



ABSTRACT

Logic gates are binary operators used to simulate electronic gates for design of circuits virtually before building them with real components. These gates are used as an instrumental foundation for digital computers; They help the user control a computer or similar device by controlling the decision making for the hardware. A gate takes in an input, then it produces an algorithm as to how to handle the output. This process prevents the user from having to include a microprocessor for decision this making. Six of the logic gates used are: the OR gate, AND gate, NOT gate, XOR gate, NAND gate, and the NOR gate. Each gate has its own operation process, design, and purpose. The use of the Logic Gates in this project is to focus on how logic gates can be used educationally to improve students' understanding of their functionality. Professors in both high-level and introductory courses can make use of these gates as educational tools.

HARDWARE

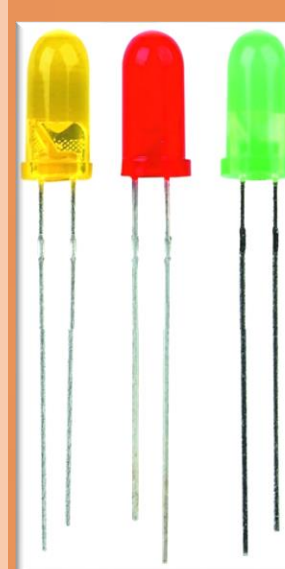
A **transistor's** operations can be understood by visualizing a faucet. Just like a transistor, a faucet is connected to a *source* of water, the faucet drains in a *sink*, and the water flowing through the faucet is controlled by a *gate*. If the faucet (gate) is turned ON, water flows from the source to the sink, otherwise, no water flows.



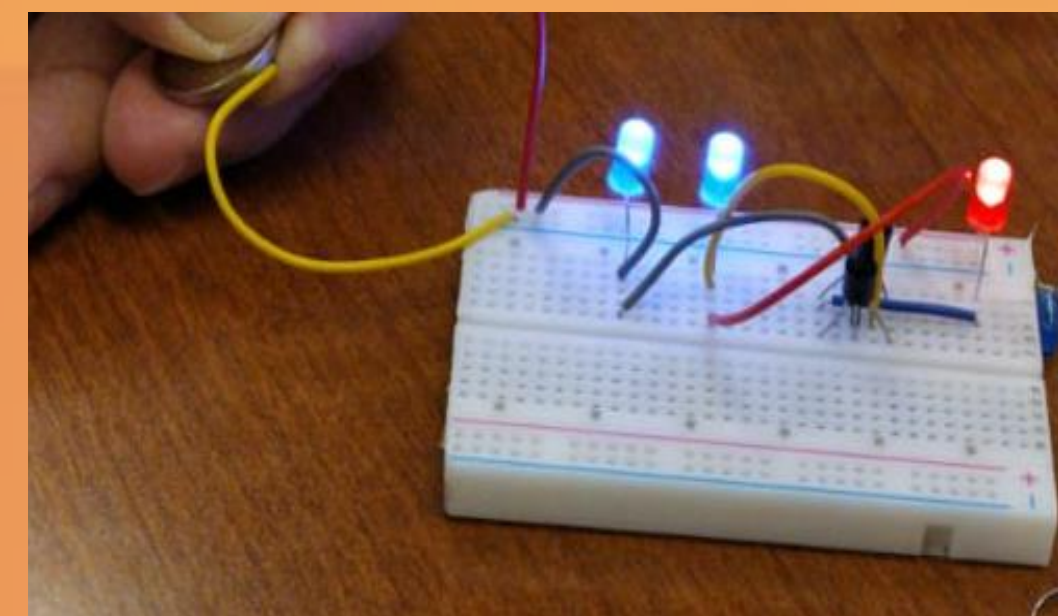
A **resistor** is an electrical component which creates resistance in the flow of an electric current. They are found in nearly all electrical networks and electronic circuits. Resistors are commercially available with resistance values over a range of more than nine orders of magnitude. For example, resistors can be used as electric brakes to discharge kinetic energy from trains or even be extremely small for electronics.



LEDs are a type of semiconductor named a "Light Emitting Diode". LEDs are light sources that combine a semiconductor with a larger hole concentration and a semiconductor with a larger electron concentration. Conventional light sources convert electricity into heat, and then into light; LEDs convert electricity directly into light, and thus waste less electricity.



