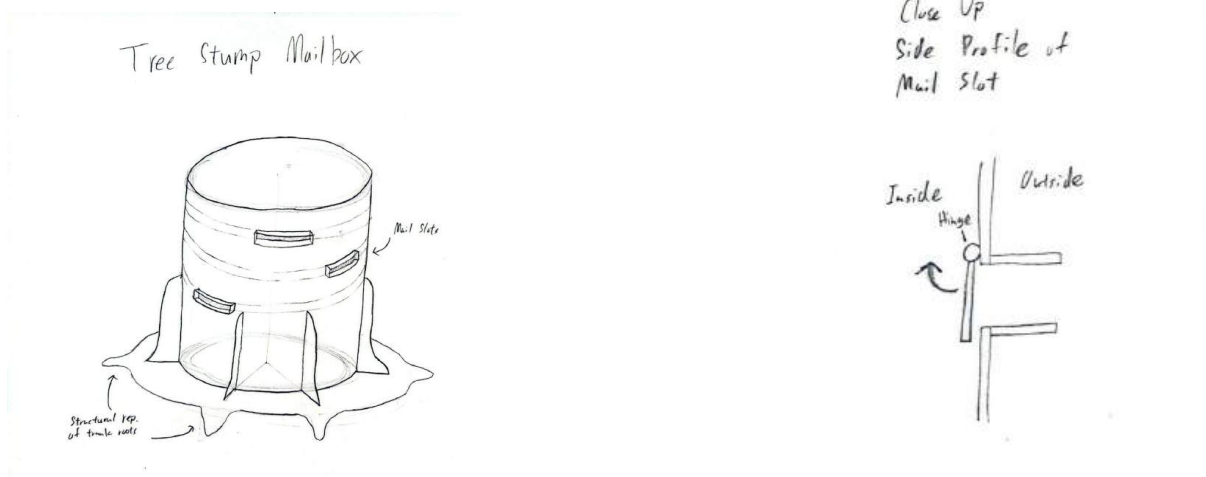


Figure 6. Sketch of Mailbox Prototype

Figure 7. Side Profile of Mail Slot

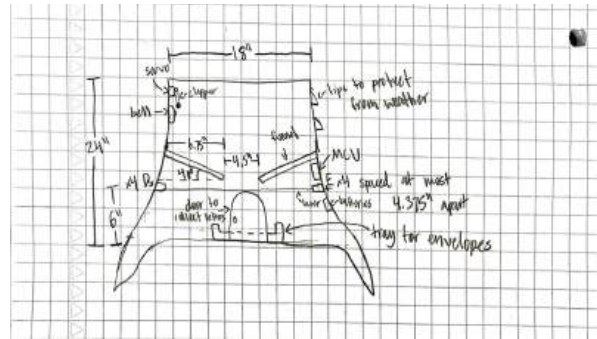


Figure 8. Dimensions of Mailbox prototype

For specific dimensions and assembly procedures, refer to Appendix F, the instructions for Hop n' Hear Construction.

Future development

Twist n' Burrow

- **Safety**
 - For future construction, we would recommend constructing the design using 3 dowels, 3 support posts, and 3 dowel holders. The two legged prototype has been found to be unstable with testing, so we recommend using 3 support legs to distribute the weight evenly.
 - In the case that the dowels do not hold, wood screws can be drilled into the side of the support posts into the dowel to provide stability and structure.

- **Maintenance**
 - We would also recommend treating the wood with wax in order to weatherproof the wood even further. A polyurethane coating is not recommended due to potentially harmful exposure to children. A wax coating would have to be reapplied periodically, typically annually.

- **Aesthetic**
 - Covering the dowel support can be done using a tree stump design similar to the our designed tree stump mailbox, using concrete to form the texture and painted to match the color of the wood.

- **Testing**
 - The size of support posts may be changed to smaller dimensional lumber to allow for more storage area and accessible area.
 - The height of the table can also be adjusted as needed to accommodate different heights. Our storage console is designed to be easily slotted into any circular table design.
 - Due to time constraints, we were unable to test how snow and rain could affect the writing utensils and pencils. Further testing into moisture and potential water leakage should be conducted before proceeding with the design and final build.
 - Testing could include testing O-ring design to seal moisture. An O-ring design would require sufficient weight to hold the seal in place, however, the weight of the console itself could be used to seal the console.
 - Testing could also include the design of the table itself. We have provided a prototype of the center storage console to demonstrate the mechanism. The table would have to include a method to encapsulate the mechanism and provide a flat surface to write.

Hop n' Hear

- **Safety**
 - Children's fingers could get caught under the flaps. Doing further testing and making appropriate modifications to the dimensions of the slot and the flap is recommended regarding this concern.

- **Maintenance**
 - Maintenance would include switching out batteries and recharging old ones, and taking envelopes out of the mailbox
 - Test how long the power can last in different weather conditions, test waterproof ability of tree stump (without electronic components inside)
 - Can consider solar power as an additional power source.

- **Aesthetic**
 - Experiment with different materials to make the most realistic tree stump and retain waterproof ability
 - A physical design to trigger a bell when the letters are inserted could be explored.
 - One such design that was explored was hanging a collection of bells internally from the top of the tree stump, like a wind chime, such that whenever a letter was inserted it would push these bells and cause sound.

- **Testing**
 - The number and height of the many slots can be changed to allow for greater accessibility and freedom.
 - Like the Twist n' Burrow, further testing into moisture and potential water leakage should be conducted before proceeding with the design and final build.
 - The mailbox can be propped up to different heights according to the common heights of children.

