ECE 212 Lab 3:

Sophomore-Level Engineering Design Project Lab

Mason Deal

Department of Electrical and Computer Engineering, North Carolina State University

ECE 212: Introduction to Logic Design

Dr. Laura Bottemley

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Introduction / ASK

Project requirements:

- Design a circuit that accepts a single input that chooses between two functions.
- The two functions should each involve the flashing of a minimum of three LEDs each. You choose the pattern and document the reason for your choice.
- The circuit should be tested on your breadboard, then transferred to a portable surface that can be encased in a design appropriate to your application. The circuit should then be (more or less) permanently connected.

I came up with several potential ideas to design and build, but ultimately I chose to build a flashing directional highway sign because of its simplicity and potential applications for other future designs.

Flashing Arrow Highway Signs:

- Two blinking arrows to indicate a direction on a highway, for example, if a curve is coming soon. These are particularly useful in mountainous areas where roads are winding.
- Each sign will use 3 LEDs for simplicity.
- An input will toggle on/off between a left and right arrow sign.
- A 555 timer will cycle through the states in each state machine.

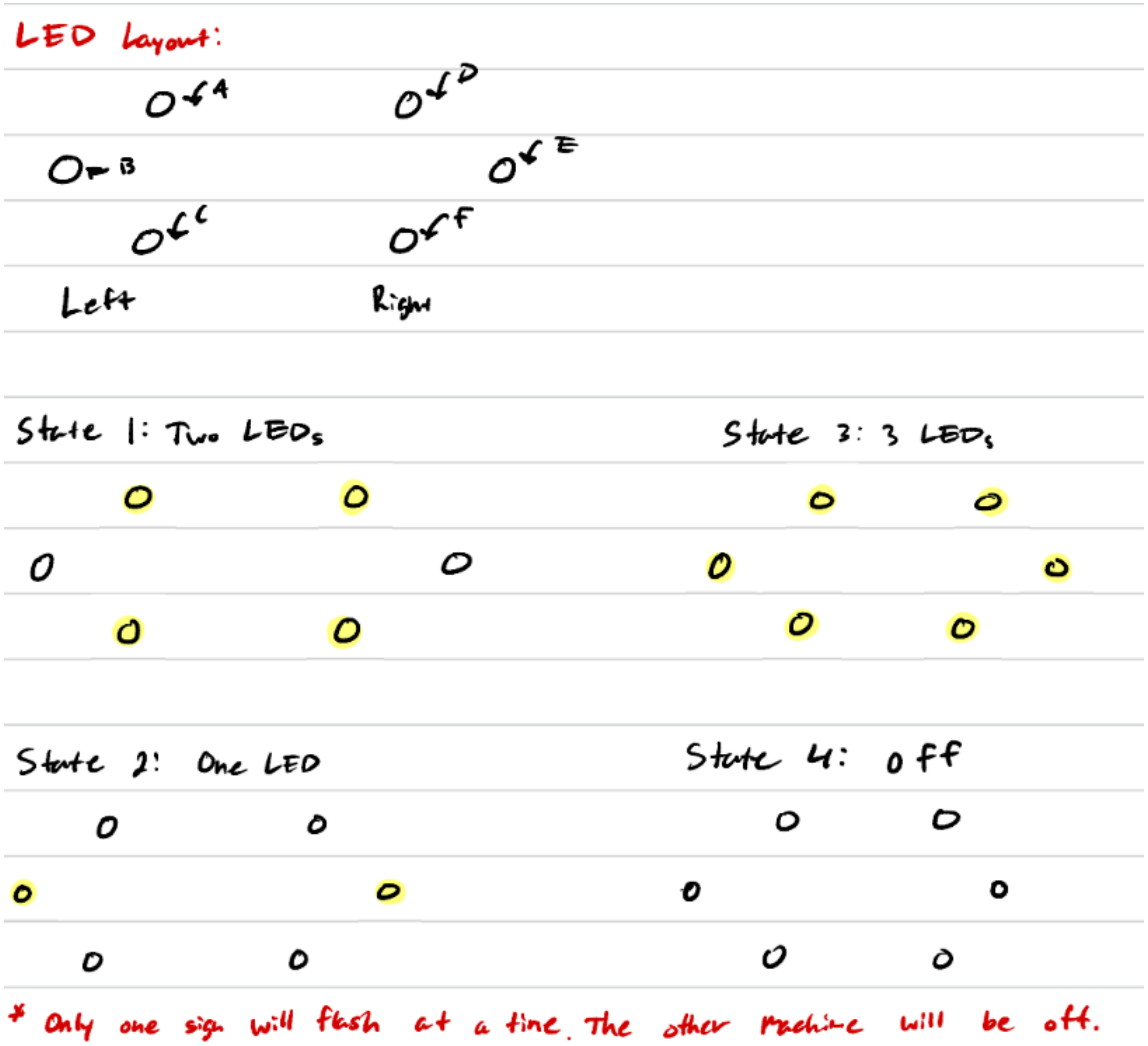
This is ultimately the concept I am going for.

