

# Time-Delay Lock Box

## Overview

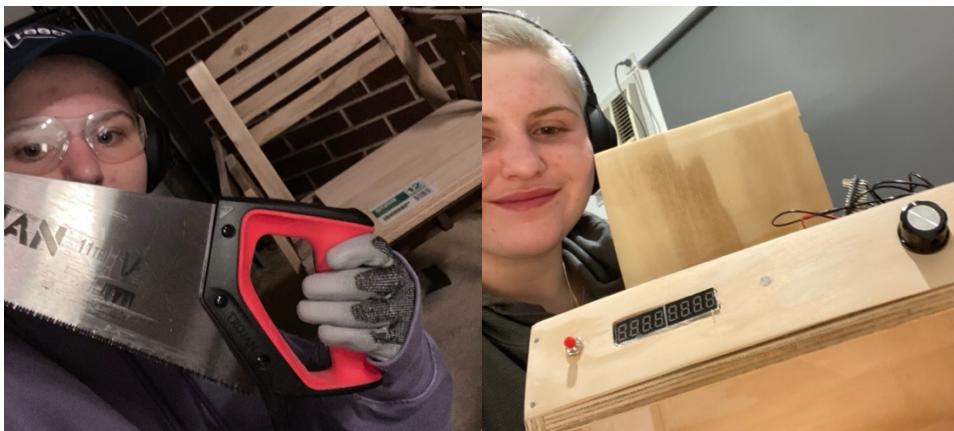
Time-delay lock box that can lock a secure wooden box for a set amount of time from 5 minutes up to 2 hours. Its primary purpose is to restrict access to whatever item is placed in the box for a set time chosen by the user, so the user can resist temptations and distractions without needing to employ any self-control.

## Demonstration

[Unlocking Demonstration](#)

[Locking Demonstration](#)

## Selfies



## Ideation

### Initial Idea

My initial idea for this creation was to build it using an electrical circuit (without a microcontroller), making majority of the box from wood, and a glass panel at the front. The box would be sealed in resin after being sanded down, and have no visible nails.

I also started with the idea to hide the internal circuitry and wiring by having a slanted top edge on the box, and some space reserved on one side of the box to house the locking mechanism. For the electrical circuit, I would have used a timer IC, a 7-segment display, push button, potentiometer, solenoid lock or piston.

### Transitional Ideas

I had to pivot many times throughout the creation of this artifact, which resulted in some transitional ideas.

After realising that getting glass cut to size was expensive, and that I didn't have the tools or room for mistake to cut a piece of glass to size myself, I began looking for other suitable clear panels that could be used for the front of the box, such as perspex.

I had to pivot away from using a solenoid for my locking mechanism once I realised it would require further electronic parts such as a diode, as well as a higher power source (12V) and therefore a

relay if the Arduino was to control it. This led to me ditching the locking mechanism altogether, and instead, making a lid with no handles that was opened and closed by a micro servo.

I also decided to add a status light to the artifact, to indicate to the user when the box was locked, unlocked or in a ‘busy’ state (i.e. when the lid was opening or closing).

### Final Idea

After many pivots due to time restrictions and lack of knowledge in electrical circuit building, I ended up with an unsealed wooden box with a clear acrylic sheet front-panel that uses a micro servo and custom-built servo motor arm to convert the rotating motion into a linear motion and achieve the locking mechanism.

## Development

### Equipment & Parts

The following tools & equipment were used to create this artifact:

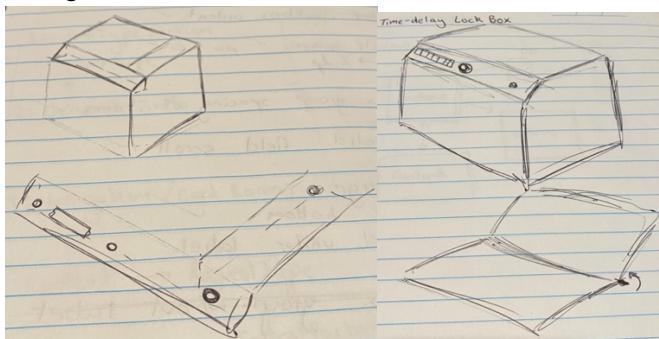
- Tools
  - Hand saw
  - Dovetail saw
  - Sandpapers of various grit
  - Sanding block
  - Hammer
  - Handheld orbital sander
  - Handheld rotary tool
  - Chisels
  - Drill & drill attachments
  - Measuring tape/ruler
  - Pencil
  - Hot glue gun
  - Multi-meter
  - Soldering Iron
  - Soldering stand and sponge
- Materials
  - Wood glue
  - Nails
  - Wooden dowel
  - Plywood
  - Hot glue
  - Clear acrylic sheet
  - 7 segment display (x2 because I accidentally soldered one to death)
  - Solenoid
  - Micro servo (x2 because I accidentally hot-glued one to death)
  - Push button
  - Potentiometer
  - Dial cap
  - Breadboard
  - Electrical tape
  - Wires

- Transistors
- Resistors
- 9V Battery
- 9V Battery Clip
- Solder
- PPE
  - Safety glasses
  - Gloves
  - Dust mask

## Box Development

Below is a simplified list of the steps I took to design and create the box.

- Design box



- Obtain required tools and parts
  - Involving many trips to Jaycar, Bunnings and Spotlight
- Woodwork
  - Cutting
    - Cut wood into measured sections to create each side of the box
    - Cut out wood pieces for the locking mechanism
    - Cut wood pieces to hide the wiring
    - Cut out space for any displays or control inputs (e.g. space for 7-segment display, button, light and potentiometer)



- Sanding
  - Sand all pieces down starting from rougher grit sandpaper (40 & 60 grit) to finer-grit sandpaper (120 & 400 grit) to achieve a flush fit for all the pieces as well as avoid rough edges that could cause splinters
- Joining
  - Cut box joins into the base and each side of the box to allow for a strong join and more aesthetically pleasing box
  - Glue each piece of the box together and hold in place until joined