- **Potential Failure Points**
 - Batteries not providing enough power
 - Solution: Replace with fresh batteries
 - Water or weather gets in and negatively effects circuit
 - Solution: Check if permanently damaged, look for failure point and reinforce sealing.
 - Circuit breaks

- Solution: Check appendix provided to see where the connections are bad, and fix
- **New Features**
 - Add other features that take advantage of the electronic system to further encourage letter writing, such as:
 - A flag that raises once a letter has been detected
 - A light that lights up in a nice pattern
 - Souvenir dispenser
 - Speaker that plays a thank you message
 - And any other ideas that arise

Conclusion

Our design provides the Morton Arboretum with unique functional solutions that both address the storage needs of their writing station as well as further immerse the children into the Peter Rabbit Garden. The design consists of two parts:

- A hidden storage system within the table that protects materials from the elements seamlessly
- A tree-stump themed mailbox equipped with an electrically-powered instant audio feedback system.

Both of these components ensure that the necessary materials for the letter writing station, from stationary to completed letters, stay safe from harsh weather.

The components were also designed with the Arboretum staff in mind, with handles for staff to easily lift the hidden storage system with, and a collection basket within the mailbox that staff can easily access.

Children need safe and accessible spaces, as well as an engaging environment to encourage them to interact with the space. Our hidden storage system is sufficiently distant from the table edge and heavy as to prevent children from being able to operate the system and thereby preventing possible injuries. Our mailbox is themed as a tree stump to further immerse the children into the Peter Rabbit theme, has multiple slots at different heights to be accessible to all children in the specified age ranges, and provides

instant feedback to children in the form of a bell ringing, rewarding kids for interacting with the space.

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Appendix A: Project Definition

TEAM 4

Anant Jain, Ethan Lanlua, Jimmy Tsai, Nathan Wu

Project Name: Peter Rabbit Writing Station

Project Partner: The Morton Arboretum

Date: 11/04/25

Mission Statement: Design safe, accessible, and engaging structures for children participating in the Peter Rabbit writing station at the Morton Arboretum, allowing children to develop literacy and engage with written language.

Project Deliverables: Final prototype, final report/design summary, and the presentation and poster during the DTC Project Expo

Design Constraints:

- A 6x6 ft space
- Cannot use glitter, balloons, plastic, or glass (can use plexiglass)
- Must have some sort of writing station

Users and Stakeholders:

- The Morton Arboretum: project partner, responsible for installing, maintaining, and producing the final product
- Children: the users of the product, will use the station to write letters for Peter Rabbit and learn in an entertaining way
- Parents/Guardians: beneficiaries of children learning to write, responsible for bringing children to the Garden

User Profile:

- Children: (focusing around ages 8 months - 8 years, but could vary from this) who use the writing station as part of their trip to Morton Arboretum
- Parents/Guardians: keeping children in control and helping them write letters

Illustrative User Scenario:

Jennifer is a park volunteer in charge of maintaining the Peter Rabbit Writing Station. It is 6:00 AM, and staff are setting up and maintaining the Children's Garden ahead of the 7:00 AM opening. Jennifer walks up to the writing station, a large round table with a center storage console. She leans over the table, grabbing both handles of the storage console (*Twist n' Burrow*), and pulls upwards. Once she feels the storage console hit the maximum height, she twists it counterclockwise until it maxes out, and she lets it down slowly. Now the storage console is at the appropriate height, where children can reach and grab paper, pencils, and crayons. The paper is stored in a paper container at the lowest level, while the pencils and pens are stored in pen holders on the second level. As children come by throughout the day, they grab the utensils and write letters to Peter Rabbit, and once finished they put it into the treestump mailbox (*Hop n' Hear*) next to the writing table. When a letter is deposited into the mailbox, it rings a bell that signals it has received the letter. At the end of the day, the Twist n' Burrow can be returned to its original close state by lifting, turning clockwise, then lowering until the Twist n' Burrow is completely level with the rest of the table. Letters can be extracted from the Treestump Mailbox through a door on the back, locked by a lock that Jennifer has the code for. After unlocking and opening the door, Jennifer takes out the box of letters and passes them off to other park staff to be read or responded to. After replacing the box, she locks the mailbox again and can leave until tomorrow morning, when the writing station is to be set up again.

Project Requirements:

Needs	Metrics	Units	Ideal Value	Allowable Value
Storage solutions for writing utensils, papers, letter envelopes accessible only for adults	Weight capacity, unit weight, # of pencils stored, # of paper stored, # of letter envelopes stored, # of compartments	lb, lb, #, #, #, #.	10, 12, 100, 100, 8. Weights were decided on average weight of a bag of trash for similar pulling motion, and study done on the average pulling force of young children. Compartment number was decided with the client's request of several compartments in mind.	5, 7, 10, 10, 10

Audio feedback after kids deliver their letter	Sound type, duration, sound level	N/A, sec, decibel	N/A, .5 sec sound or 5 sec message, 50. Decibel level was decided on health guidelines from the Hearing Health Foundation . Sound types will be explored and determined by client.	N/A, >.5 sec, 40
An accessible and weatherproof way of storing letters	# of letters stored, unit area, # of openings, range of opening heights, # of damaged letters after weather testing	#, ft ² , #, in, #	100, 4ft ² , 6, 20, 0 Area based on observed usable space from site visit. Range of opening heights based on range of average heights from 18 months to 8 years old found here .	10, 2ft ² , 3, 15, <3
An area for kids to write	Writing surface area, smoothness of surface, lighting	ft, material, lumens	6x6 (if we have an 8x8 area), wood (smooth and probably coated with resin/epoxy), bright lighting that's soft on the eyes even on cloudy days	3x3, wood (smooth), lightly dimmed
Match the Peter Rabbit aesthetic	References, a good color scheme, items/decorations that would fit in that world	#, # of colors that match the garden, #	3-4, all match, 4	2, most match (maybe like 2 don't), 2

Table 1. Project Requirement Matrix

Appendix B: User Interview/Observation Summary

TEAM 4

Anant Jain, Ethan Lanlua, Jimmy Tsai, Nathan Wu

An interview with Emilian Gezci was conducted in class on September 24th, 2025 from roughly 4:00-4:50pm. An additional in-person observation took place on October 1st, 2025 at the Morton Arboretum from approximately 4:50pm to 6:40pm. Both were conducted to understand the lay of the land, preferred materials and aesthetics, as well as the existing furniture at the Garden.