Imagine:

All of the LEDs will be arranged in two triangular patterns. The two on top of each other will flash in unison, this allows two of the outputs to be potentially shared by one equation.

- State 1: the two LEDs that are shared will flash.
- State 2: the one independent LED will flash.
- State 3: all LEDs will flash.
- State 4: off state (this is only triggered when the other state machine is running).

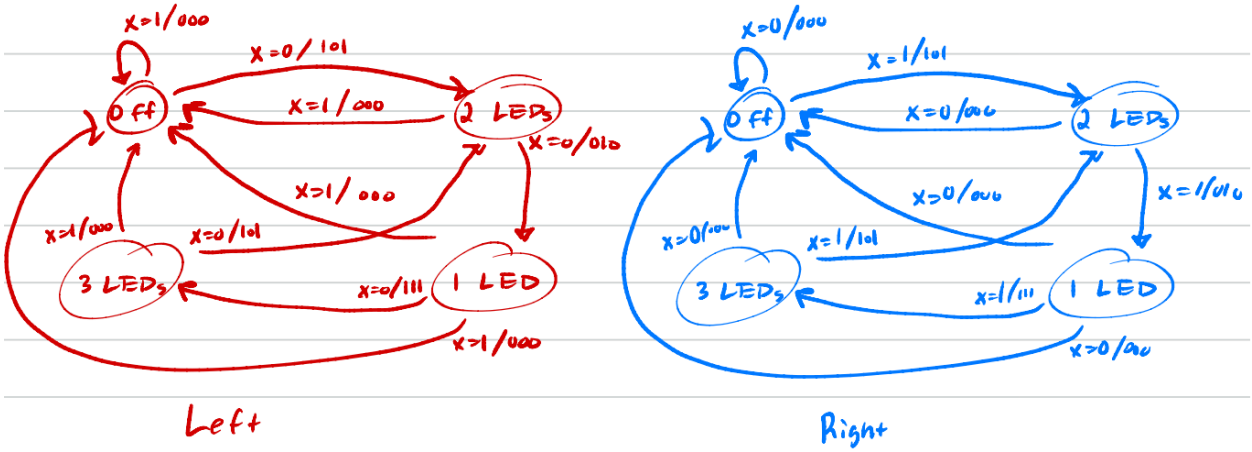
Only one sign will flash at a time. The other state machine will be toggled off.



Plan:

State Transition Diagrams

- X is the toggle input (0 = left, 1 = right)
- ABC is the LED outputs (0 = off, 1 = on)



State Transition Tables

Encoding:

State	Q_0	Q_1
Off	0	0
2 LEDs	0	1
1 LED	1	0
3 LEDs	1	1

Left:

Q_0	Q_1	X	Q_0^*	Q_1^*	A	B	C
0	0	0	0	1	0	0	0
0	0	1	0	0	0	0	0
0	1	0	1	0	1	0	1
0	1	1	0	0	1	0	1
1	0	0	1	1	0	1	0
1	0	1	0	0	0	1	0
1	1	0	0	1	1	1	1
1	1	1	0	0	1	1	1

Right:

R_0	R_1	X	R_0^*	R_1^*	D	E	F
0	0	0	0	0	0	0	0
0	0	1	0	1	0	0	0
0	1	0	0	0	1	0	1
0	1	1	1	0	1	0	1
1	0	0	0	0	0	1	0
1	0	1	1	1	0	1	0
1	1	0	0	0	1	1	1
1	1	1	0	1	1	1	1

