Lockbox Design Document

1. Single-Piece Lockbox Prototype

Overview

- External dimensions: 9" (W) × 9" (H) × 7" (D)

- Printed as one solid piece with the front door as a separate hinged panel

- Integrated mounting points inside for:

  - Servo motor controlling a sliding bolt locking bar

  - Wiring channels for LEDs and buttons

  - Button nodes arranged as a physical binary tree with LED indicators

- Internal ribs and supports for mechanical strength

- Slots for optional metal rod reinforcement along walls (to be inserted after printing)

Printing Notes

- Use regular PLA for prototype print

- Print orientation: bottom flat on the print bed

- Layer height: 0.2 mm for a good balance of speed and quality

- Wall thickness: minimum 3-4 perimeter lines (~1.2-1.6 mm)

- Infill: 20% for strength; increase if desired

- Supports: only for door hinge and undercuts

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2. Step-by-Step Multi-Part Prototype Version

Part A: U-Shaped Body Shell

- Includes left, right, and bottom walls printed as one piece

- Dimensions: 9" (H) × 9" (W) × 7" (D)

- Features:

- o Channels for wiring and LED/button mounting

- o Vertical slots to insert metal rods for reinforcement

- o Mounting points for servo bracket and microcontroller

Part B: Door Panel

- Separate panel measuring approx. 6" × 6"

- Designed for servo-operated sliding bolt lock

- Mounts for LED indicators and buttons (binary tree nodes)

Part C: Top and Back Panels

- Printed flat for easy assembly

- Removable for electronics access

- Cutouts for power cable, microcontroller USB, ventilation if needed

Part D: Binary Tree Button Panel

- Physical layout of buttons as tree nodes with LEDs

- Mounted on separate acrylic or 3D printed panel

- Connected via JST connectors or soldered wiring

Assembly Instructions

1. Insert metal rods into body shell slots for reinforcement.

2. Attach servo bracket inside the shell.

3. Mount servo and connect locking bar to sliding mechanism.

4. Connect wiring for buttons and LEDs through internal channels.

5. Assemble door panel and attach with hinges or screws.

6. Attach top and back panels, securing electronics inside.

7. Test servo and button functionality with microcontroller.

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3. Carbon Fiber + Metal Reinforced Prototype

- Print body shell and door in carbon fiber filament for strength.

- Use steel or aluminum rods in reinforced channels.

- Use metal servo with high torque for locking mechanism.

- Reinforce hinges and locking bar with metal components.

- Optionally, laser-cut metal brackets for extra rigidity.

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4. Parts Checklist

Part	Material	Notes
U-Shaped Body Shell	PLA or Carbon Fiber	Printed as one piece (or multi-part)
Door Panel	PLA or Carbon Fiber	Separate hinged panel
Top Panel	PLA or Carbon Fiber	Removable for maintenance
Back Panel	PLA or Carbon Fiber	Access panel with cutouts
Binary Tree Button Panel	PLA or Acrylic	Separate button mount with LEDs
Metal Rods	Steel or Aluminum	Inserted into shell for reinforcement
Sliding Bolt Lock Bar	Aluminum or CF-PLA	Servo-actuated locking bar
Servo Motor	Metal gear, high torque	Controls locking mechanism
Hinges or Screws	Metal	Attach door panel
Wiring and Connectors	Various	LEDs, buttons, JST connectors
Microcontroller	Arduino or compatible	Controls logic and servo

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5. Recommendations

- Start by printing the single-piece PLA prototype to test fit and mechanism.

- Gradually upgrade to carbon fiber filament and metal reinforcement.

- Use high-torque servo motors for reliable locking.

- Carefully plan wiring paths inside printed channels to avoid pinching.

- Secure mechanical parts firmly with screws or brackets for durability.