Methodology

We were given a tour through the Children's Garden, in which we sought out existing furniture that stayed outdoors all year and was commonly used by children. We saw the existing "Taco Gardens" (later to be turned into the Peter Rabbit gardens), measured the size of children's furniture, and asked clarifying questions on details of the design.

Results

Long Term Plans

- Peter rabbit is the start of a 5-year plan
- Peter Rabbit is a test kitchen
 - It will have a small footprint, but will affect how the rest of the garden will be designed and operated
- We have lots of creative freedom in terms of design
- Signs in the garden need to be refreshed
- Megan imagines the entrance of the garden will be an arch entrance with fence surroundings

Physical Preferences/Limitations (Refer to Figure 1.)

- ADA compliance - brush drum is 4'
- Great preference for natural materials
 - Prefers wood
 - No plastics preferably
- Peter Rabbit garden should remain open year round

- Other interactive spaces close around November due to weather conditions.
- Garden 6'x6' to around 8'x8'
- Can add little decoration—pots, raised beds, etc.
 - Like the “Alphabet Garden”
- Writing station ideally located in the shade, back corner of the current lot (see image)

Storage and maintenance

- There are on-site carpenters who make, repair, and maintain furniture and structures in the garden
- Waterproofing is important for storage, and we need to prevent children from easily stealing pencils and other tools
 - Volunteers are very open for maintenance, and we can dictate how much our station needs
- Maintenance at 6am, staff at 9am, open at 10am
- Produce planted in the garden is donated

Measurements in Observation

- Mini chair for children at the Garden has the following dimensions
 - Height 11.5”
 - Width 16.5”
 - Depth 13”
 - Back Height 15”
- Mini Table
 - Height 20.5”



Figure 9. Annotated image of the planned Peter Rabbit Garden plot



Figure 10. Map of the Children's Garden



Figure 11. Additional images of the "Taco Garden", later to be the Peter Rabbit Garden

Discussion

Big Takeaway: Lots of Creative Freedom

Through our interview with Megan, we understand that our project is being built at a time of redevelopment within the Children's Garden, with the Peter Rabbit garden serving as a test run before they fully commit to the full revamp of the theme of the Children's Garden. Furthermore, the general future of the new Children's Garden is still early in the brainstorming phase, so there are very few limitations upon us.

The key limitations to consider as we continue with the design process is space allotted and material selection. Megan made it clear that we could only use wood, as the head of the Children's Garden is strongly against any plastic features. She also noted that the arboretum has on-site carpenters who are responsible for building and maintaining all of the wooden features in the garden, so final designs should be made with the idea of easy assembly in mind. The space that is allotted for the Peter Rabbit garden is shown above in Figure 1. Megan stated that we would be allotted approximately an 8'x8' area to work with, and to keep in mind that any walking paths we want in our space must be at least 3' wide by ADA standards to accommodate wheelchairs, and approximately 5' wide if we wanted to accommodate for the snow plow and keep the space open during the winter. We were recommended to place the writing station in the corner of the full Peter Rabbit garden because of the shade that place gets, but were also welcome to put it in other locations.

Touring the Children's Garden also revealed to us the importance of interactive spaces for the children. We saw several spaces designed for children to play with including a tadpole pool, play structures, and a stream with rocks that kids were free to play with. Megan emphasized the importance of making the Peter Rabbit garden an open space with several interactables throughout, and how the writing station should serve as a lower-energy space for the children.

Appendix C: Mockup Testing/Feedback Summary

TEAM 4

Anant Jain, Ethan Lanlua, Jimmy Tsai, Nathan Wu

An in-person meeting with Emilian Gezci was conducted in class on October 24th for around 15 minutes for each team. Another visit to the Morton Arboretum was conducted on October 25th from approximately 2:00-3:30 pm, revisiting the layout of the Children's Garden and getting additional feedback from Doctor Gezci. Both of these meetings advised our direction in the project and ironing out our design review.

Methodology

We presented our mockup ideas to Doctor Gezci in our 15 minute meeting, getting his thoughts on both the aesthetic and functionality of design. Additionally, we visited the garden, getting to measure the dimensions of in-use storage containers and meeting the people who will maintain our design. We gathered their feedback on what would be favored in terms of cost, size, and maintainability.

Results

Feedback for each mockup design

- Tree stump
 - Concerns about weather, potentially a lip/covering
 - Additional concerns about bees/wasps in the summer

- Audio Feedback
 - Gezci loves the idea of instant feedback
 - Brings up example of being at a library, pressing a button, printing out a poem/spitting out a little message
 - “Analog bell would be perfect”
 - Also possible for a Peter Rabbit voice integration
 - They can fix simple wiring/circuits if need be

- Carrot Pens
 - Planting the pens was well received
 - Many of the pencils would walk away, cheap enough to replace, or cheap enough to make in some ways

- If cheap enough to replenish, then it would be fine to be lost
 - If not cheap, then there'd be a need to keep them safe
 - Preferred if cheap => bought in bulk
- Table Center Storage
 - Interested in the idea of a heavy center console
 - Would require adult presence to pass out the material
 - A heavy design perhaps
 - Writing station must accommodate both parents being there and also kids using the station solo
- Tunnel
 - Would be a challenge structurally, as it must be able to be climbed on and kicked, etc.
 - Do like the concept, worried about price tag
- Rotating Prompt Display
 - There's a rotating display in the Garden already, would be good reference
 - Kids love interacting with things
 - Need to address spamming from the kids, or messy usage
 - So needs to be durable

Additional Information from on site visit

- Strong material used in sculptures in the park
 - Fiber reinforced sculptural cement over steel frame work stuffed with aluminum foil
 - Less favorable, but straight concrete can be used