Left State Machine K-Maps

D_0

X \ Q_0Q_1	00	01	11	10
0	0	1	0	1
1	0	0	0	0

$D_0 = Q_0' Q_1 X' + Q_0 Q_1' X'$

$D_0 = X'(Q_0' Q_1 + Q_0 Q_1')$

D_1

X \ Q_0Q_1	00	01	11	10
0	1	0	1	1
1	0	0	0	0

$D_1 = Q_0 X' + Q_1' X'$

$D_1 = X'(Q_0 + Q_1')$

A

X \ Q_0Q_1	00	01	11	10
0	0	1	1	0
1	0	1	1	0

$A = Q_1$

B

X \ Q_0Q_1	00	01	11	10
0	0	0	1	1
1	0	0	1	1

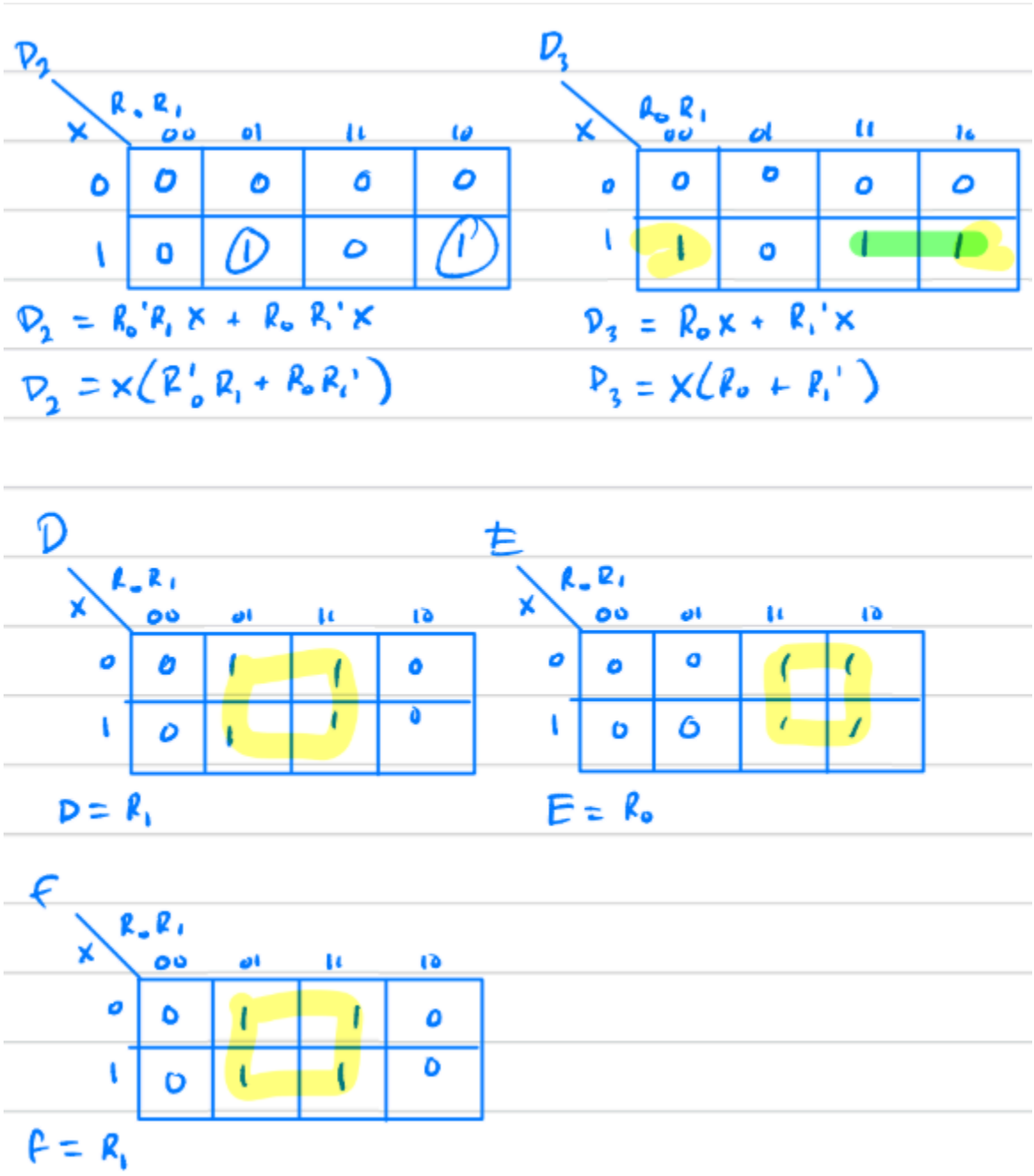
$B = Q_0$

C

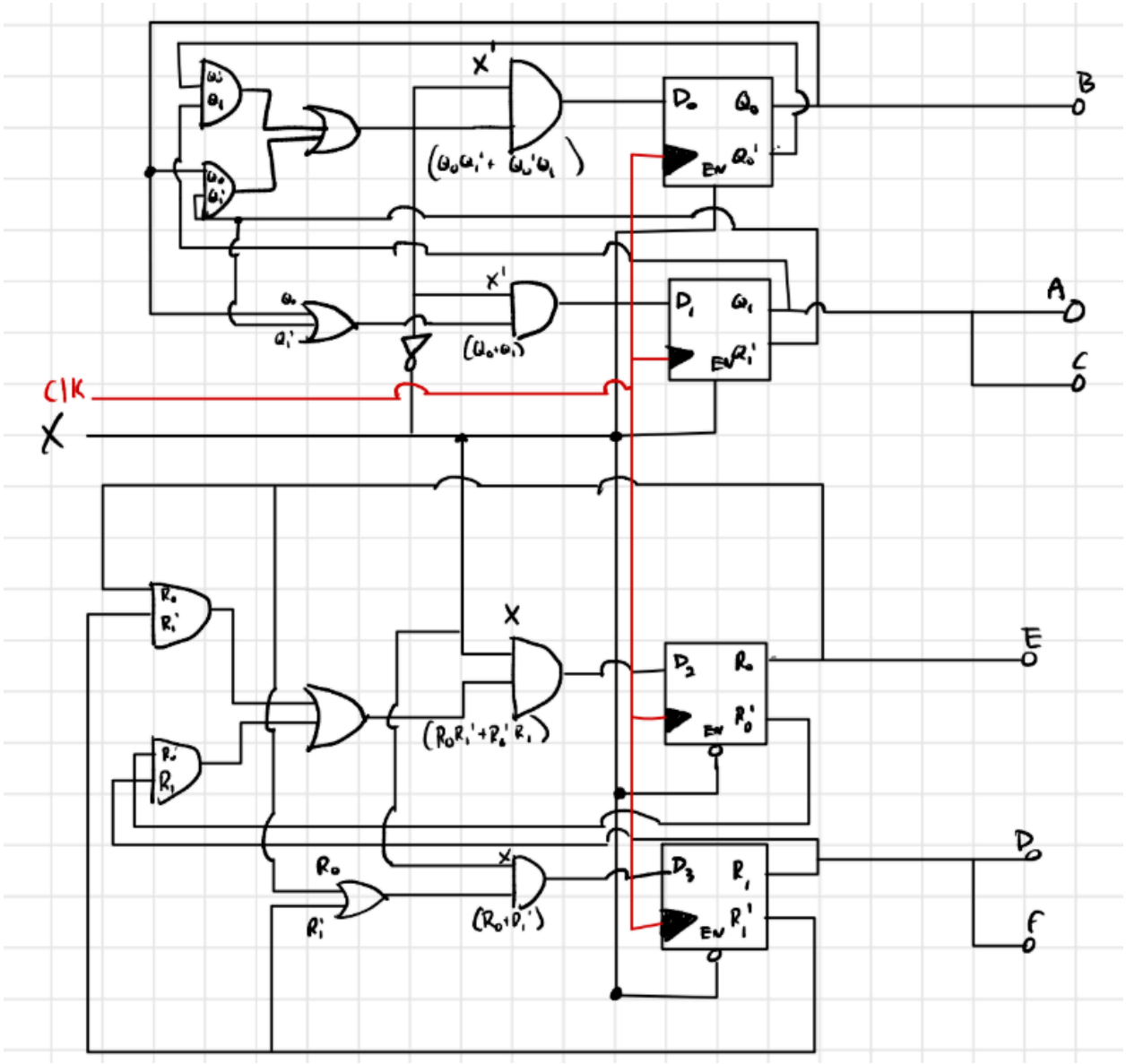
X \ Q_0Q_1	00	01	11	10
0	0	1	1	0
1	0	1	1	0

$C = Q_1$

Right State Machine K-Maps



Design



Component List

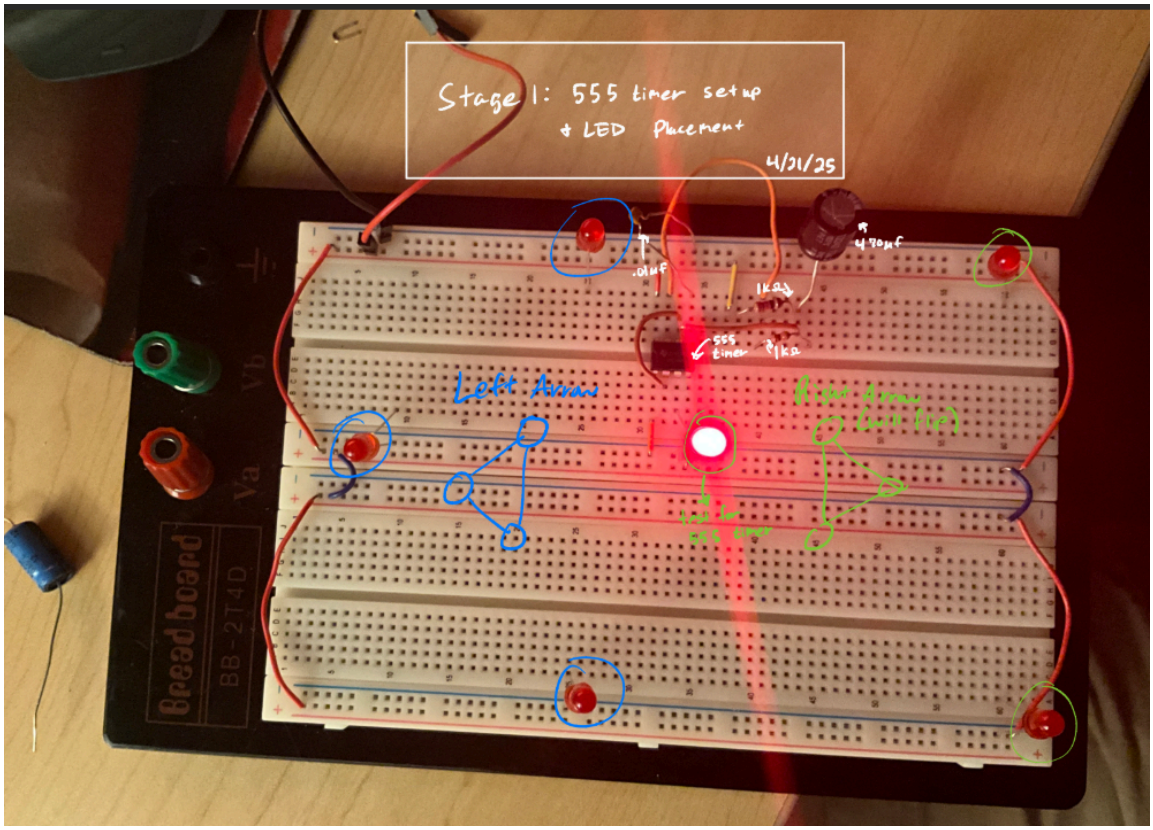
Component	Purpose	Quantity
LED	Display output and flash light.	6