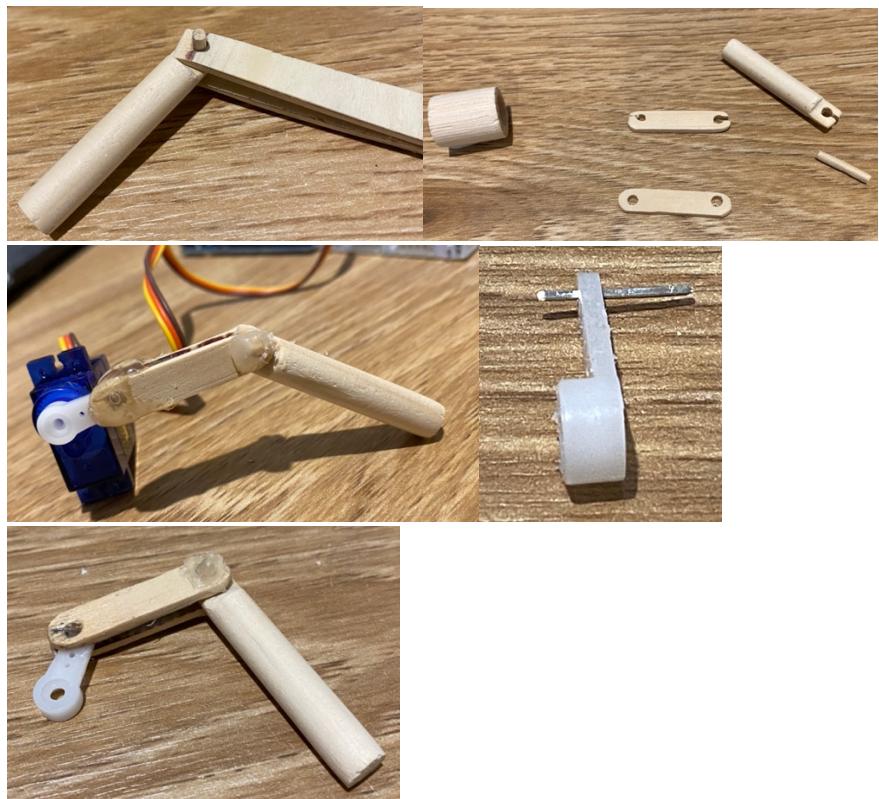
- Lid

- Make a rotating lid with a handle by gluing a small block onto a flat wooden panel, and gluing one edge of the wooden panel to a piece of wooden dowel
- Drill holes into either side of the box big enough to hold the wooden dowel without too much friction
- Insert each end of the dowel into either side of the wooden box where the holes are
- Add a larger piece of wooden on one end of the dowel to prevent the lid from being removed



- Locking Mechanism

- Using wooden off-cuts and some wooden dowel, create an arm for the micro servo to turn rotational motion into a linear motion
- Secure the ends of the joints using hot glue



- Final Touches

- Fill any gaps using a paste made from wood glue and sawdust



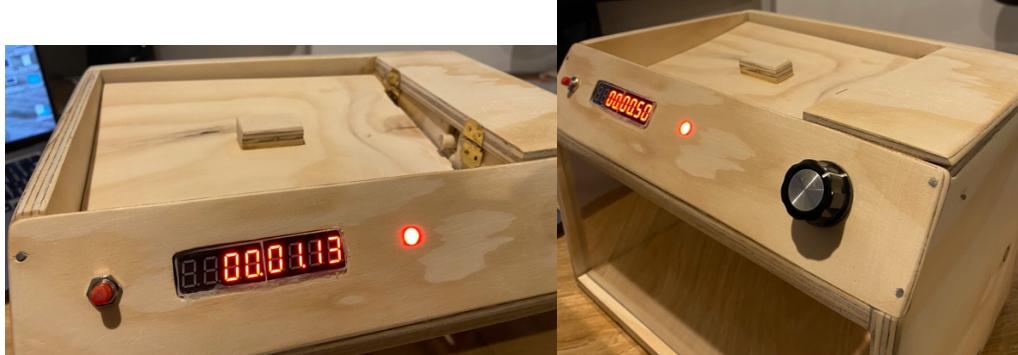
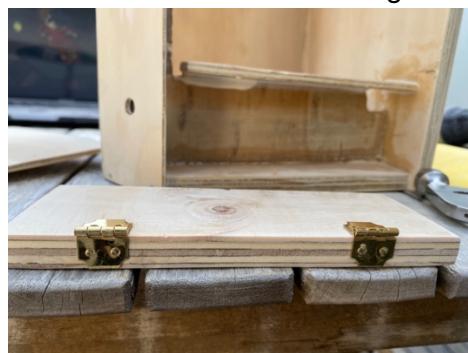
- Sand down any wood glue stains