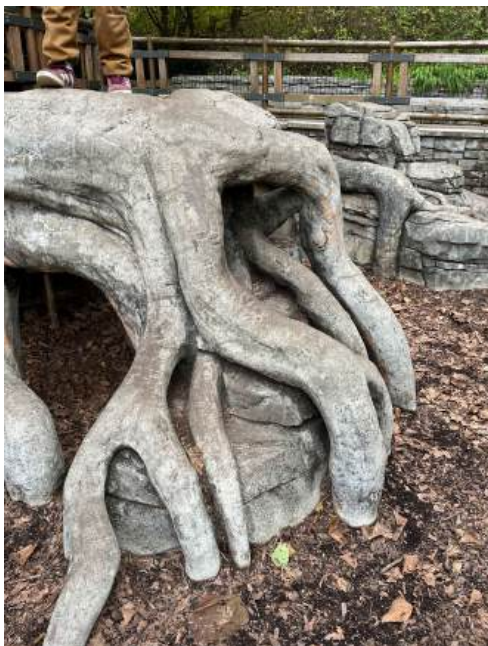


Figure 12. Example of concrete structure

- Table capabilities will determine its use:
 - If portable, then could be moved to accommodate other stations
 - If writing station is popular, then could be kept up all year
 - If no seating, then would have more space and useful if adapted into another station
 - No preference overall for seats or no seats
- Most favored material for the table is wood
 - Must be somewhat moveable, even if it is extremely heavy
- They use snack trays to hold various items in the garden.
 - Useful inside the classrooms to hold pincecones, pens, etc.
 - 13.5” in diameter



Figure 13. Snack Tray Example

Discussion

In our discussion and visit to the arboretum with Emilian Gezci, we were able to refine our mockups and ideas. The two ideas that stuck out to Gezci were the audio feedback and the center table storage, which we plan to implement further. He made it clear that children are extremely receptive to feedback of any kind, and that a physical bell would be a great idea. In addition, he emphasized the fact that at the very least, we must design a writing station. He liked the table idea, bringing it up again when we met him at the arboretum. He showed a snack tray that they commonly used inside classrooms, which we measured to be 13.5” in diameter. When asked about a tunnel design, Gezci showed reservations on the amount of space and cost, which we are taking as a sign to not continue with it, and instead direct our energies to other ideas. Similarly, the feedback we gathered for the rotating prompt display and carrot pens were not positive enough for us to believe it is worth dedicating significant effort into.

Our main takeaway from the interview came out to a focus on both the mailbox/feedback system along with the table/storage system. Continuing with this line of thought, we are looking to combine the two mockups into a complete writing station workflow, where kids will go to the station, get their materials and tools from the storage

system, and deposit their letters into a mailbox which will result in an auditory reward.

- Continue with both the mailbox and the table
- Test more central storage solutions
- They really like our designs that include engaging the children and adding something for them to play with
- Do research on if we can find cheap vegetable themed pencils or make them cheaply
- Try to combine some of the mockups

Appendix D: Design Review Summary

TEAM 4

Anant Jain, Ethan Lanlua, Jimmy Tsai, Nathan Wu

We conducted a design review on October 31, 2025, gathering feedback from our DTC class peers and instructors. The feedback is used to orient ourselves for the design freeze and to make final design changes before prototyping and construction.

Methodology

In our presentation, we took questions from the crowd and noted down the concerns. Additionally, we had the crowd fill out a Google Form detailing limitations and potential problems to possible places of improvement in our design. Our presentation slides can be found here: [📄 Design Review Team 20.4](#).

Category	Design Review Issues	Actions to Take
Mailbox	Letter could get stuck permanently affecting the beam	<ul style="list-style-type: none">● Create housing around the break beam to prevent letters getting stuck on electrical components.<ul style="list-style-type: none">○ Ensure a big enough gap between the break beam and letter collection area so that a vertical letter won't interrupt.○ Ensure weatherproof enclosure through the mailbox, and have the housing be able to protect from stray weather effects. Read datasheets to make sure all components work in various temperatures.
Mailbox	Electronics in the harsh winter — longevity and maintenance	<ul style="list-style-type: none">● Ensure weatherproof enclosure through the mailbox, and have the housing be able to protect from stray weather effects. Read datasheets to make sure all components work in various temperatures.

		<ul style="list-style-type: none"> • Explore alternative design: hanging strings from roof of mailbox near slots, which will be disturbed by inserting the mail. Like an internal wind chime.
Mailbox	Children may put random things in the mailbox	<ul style="list-style-type: none"> • Decrease the slit size of the mailbox to a size just enough to fit an envelope, but not bigger as to fit rocks or other larger items.
Storage	Water potentially seeping through into storage	<ul style="list-style-type: none"> • Integrating a rubber gasket/ o-ring to seal off internal mechanisms and material from water.
Storage	What will you make peg out of? How will it be connected to the rest of design?	<ul style="list-style-type: none"> • The peg would also be made out of wood, and it would be securely fastened using metal fasteners to the wooden storage.
Storage	Is the table reusable in both positions? pulled up or down?	<ul style="list-style-type: none"> • When the position is down, then the storage is at table height and the table would be flat
Storage	Maintenance for the storage console? How to remove it?	<ul style="list-style-type: none"> • Add a secure cover to the bottom section of the storage where you can access to take out the pegs and extract the center piece
Storage	More writing utensils?	<ul style="list-style-type: none"> • Include a variety of utensils other than pencils, such as crayons, markers, and colored pencils

Table 2. Design Review Matrix

Appendix E: Instructions for Twist n' Burrow Construction

TEAM 4

Anant Jain, Ethan Lanlua, Jimmy Tsai, Nathan Wu

Introduction

This document provides step-by-step instructions for **constructing the center storage console** for use in the Peter Rabbit Garden in the Children's Garden at the Morton Arboretum. This design primarily uses dimensional lumber and wood panels along with angle brackets and wood screws to assemble the storage.