TI 74LS10N	Sequential state machines.	2
NE555	Timer to cycle between states.	1
TI 74LS08N	AND chips for glue logic for output.	2
TI 74LS32N	OR chips for glue logic and output.	1
TI 74LS04N	Inverter for X’.	1
1kohm Resistor	Pullup and pulldown for timer.	2
470 microFarad Capacitor	Charge and discharge for high and low signals.	1
.01 microFarad Capacitor	De-bounce for control voltage.	1

Create:

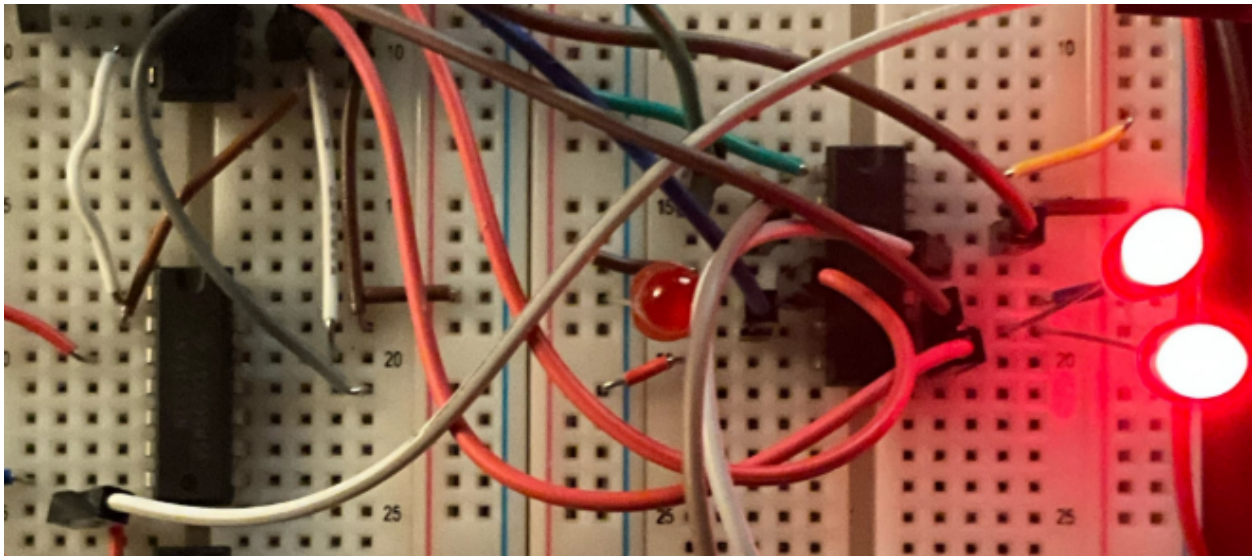
Stage 1: 555 Timer

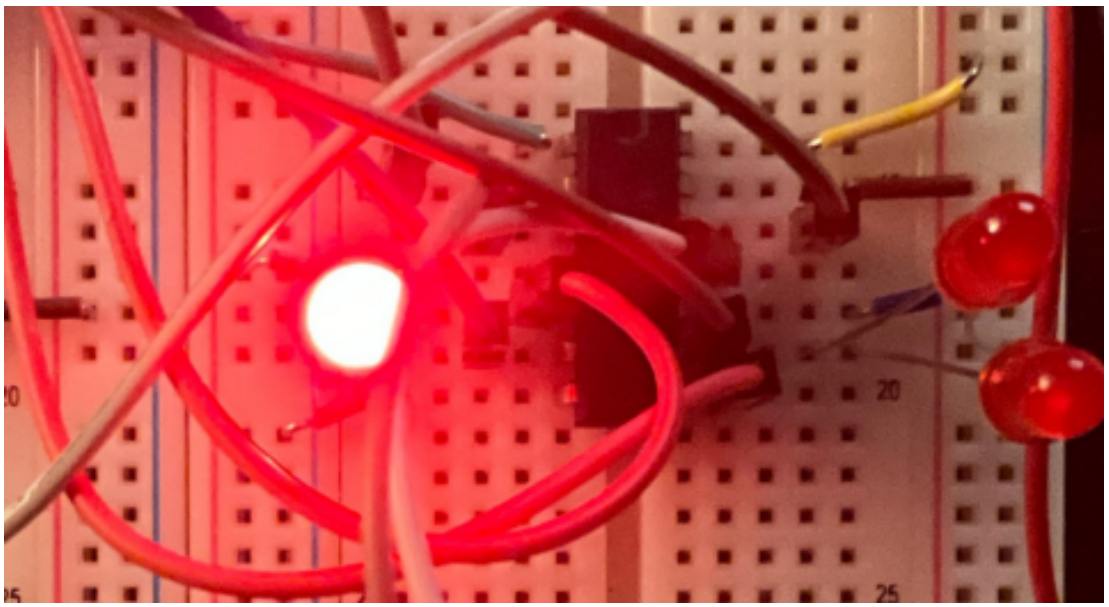
I started by placing 6 LEDs and getting a cardboard box from home to encase my design in. It took me some time to figure out how the 555 timer worked. At first, I tried to have ChatGPT explain it to me but I could not figure it out. After watching a YouTube video, however, I was able to figure out the timer.