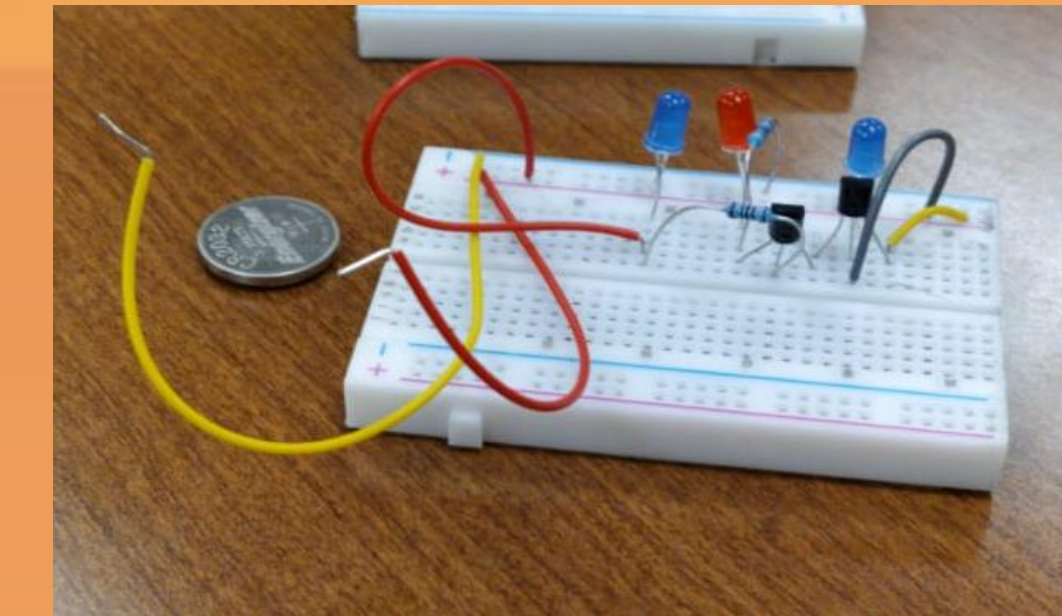
THE LOGIC GATES



Or Truth Table		
A	B	Q
0	0	0
0	1	1
1	0	1
1	1	1

OR GATE

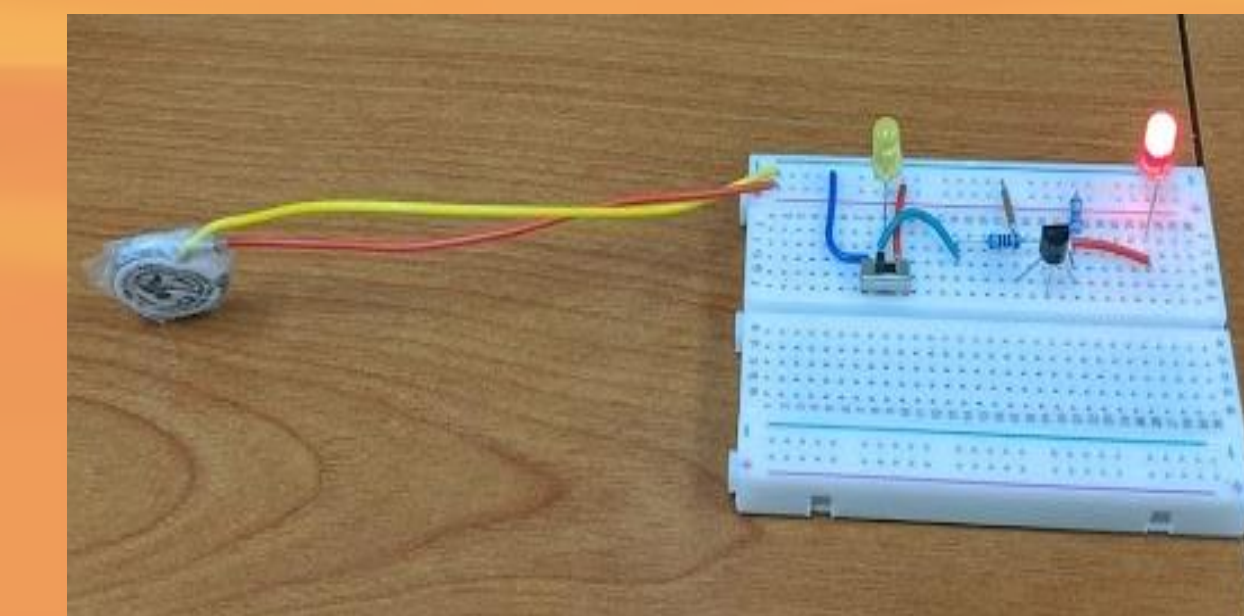
The **OR** gate is a logic gate with at least two inputs and only one output that performs what is known as *logical disjunction*, meaning that the output of this gate is true when any of its inputs are true. If all the inputs are false, the output of the gate will also be false.



AND Truth Table		
A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1

AND GATE


An **AND** gate is a consists of at least two inputs and one output that performs what is known as *logical conjunction*, meaning that the output of this gate is false if one or more of an AND gate's inputs are false. Otherwise, if all the inputs are true, the AND gate output is true.