These instructions are designed for **Arboretum staff responsible for installation, upkeep, and repair** of the storage console, and should have experience with woodworking.

By following this documentation, users will be able to:

- Construct and create the center storage console for use in the garden

These instructions will first detail the instructions for constructing **our prototype**. The second half details suggestions for building the actual design for use in the Garden.

Prerequisites

Required Skills (Minimal)

No specialized technical background is required. A user should be able to:

- Safely operate common hand tools (drill, scissors, box cutter, etc.)
- Safely operate bandsaws, drill press, and universal laser cutters
- Follow diagrams, measurements, and sequential instructions

Work Environment

- A clean, well-lit workspace
- Proper ventilation (especially when using expanding foam)
- Enough table or floor space to comfortably assemble a frame approximately 18–20 inches wide

Though accomplishable by a single individual, we highly recommend multiple hands to assemble the design and attach parts.

Part List

Parts for the Console:

- 4ft of 2x4 wood planks
- 7 sheets of 36" x 24" 1/8 inch plywood
- 24 L angle brackets
- 30 wood screws
- 1-inch Dowels

Tools for construction and assembly:

- Vertical Bandsaw
 - Drill Press
 - 1-inch diameter drill bits
 - Universal Laser Cutter
 - Power drill
 - 3/8 drill bit
 - 1/8 drill bit
-

b. Central Storage Layers - cut out 3 layers

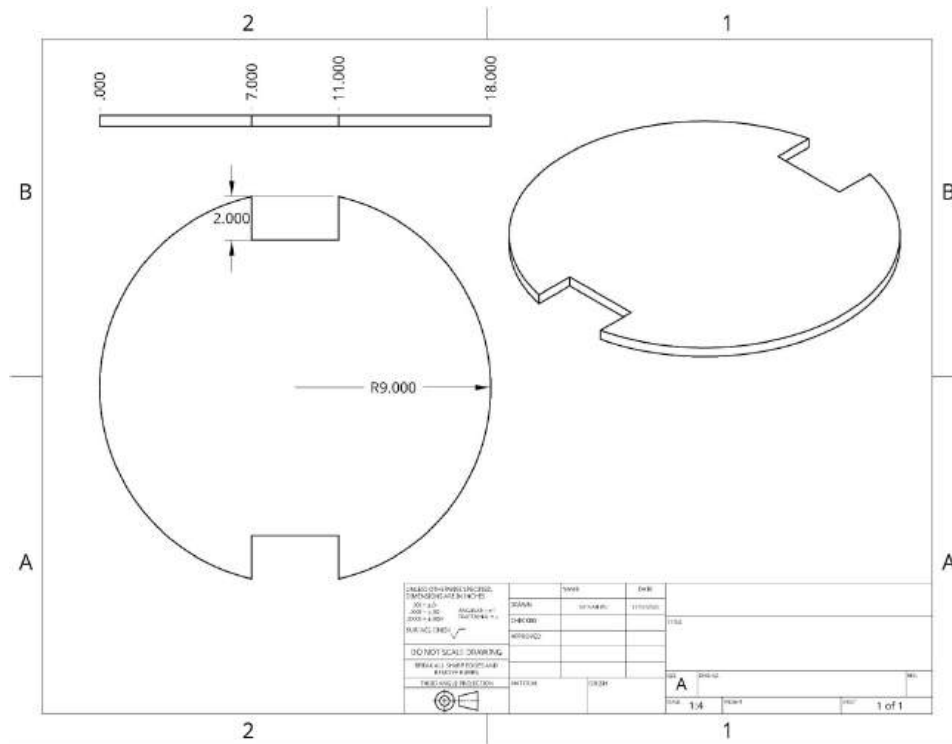


Figure 15. Center Storage Layer



Figure 16. Example of laser cut parts

Assembly of Central Storage

1. On each of the circular center layers, place L-angle brackets facing against the rectangular hole, marking the location and holes with a writing utensil
 - a. Four angle brackets per connection for safety and stability
2. Once done with all three layers, remove the angle brackets
3. Drill through the hole markings using a 3/8th inch drill bit
4. Place L-brackets back onto the layers, attaching them using an 3/8 nut and bolt



Figure 19. Example of attached angle parts

5. Place metal handles onto the the top layer
 - a. Place at the edges above the support post hole
 - b. Mark the hole markings of the handle onto the top layer
 - c. Drill the holes using the 3/8 drill bit
6. Taking the support posts, measure and mark heights of 8.24 inches and 11.74 inches. These will be the heights of the two writing utensil holding layers.
7. Attach the layers onto the two posts, placing the top of each layer at the markings
8. Mark the location of the angle brackets holes on the support posts
9. Using a power drill, drill pilot holes into the support posts at the marked spots
10. Attach the layers and angle brackets to the support posts using wood screws



Figure 20. Example of attached structure

11. Use a hammer to hammer in the 1 inch dowel into the designated hole on the posts
 - a. If the dowel cannot enter the hole, sand down the sides of the hole and try again until there is a snug fit
 - b. Can use wood screws to lock the dowel into the table

Assembly of Dowel Holders

1. Stack two sheets of the dowel holders together, making 4 total stacks
2. Attach each of the two sheets together using wood glue
3. Using masking tape, tape the sides to ensure the sheets stay in place
4. Wait for 30 minutes to 1 hour
5. Attach two sets together to create a total width of four with wood glue
 - a. Use masking tape to keep the sheets in place
 - b. Repeat for the other two sets



Figure 21. Attached sheets being glued together

6. Align the two holders along the central dowel hole (the long part of the L) and make sure they are opposite of each other inside.
 - a. Attach together using 18 inch length 2x4 planks at the bottom for stability

Suggestions for Further Construction

For future construction, we would recommend constructing the design using 3 dowels, 3 support posts, and 3 dowel holders. Essentially, instead of the current two legged design, which we have found to be too unstable with testing, we recommend using 3 support legs to distribute the weight evenly.