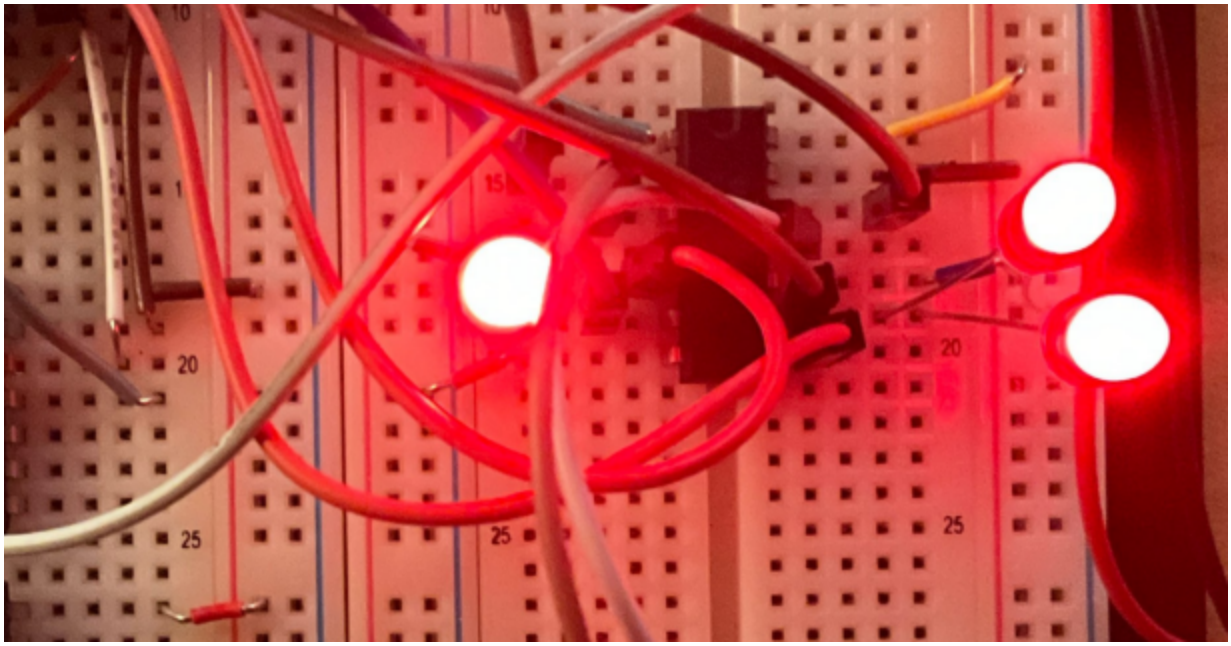


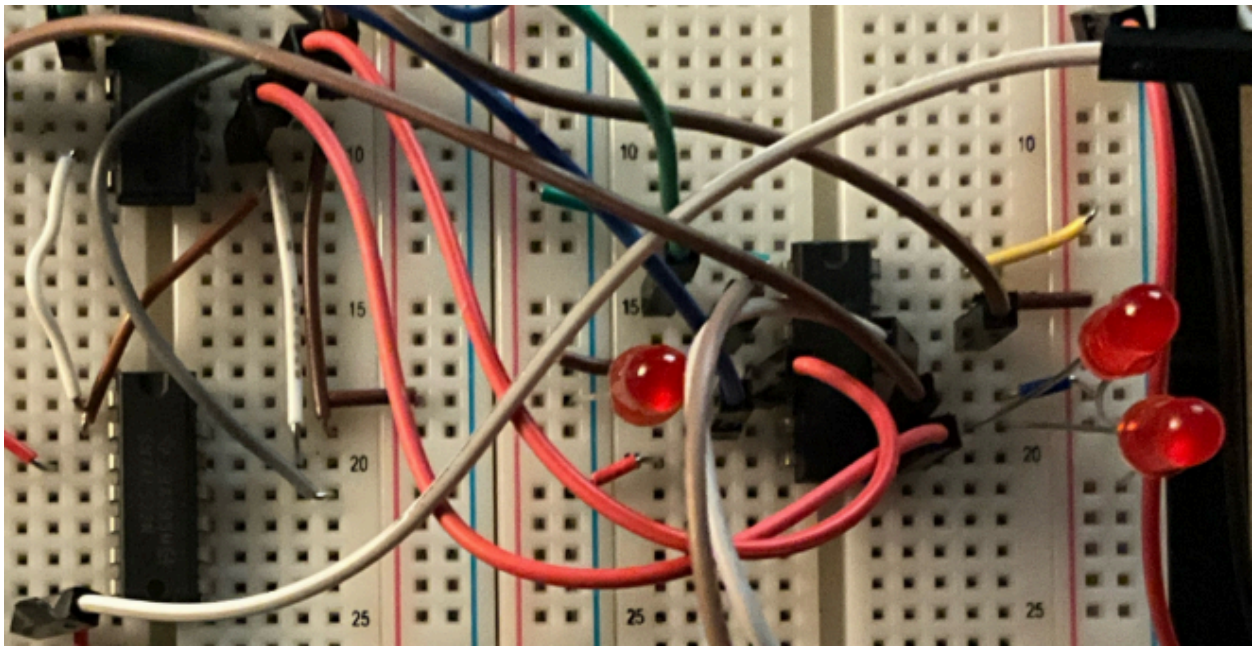
Stage 2: Left Sign Testing

I successfully built and tested the first of my state machines in one attempt! Honestly was not expecting it to work on the first try whatsoever, so I got lucky. All three of the states the timer cycle between works, and adding the extra X input to toggle between the state machines successfully forced the machine into an “off” state. Overall, I had the most trouble consulting datasheets and making sure that the wires are plugged in correctly.