- Slide in the clear acrylic sheet front panel

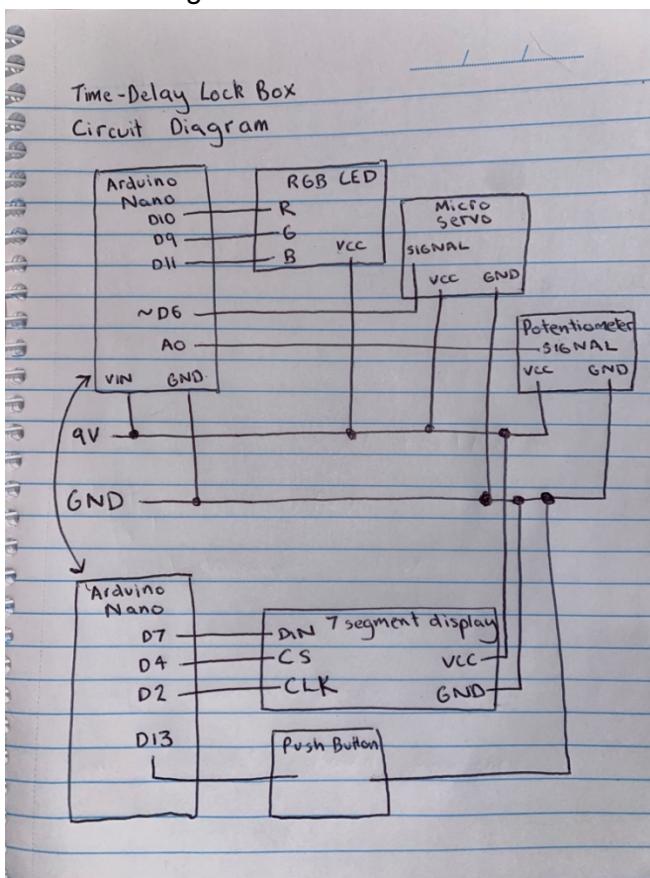


- Join the control hatch lid using decorative hinges



## Circuit Development

Below is a diagram of the circuit used to create the electrical components of this artifact.



## Software Development

The Arduino software used to control the electrical component of this artifact can be found at the following link.

[Microcontroller Code](#)

## Challenges

Below are the various challenges I encountered whilst making this creation.

### *Injury*

Before I realised the need for PPE, I endured a few minor injuries.

While using the sander and saw, I frequently burnt my fingers through their proximity to the heat generated by the friction caused from sanding or sawing. I also melted the skin on my fingertip when I (stupidly) used a rotary tool to remove the end of a nail that was sticking out and touched the hot nail. I have had to reset my touch ID on all devices frequently throughout this project!

Before wearing gloves and long sleeves, I accidentally sanded off my fingertips and sawed my arm a few times.

I also inhaled a lot of saw dust and particles of acrylic plastic that came off when I was sanding all the pieces to size.

Finally, when I was soldering the electrical components, I accidentally flicked a piece of hot solder into my eye but luckily it didn't cause any permanent damage.

After all of that, I now know the importance of wearing proper PPE!

### *Woodworking Novice*

My inexperience in woodworking and lack of proper tools posed a decent challenge.

The woodwork required for this artifact took a lot of time and muscle as I had to use predominantly manual tools. Also, I could only work on the box during the day time as I didn't want to wake up my neighbours with loud noises or have to operate a hand saw in the dark.

Furthermore, without a table or vice to secure the wood whilst working on it, I had to use a deck chair which was quite difficult due to its instability.

I also struggled with hammering in nails straight, and I ended up with a few protruding nails that I had to sand off.

In retrospect, more daylight and power tools would have drastically sped up the woodworking process, as well as allowed for tighter-fitting pieces.

### *Evidence of nails poking through side of box*



### UX Considerations

Various user experience (UX) principles were considered during the creation of this artifact to ensure that the product is easy to use, fix and extend in the future.

- I added a status light to indicate the current state to the user: LOCKED (red), BUSY (amber), UNLOCKED (green)
- I tried to avoid gluing or soldering the sensors and control inputs in case I needed to replace them in the future
- I soldered electrical components together where possible to ensure a strong connection
- I added a hatch to access the Arduino, battery and wiring so I can easily replace the battery if needed, as well as update the Arduino firmware or change the wiring
- I made sure the wooden panel that houses the displays and control inputs was on an angle to allow for easier manipulation of the control inputs and visibility of the displays

## Aesthetic Considerations

Various aesthetic considerations influenced the creation of this artifact to make the lock box look as polished and complete as possible.

- I used box joins to join some of the sides of the wooden box, uplifting a simple wooden box to a more aesthetically-pleasing design
- I intentionally catered for the space taken up by wiring, battery packs and sensors and hid the internal electronics to achieve a cleaner look
- I used a clear front panel to allow the user to see the item they chose to lock in the box

### *Evidence of methods for hiding wiring*