We would also recommend treating the wood with wax in order to weatherproof the wood even further. A polyurethane coating is not recommended due to potentially harmful exposure to children.

Covering the dowel support can be done using a tree stump design similar to the our designed tree stump mailbox, using concrete to form the texture and painted to match the color of the wood.

Appendix F: Instructions for Hop n’ Hear Construction

TEAM 4

Anant Jain, Ethan Lanlua, Jimmy Tsai, Nathan Wu

Introduction

This document provides step-by-step instructions for **installing, maintaining, and troubleshooting the Mailbox Reward System** used in the Peter Rabbit–themed children’s writing station at The Morton Arboretum. The system uses breakbeam sensors, a servo-actuated bell, and an Arduino-based control circuit to provide an auditory “reward” when a child inserts a letter into the mailbox.

These instructions are designed for **Arboretum staff responsible for installation, upkeep, and repair** of the mailbox module. The procedures do not require advanced technical training; however, **basic familiarity with simple circuits, Arduino components, and handheld tools** will make installation and maintenance faster and easier.

By following this documentation, users will be able to:

- Install the mailbox reward system into its tree-stump enclosure
- Properly mount and align breakbeam sensors, servo, bell, and supporting hardware
- Power, position, and secure the Arduino control circuit
- Perform routine maintenance such as replacing batteries and checking component alignment
- Diagnose and fix common mechanical and electrical issues

These instructions are designed for use **on-site at The Morton Arboretum**, both during the initial installation and later whenever a malfunction occurs. Notes, warnings, and troubleshooting guidance are included throughout to help users quickly identify problems and restore proper function.

Prerequisites

Required Skills (Minimal)

No specialized technical background is required. A user should be able to:

- Safely operate common hand tools (drill, scissors, box cutter, etc.)
- Identify basic electronic components (wires, sensors, servo, Arduino)
- Follow diagrams, measurements, and sequential instructions

Some familiarity with Arduino or simple electrical circuits is helpful but **not required**.

Work Environment

- A clean, well-lit workspace
- Proper ventilation (especially when using expanding foam)
- Enough table or floor space to assemble a frame approximately 18–20 inches wide

Everything should be able to be done with one person, the step that can be quickened by multiple people is cutting slots, making flaps, and adding protection from the expanding foam.

The process (if using our method for making the outside of the stump) has one big downtime, which is waiting for the foam to cure. This will take 8 hours. Other than that, it has no waiting time. For reference, it took me **8 hours**

Parts List

Parts for the Circuit:

- [4 breakbeam sensors](#)
- [1 servo](#)
- [1 bell](#)
- [1 arduino uno](#)
- [Zip ties](#)
- Breadboard (only need a power and ground line)
- [Male male barrel jack](#)
- 2 3.7 V rechargeable batteries
 - [4 & a battery charger for 100% uptime](#)
- [Battery holder](#)

Parts for the Tree stump:

- Cylindrical object (mesh, cardboard, bucket) to form tree stump
- Funnels
- [hinges](#)

Our way of making the outside of the stump:

- [Expanding foam](#)
- cardboard
- Gloves
- Safety glasses
- Mask

Tools for construction and assembly:

- Hand drill
- 3/16 drill bit
- Ruler & tape measure (can do everything with ruler, tape measure is nice quality of life)
- Straight edge
- Scissors
- Box cutter
- USB B cable

Good ventilation is needed for expanding foam and spray paint

Safety Information

Servo:

- Could move unexpectedly and pinch a finger or damage components
 - Enclose the servo and its path so nothing can get inside
 - Add mechanical limit so it can't go past it and damage components

Circuit:

- Could short, resulting in smoke and really hot components
 - Tie wires down so they don't get yanked out/moved around from movement

Bell:

- The only heavy component that is tied at a high area, could fall down and damage components

All of these are CAUTION

American National Standards Institute (ANSI) standard Z535.4-2023 Product Safety Signs & Labels

Sequentially Ordered Steps

The code for the circuit can be found [here](#). Load the code onto the arduino using the USB B port, and the circuit will be described later.

Frame for the circuit

Create a frame for the break beam sensors and servo to attach to. [Figure 1]

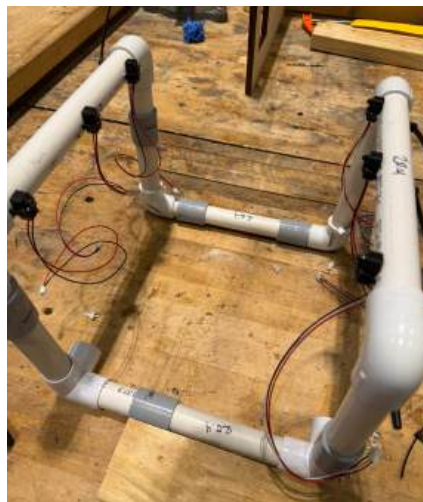


Figure 22. Frame of the circuit with sensors attached

Using a circular base of radius 9 inches, the frame for the circuit should be:

- The length of the frame that the sensors go on should be 13 inches.
- The height should be 10 inches.
- The distance between the sensors should be 9 inches.

Then, drill two holes with a 3/16 size drill on the frame that the break beams will be mounted to for each sensor to go between, and then zip tie the sensor using those two holes. The break beam sensors should be at most 5 inches apart, as the smallest size of the envelopes are 5.75 inches, and that gives more room for error.

When mounting the sensors, make sure that they're facing each other, and at the same level. The selected sensors do have a wider detection region than they look, but they still should be facing each other to leave room for error.