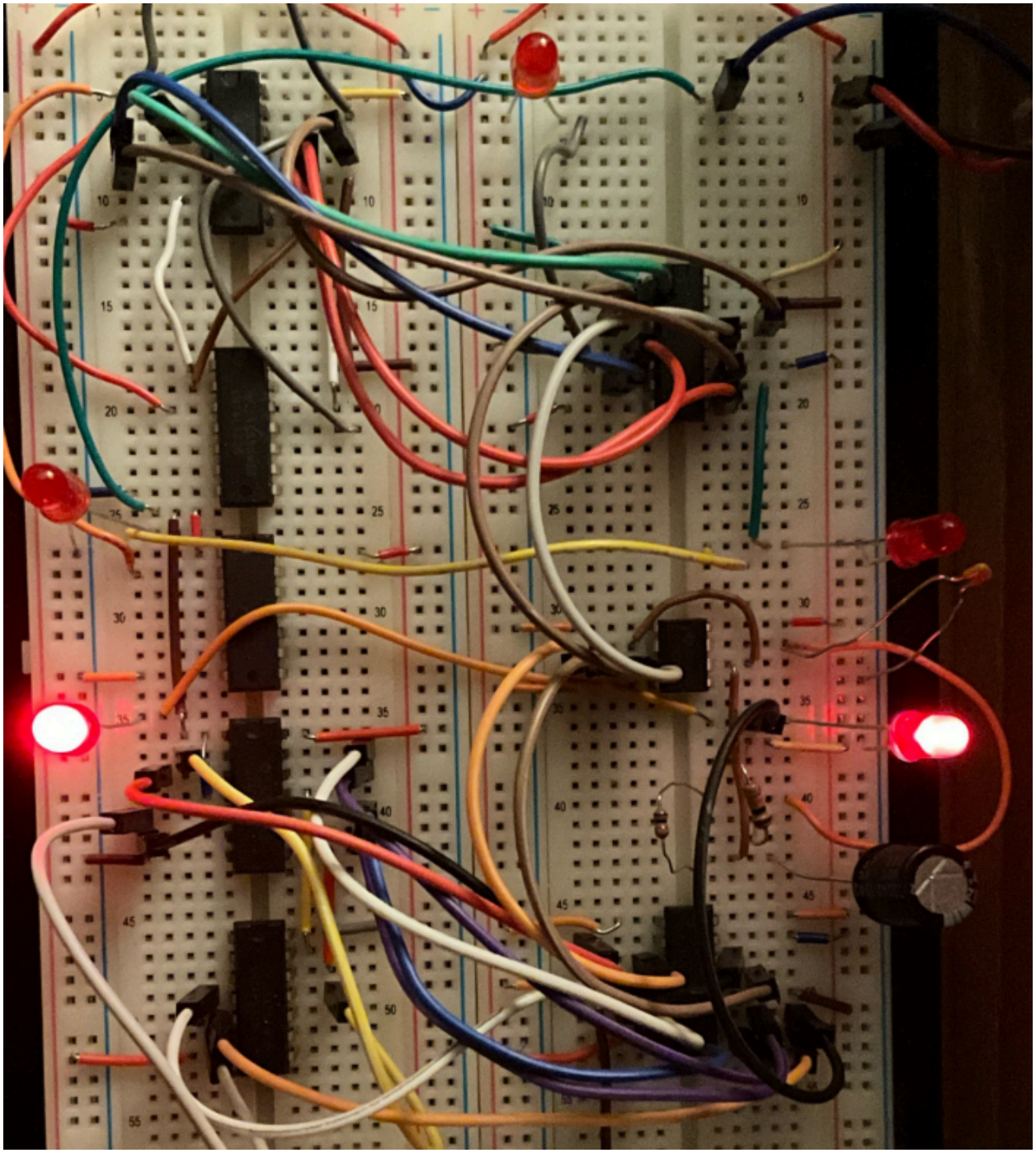


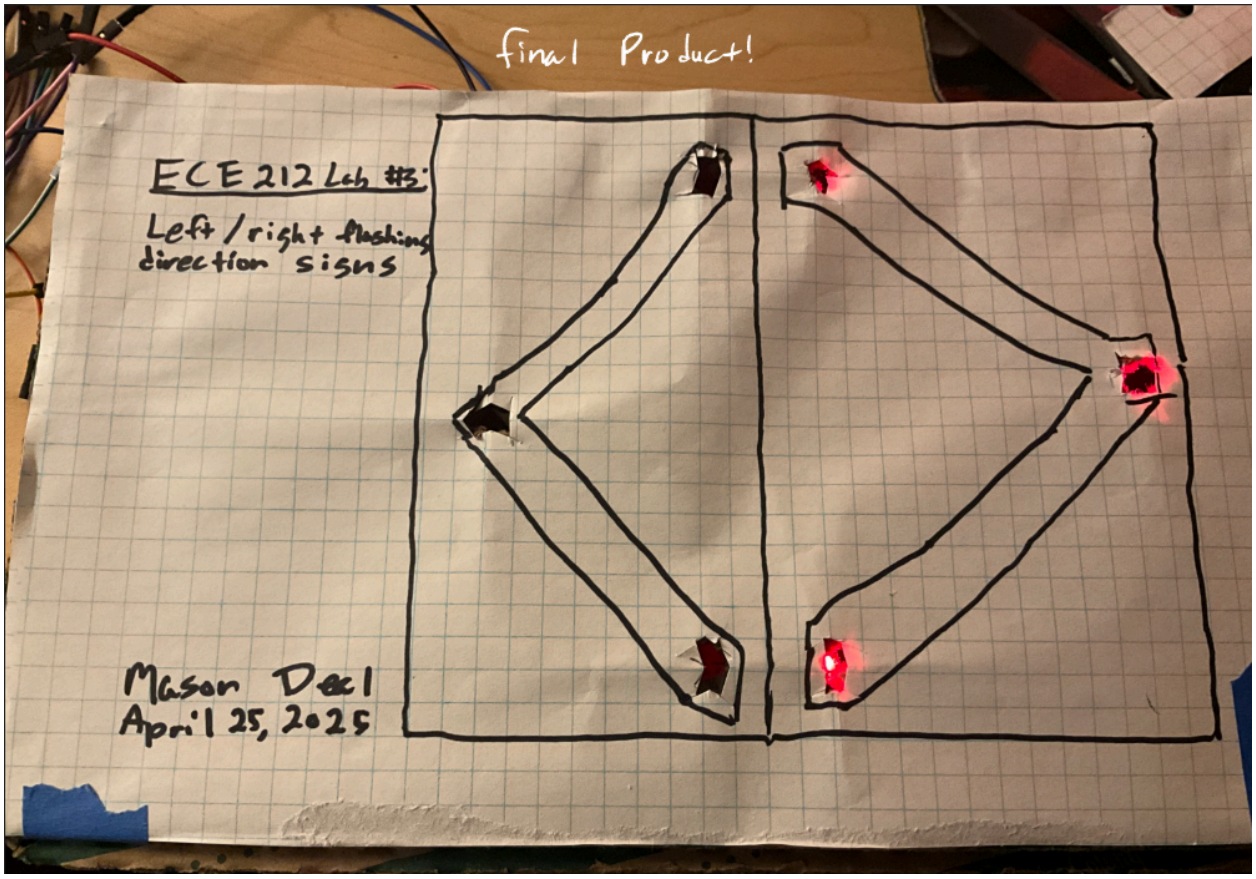




Stage 3: Right Sign and Enclosure

I had a bit of trouble with constructing the right sign at first. When I first powered it on the LEDs were flashing in the same pattern as the clock was. This was ultimately because I didn't put some of the connected wires in the correct pins. After I noticed that and fixed it the right sign worked, along with the toggle switch between the two state machines. I also decorated the enclosure.





Improve:

a. Did you iterate on your design?

No, but I did have to add additional unexpected components to make the 555 timer work correctly.

b. Did you add to it once you had the first bit working?

I thought about tweaking my right state machine to flash a different pattern, but I ultimately went with what worked and the simpler route.

c. How did you encase your design to make it look like a finished product?

I took a cardboard box from my house and taped my circuit inside. I also cut holes in the top for the LEDs to shine through and separate holes in the side for the AD3's wires to pass through.

d. What else did you do to improve your design?

I wanted to possibly add another mode to have both signs flash like car flashers. I also wanted to use shorter wires for a cleaner look and wanted to lay them out in a cleaner manner. This would improve the circuit's reliability and help reduce the risk of a wire being unplugged.

e. Show a final video clip of you demonstrating your design.

The video is attached!