3/27/2025

Logic Forge Design Review

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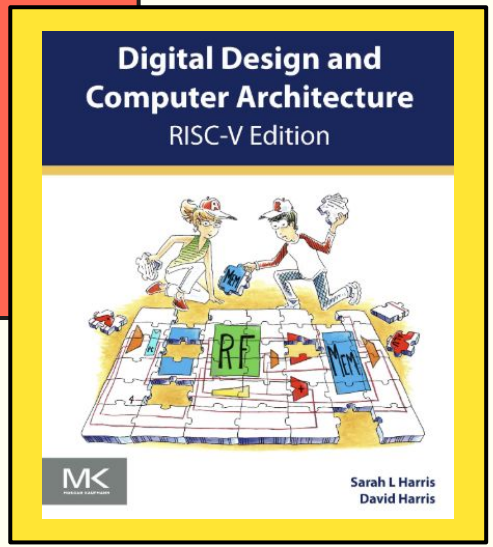
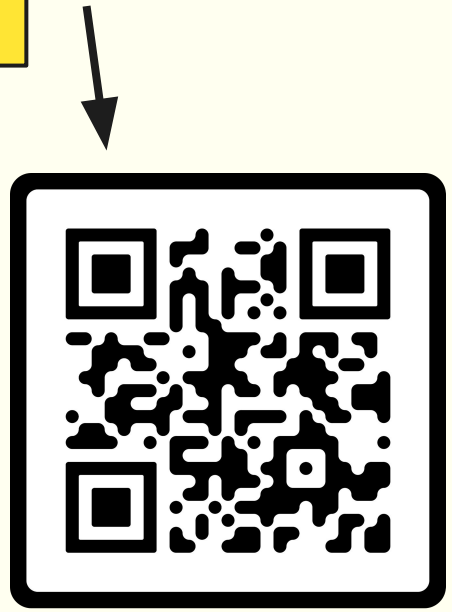


Overview

- Client Problem
- Problem Statement
- Constraints
- Objectives & Metrics
- Functions & Means
- Morphological Chart
- Design Alternatives



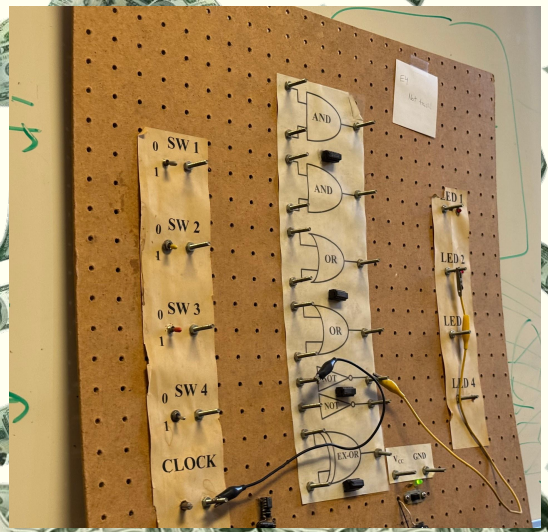
Presentation Slides

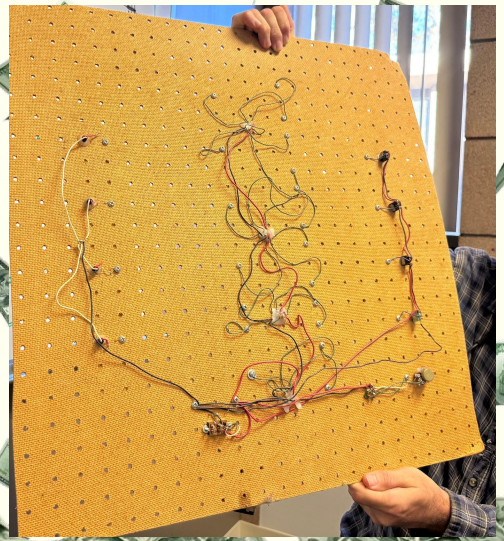
Client Problem

Our Client:

Prof. Harris

Current Board (lasted 28 years):





Issues with Current Board:

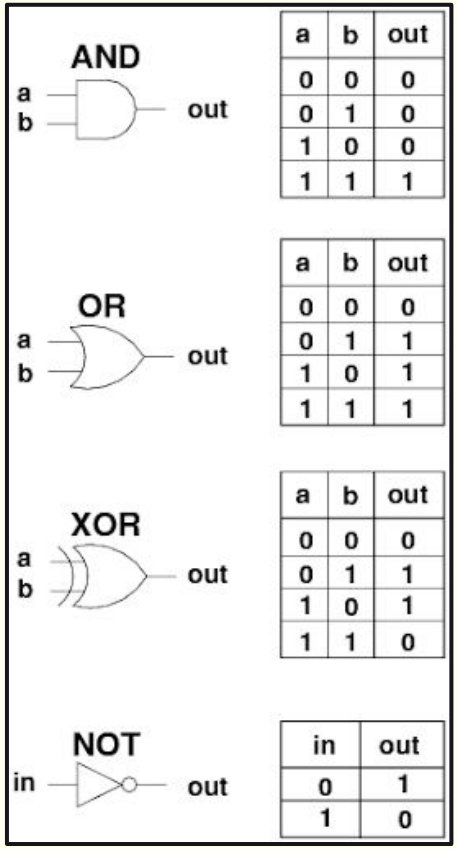
- The wires connected currently get loose and cannot be simply repaired
- The batteries leak acid
- The LEDs are not very bright
- The wood is currently too flexible
- The batteries tend to fail
- The power switch can be hard to use

Revised Problem Statement

The client, Professor Harris, needs a tactile and portable Logic Gate Demo Board to visually represent logic gates that are being drawn and discussed in his E85: Digital Electronics and Computer Architecture class. The board should have two AND gates, two OR gates, two NOT gates, and an XOR gate. The board should enable students to build an XOR gate using the AND, OR, and NOT gates on the board. The board should be able to represent the inputs and outputs as 0 or 1.

Constraints

- Must represent the inputs and outputs as 0 or 1 (on or off)
- Must contain at least 2 AND gates
- Must contain at least 2 OR gates
- Must contain at least 2 NOT gates
- Must be transported in maximum 1 trip from Prof Harris's office
- Must be possible to build an XOR gate using the AND, OR, and NOT gates on the board
- Must be made out of digital circuits and not a programmed computer
- Board must contain no unsafely high voltages
- Board must contain no sharp edges that could injure the user



Objectives

1. Minimize Time Needed to Transport
2. Minimize Weight
3. Maximize Visibility (Board Components)
4. Maximize Visibility (Outputs)
5. Maximize display similarity to E85 logic circuit drawings
6. Maximize Interactivity
7. Maximize Durability
8. Maximize Ease of Use
9. Maximize Aesthetics
10. Maximize Repairability
11. Minimize Cost

Metrics

	Type of scoring: Qualitative	
Visibility (Outputs)	Description: We will test if the students are able to read the board outputs from a set distance away from the board	Score
	Able to identify from a maximum of 35 feet from the board	5
	Able to identify from a maximum of 30 feet from the board	4
	Able to identify from a maximum of 20 feet from the board	3
	Able to identify from a maximum of 10 feet from the board	2
	Able to identify from a maximum of less than 5 feet from the board	1

	Type of scoring: Qualitative	
Visibility (Board Components)	Description: We will test if students are able to read the board components from a set distance away from the board	Score
	Able to read from a maximum of 35 feet from the board	5
	Able to read from a maximum of 30 feet from the board	4
	Able to read from a maximum of 20 feet from the board	3
	Able to read from a maximum of 10 feet from the board	2
	Able to read from a maximum of less than 5 feet from the board	1

	Type of scoring: Quantitative	
Time needed to transport	Description: Additional time needed to transport board from office to classroom as compared to walking. Let Transport Time be the additional time taken to transport the board as compared to walking to class without the board.	Score
	Transport Time <= 30 seconds longer	5
	30 seconds < Transport Time <= 1 min	4
	1 min < Transport Time <= 2 min	3
	2 min < Transport Time <= 3 min	2
	Transport Time > 3 min	1