We made a rectangle out of wood that could enclose the sensors tightly to make sure they were facing each other. [Figure 2]

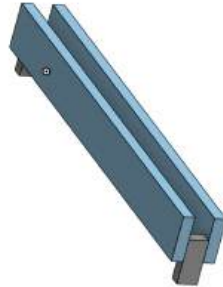


Figure 23. Contraption to make sure the sensors are facing each other

Base

Find a circle a few inches (2-3) smaller of a preferred tree stump base, and put the frame of the circuit on top. Make sure that the sensors are equal distance away from the edges of the circle, and that the sensors are still lined up.

Securing the frame

Drill two holes next around the bottom horizontal leg of the frame, and zip tie it so that it's secured to the base and won't move around in future steps. [Figure 3]



Figure 24. The zip ties attached to the frame

Adding a bell & servo

Add the bell you choose and put it next to the bottom of one of the legs (make it very close to the leg)

Then, put a servo above it so that the servo's arm can reach the bell and make it ring when spun, and mark where the zip tie will have to go to hold the servo to the leg.

If the servo is still wobbly (it was for us), hot glue the servo to the leg. [Figure 4]



Figure 25. Servo ziptied to the leg of the frame and hot glued.

Securing the bell

For our bell, we drilled 4 holes (2 on the inside of the bell, and 2 on the outside) and then ran zip ties through the bottom of the bell, securing the bell. [Figure 5]



Figure 26. Bell zip tied to the base

Secure the arduino, battery pack, and breadboard the same way in a space between the breakbeam sensors and the outside of the circle. Make sure the battery pack is in an easily accessible spot for the door hinge.

The circuit should look like this: [Figure 27]

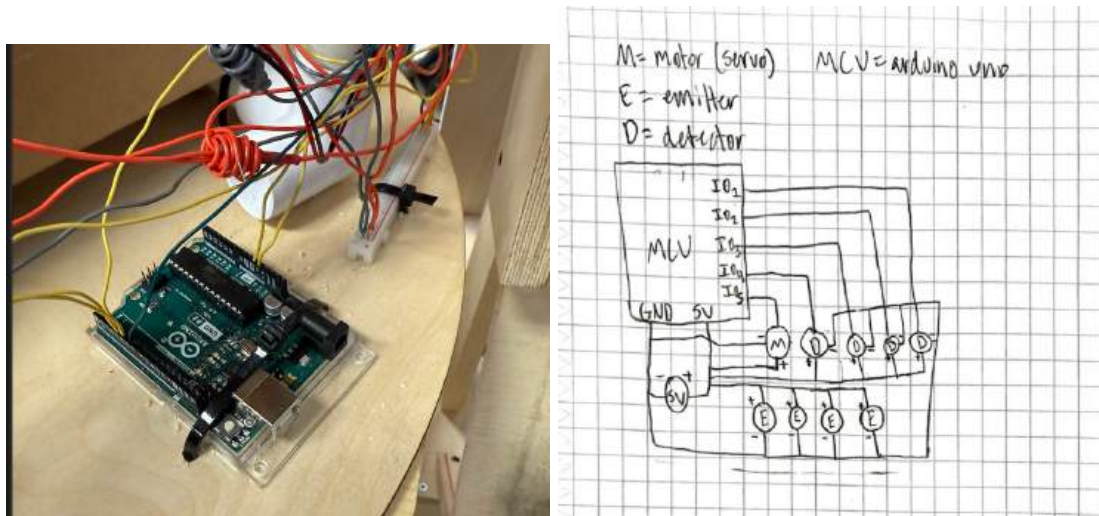


Figure 27. The circuit in real life and in drawing

On the circuit:

The servo is going into pin 3 of the arduino, and the break beam sensor inputs go into pins 4-6. It doesn't matter which ones go into which. The schematic also uses 4 break beams instead of 3, like in the actual design, which is up to user preference.

The wires provided in the prototype can connect 4 different break beams to one power line, making it easy to put into the breadboard. Additionally, they are made longer in case the user decides to build a tree stump with bigger dimensions. The colors of the wire are as follows:

- Orange for power
- Gray for ground
- Yellow/green for signals

Adding the wall of the stump

Once all components have been secured to the base, add the wall to the outside and secure it to the base somehow. For us, we used cardboard because it was very malleable and easy to form into a circle. Then we used hot glue to secure it to the base. [Figure 7]

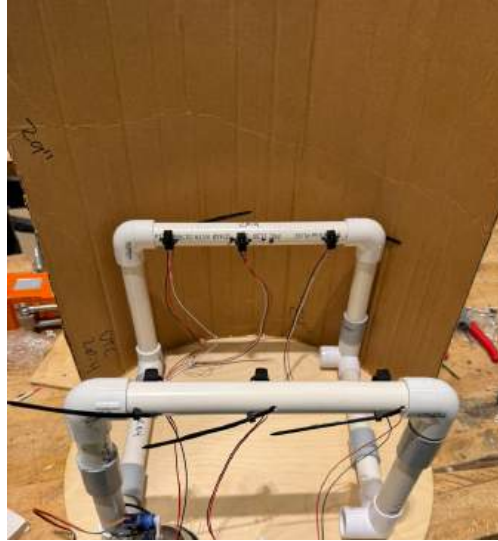


Figure 28. Wall around the base

Installing the funnel

The CAD to the funnel and the structure of the tree stump with all the geometry is [here](#) on Onshape. After laser cutting the funnel out, we hot glued it at a 25° angle where it ended just above the sensors. [Figure 8 & 9]



Figure 29. Funnel attached to the wall



Figure 30. display of the angle we used

Add basket for letter retrieval

Create a flat basket and put it under the gap between the funnels, and add a handle so it's easy to take out. [Figure 10] Make sure that it fits through the door that you are going to make on the side of the tree stump.