Metrics

Similarity to E85 Drawings	Type of scoring: Qualitative	
	Description: Students enrolled in the course should be able to recognize which components are which	Score
	The average student can easily match all of the professor's drawings to the components on the design	3
	The average student has difficulty matching all of the professor's drawings to the board components	2
	Students cannot identify a single one of the components after seeing the professor's drawings	1

Durability	Type of scoring: Quantitative	
	Description: TD represent the # of times dropped from a height of 4 feet until a component of the board breaks.	Score
	TD > 30	5
	30 > TD >= 20	4
	20 > TD >= 10	3
	10 > TD >= 5	2
	TD < 5	1

Interactivity	Type of scoring: Quantitative	
	Description: number of steps completed by student per demonstration	Score
	5	5
	4	4
	3	3
	2	2
	1	1

Metrics

	Type of scoring: Qualitative	
	Description: Client ranking out of 5	Score
Ease of Use	5	5
	4	4
	3	3
	2	2
	1	1

	Type of scoring: Qualitative	
	Description: Client ranking out of 5	Score
Aesthetics	5 (wow it's beautiful)	5
	4	4
	3	3
	2	2
	1 (ow it hurts my eyes)	1

	Type of scoring: Quantitative	
	Description: % of components that are replaceable	Score
Repairability	>75	5
	66-75	4
	56-65	3
	46-55	2
	<46	1

Metrics

Cost	Type of scoring: Quantitative	
	Description: $	Score
	<150	5
	150-159	4
	160-169	3
	170-179	2
	>179	1

Weight	Type of scoring: Quantitative	
	Description:	Score
	<5 pounds	5
	5-15	4
	16-25	3
	26-35	2
	>35	1

Discussion Time!

Discuss with your table:

1) Do you have any Objective or Constraint suggestions that we did not include?

2) What are some alternatives for our qualitative metrics? (Visibility, Ease of Use, etc.)

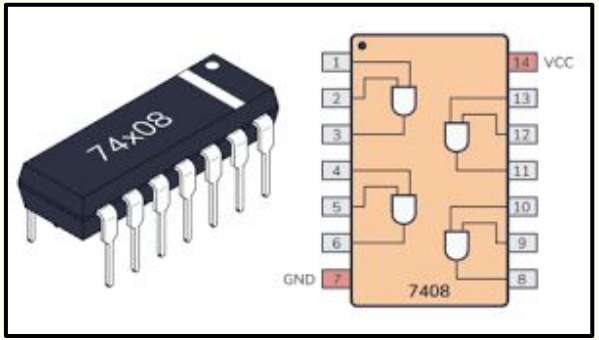
3) Choose a representative from your table to report discussion findings *on the sticky notes.*

Presentation Slides

02:30

Functions & Means

- Represent Logic Gate Interactions (Ensuring Inputs correspond to correct outputs based on truth tables)
- Represent Logic Gate Inputs
- Represent Logic Gate Outputs
- Present Logic Gate Interactions In front of an Audience



Morphological Chart

Functions					
Represent Logic Gate Inputs	Using Button Lights (Push to light up) to shown On, Off for the inputs for each logic gate	Using mechanical gears to turn to a state showing "0" and a state showing "1" for the inputs each logic gate	Using Switches (similar to a light switch) to represent an "On" or "Off" state	Binary Cards, cards that have "0" and "1" written on them	Dials with labeled "1" and "0" Positions
Represent Logic Gate Outputs	Using Lights (LEDs) to shown On, Off for the outputs for each logic gate	Popit like output that pops out when "1" and in when "0"	Speakers that play a loud beep for "1" and no noise for "0"	A Motor that Moves when it is on "1" and it stationary when it is off "0"	A motor that rotates an arrow to point at a "1" or a "0"
Represent Logic Gate Interactions (Ensuring Inputs correspond to correct outputs based on truth tables)	Alligator Clips connecting two electronic components	magnetic puzzle like pieces that attach to the main design and show the logic gate being used	Using mechanical gears that turn based on their inputs, showing the LogicGate in motion	Balls + gravity + gates that need different weights on them to open	Using Gravitational Sand (Like Kinetic Sand) to show the logic gate taking inputs and returning an output
Present Logic Gate Interactions In front of an Audience	Giant Laser-Cut Wood Board	PCB board connected via Soldering and electrical components	A "Puzzle-Piece" like board made from 3D-Printed PLA	Electronically Represented Logic Gates using CircuitVerse	Projection onto board with interactive components that mimic the workings of the projection.

Morphological Chart (Cont.)

Functions						
Represent Logic Gate Inputs	A green LED thata represents "1" and a Red LED that represents "0", and the LED that is on will represet the input	Pins on the board that can be moved to spot labeled 1 and 0. Whichever spot the pin is in is the input.	Marine waterproof switches with low surface profile to turn on and off the inputs to each gate	Momentary metal push button with an LED ring around it to display wether the input is on or off		
Represent Logic Gate Outputs	A motor that opens/closes a door to show a "1" or a "0"	flip-dot display that physically flips to show "1" or "0"	An LED that shines red if the output is a 0 and green if the output is a 1	Computer screens that play an animation when the output is "1" or "0"	Electric rods that users touch and if they are on it shocks them	
Represent Logic Gate Interactions (Ensuring Inputs correspond to correct outputs based on truth tables)	Liquid Crystal Displays (LCD) that shows what inputs are being put in and the output that it will return	Hand Drawings of the Logic Gate Symbols for the E85 Class	Printed Cutouts of the Logic Gate Symbols that are used in the E85 Class	String represents connections between inputs gates and outpust	Wires with magnetic connection points for quick connecting	LED path running from each connection point lights up when each wire is "on" just like circuitverse
Present Logic Gate Interactions In front of an Audience	Giant polycarbonate board that allows students to see through it	Giant smoked polycarbonate board that allows some visibility through	Wooden lazer cut or cnc machined box	Aluminum board		

Design Alternatives

Design Alternatives	Represent Logic Gate Inputs	Represent Logic Gate Outputs	Represent Logic Gate Interactions (Ensuring Inputs correspond to correct outputs based on truth tables)	Present Logic Gate Interactions In front of an Audience
Design Alternative 0 (Current Solution)	Using Switches (similar to a light switch) to represent an "On" or "Off" state	Using Lights (LEDs) to shown On, Off for the outputs for each logic gate	Alligator Clips connecting two electronic components	Cardboard Board with drilled holes containing the components
Design Alternative 1	Dials with labeled "1" and "0" Positions	Using Lights (LEDs) to shown On, Off for the outputs for each logic gate	Wires with magnetic connection points for quick connecting	Giant Laser-Cut Wood Board
Design Alternative 2	Using mechanical gears to turn to a state showing "0" and a state showing "1" for the inputs each logic gate	Using mechanical gears that turn based on their inputs, showing the LogicGate in motion	An LED that shines red if the output is a 0 and green if the output is a 1	Aluminum Board

Design Alternatives (Cont.)

Design Alternatives	Represent Logic Gate Inputs	Represent Logic Gate Outputs	Represent Logic Gate Interactions (Ensuring Inputs correspond to correct outputs based on truth tables)	Present Logic Gate Interactions In front of an Audience
Design Alternative 3	Using Button Lights (Push to light up) to shown On, Off for the inputs for each logic gate	Using Lights (LEDs) to shown On, Off for the outputs for each logic gate	Liquid Crystal Displays (LCD) that shows what inputs are being put in and the output that it will return	PCB board connected via Soldering and electrical components
Design Alternative 4	Momentary metal push button with an LED ring around it to display wether the input is on or off	Using Lights (LEDs) to shown On, Off for the outputs for each logic gate	LED path running from each connection point lights up when each wire is "on" just like circuitverse	Wooden lazer cut or cnc machined box
Design Alternative 5	Binary Cards, cards that have "0" and "1" written on them	flip-dot display that physically flips to show "1" or "0"	Wires with magnetic connection points for quick connecting	Giant smoked polycarbonate board that allows some visibility through

Discussion Time!

Discuss with your table:

1) Do you have any design alternative suggestions that we did not include?

2) What is the “best” design alternative in your opinion? Why?

3) Choose a representative from your table to report discussion findings *on the sticky notes*.

Presentation Slides

02:30

Thank You!

Q&A?