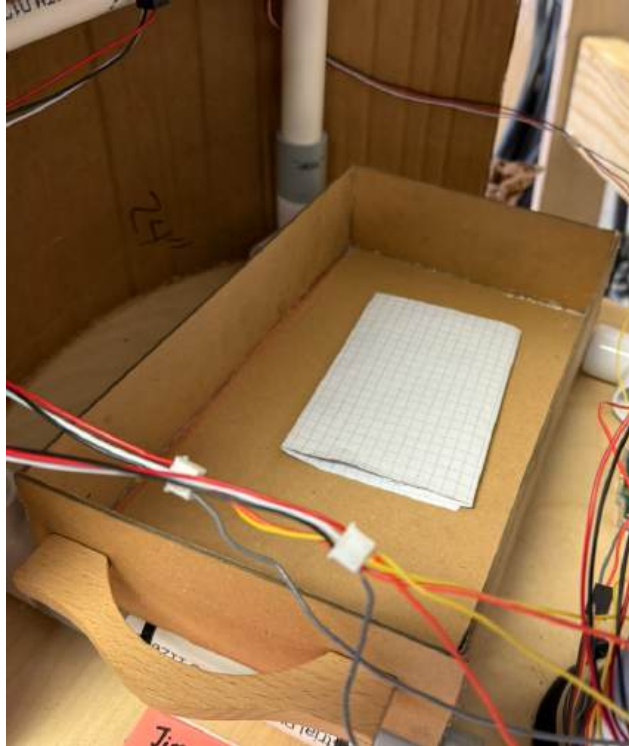


Figure 31. Basket for easy letter retrieval

AT THIS PART, IF YOU ARE USING A DIFFERENT METHOD TO CREATE THE OUTSIDE OF THE STUMP (including flaps), YOU'RE DONE!

If you want to use the method we used, continue on.

Front of the stump

Once everything inside the stump is complete and secure, take a piece of cardboard that is large enough to cover the bottom of the tree stump, and cut out a base of the tree stump with the roots using a box cutter. Then, cut out more cardboard to stand vertically and act as a skeleton for the roots when we apply spray foam to them. [Figure 11]



Figure 32. Cardboard attached to the stump

Cutting out slots for the letters

Put a ruler tangent to the wall at the 3 inch mark. Then, trace out 6 inches (3 from the left and right of the 3" mark), not following the wall but rather the ruler. Then, draw another line parallel to that around 1/4 inches apart. Make sure the cut out slots above the funnel, and to space them out at different heights so children of all ages can reach the mailbox. [Figure 12]



Figure 33. Traced slots

Cutting out slots

Using a box cutter cut out the slots you traced.

Making flaps

Using the pieces of the wall you cut out, cut them in half and cut a tiny bit ($1/16$ - $1/8$ inch) from the top, and hot glue them to hinges, and the inside of the wall. [Figure 34 & 35]

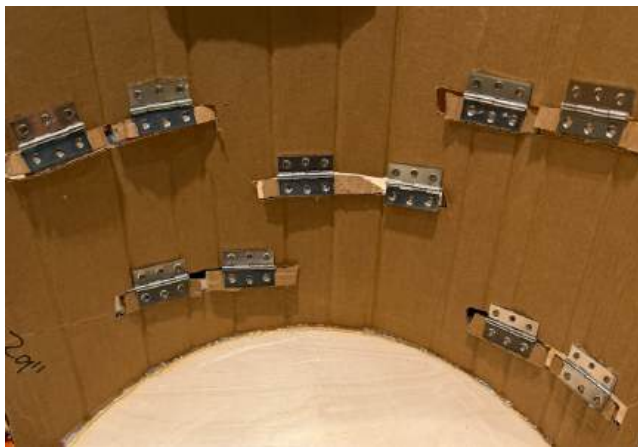


Figure 34. Inside of the wall



Figure 35. Outside of the wall

Glue overhang to the outside

Using other cardboard cut out sections that can protect the flaps from the expanding foam we are going to use in the next step. [Figure 15]



Figure 36. Protected slots

Cut out door for letter retrieval

Cut out a door shape that can swing open for letter retrieval.

Expanding foam (TAKE CARE)

This is arguably the most fun (and dangerous) part. Make sure you're doing everything in a ventilated space, and that the foam can cure in a ventilated space as well.

Tape the openings of the mailbox to prevent foam from getting in and blocking letters from entering the mailbox.

Put on the gloves, mask, and safety glasses. Then, starting from the base of the stump, use the expanding foam to make vertical lines along the wall and vertical root skeleton.

At the end, it should look something like this: [Figure 37]



Figure 37. Expanding foam right after being applied

Texturing the foam

After waiting **8 hours** (according to the can), use the razor blade/scissors to cut downwards and texture the foam so it looks more like wood. A wire brush works even better.

Spray paint

Spray brown paint onto it, and use any other decorations you want [Figure 17]



Figure 38. Finished exterior of the tree stump

Troubleshooting

Problem	Possible Cause	Solution
Circuit not working	Circuit not connected, power not enough	Check breadboard and sensor wires to see if everything is where it should be. Recharge batteries. Connect USB B to the arduino to read serial output to see if the beam is broken at correct times. If they are, make sure the servo is properly connected and has space to sweep and ring the bell.
Part of mailbox fell off	Loose connections	Reattach with more adhesive!
Funnel not directing letters properly	Gap length not big enough, funnel friction too high	Make sure the gap between the funnel is 9", if friction is too high add low-friction tape to the funnel.

Table 3. Troubleshooting Guide

You can consider providing the user with information on what might go wrong with the product or process described in the instructions. This information can be included at the end of certain steps or sub-sections or can be presented in a table. This table could contain 3 columns, for example: Problem, Possible Cause, Solution

Tests to Conduct to Ensure Functionality:

- Circuit
 - When the USB B is attached to the computer and the circuit is complete, wave your hand in front of the sensor to break the beam and see if the servo moves properly.
 - When only connected to the battery, do the same thing.
- Funnel
 - Drop letters in from different slots to make sure it falls inside the gap every time
- Flaps
 - When dropping letters from different slots make sure the flaps fall back down