NOT Truth Table	
A	Q
0	1
1	0

NOT GATE

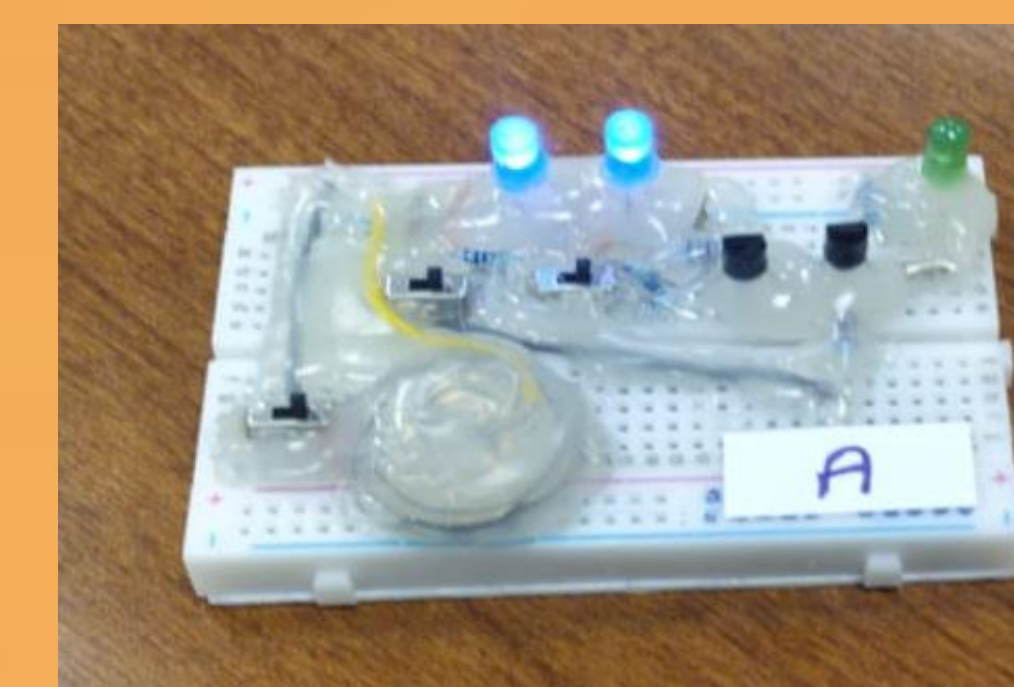
A **NOT** gate, also known as an inverter, has just a single input with rather simple behavior. A NOT gate performs what is known as *logical negation*, which means that if its input is true, then the output will be false. Likewise, a false input will result in a true output.



XOR Truth Table		
A	B	Q
0	0	0
0	1	1
1	0	1
1	1	0

XOR GATE


The **XOR** gate (Exclusive OR gate) is a logic gate with at least two inputs and one output that performs *exclusive disjunction*. The output of the gate will be true only when one of its inputs is true. If all the XOR gate's inputs are false, or if all its inputs are true, then the output is false.



NAND Truth Table		
A	B	Q
0	0	1
0	1	1
1	0	1
1	1	0

NAND GATE

A **NAND** gate (Negated AND gate) is a logic gate with at least two inputs and one output with behavior opposite of that of an AND gate. The output of this gate will be true at least one, but not all, of its inputs are false. If all a NAND gate's inputs are true, then the output of the gate will be false.



NOR Truth Table		
A	B	Q
0	0	1
0	1	0
1	0	0
1	1	0

NOR GATE

A **NOR** gate (Negated OR gate) is a logic gate with at least two and just one output with the opposite behavior of the OR gate. If all inputs of this gate are false, then its output will be true. If at least one of the NOR gate's inputs are true, then the output of the gate will be false.

REFERENCES

(2012, February 5). *What is a resistor?*. Resistor Guide. <http://www.resistorguide.com/what-is-a-resistor/>

(2017, April 4). *What are LEDs and How Do They Work?*. Rohm. <https://www.rohm.com/electronics-basics/leds/what-are-leds>

(1995, April 12). *Transistors and Faucets!*. Boston University. <http://www.cs.bu.edu/~best/courses/cs109/modules/transistors2gates/>

Sattel, Sam. (2017, May 16). *You Shall Not Pass - How Logic Gates Work in Digital Electronics*. Autodesk. <https://www.autodesk.com/products/eagle/blog/you-shall-not-pass-how-logic-gates-work-in-digital-electronics/>

(2011, January 23). *NOT Gate*. logic.ly. <https://logic.ly/lessons/not-gate/>

(2011, January 23). *AND Gate*. logic.ly. <https://logic.ly/lessons/and-gate/>

(2012, October 29). *OR Gate*. logic.ly. <https://logic.ly/lessons/or-gate/>

(2011, January 28). *NAND Gate*. logic.ly. <https://logic.ly/lessons/nand-gate/>

(2011, January 23). *NOR Gate*. logic.ly. <https://logic.ly/lessons/nor-gate/>

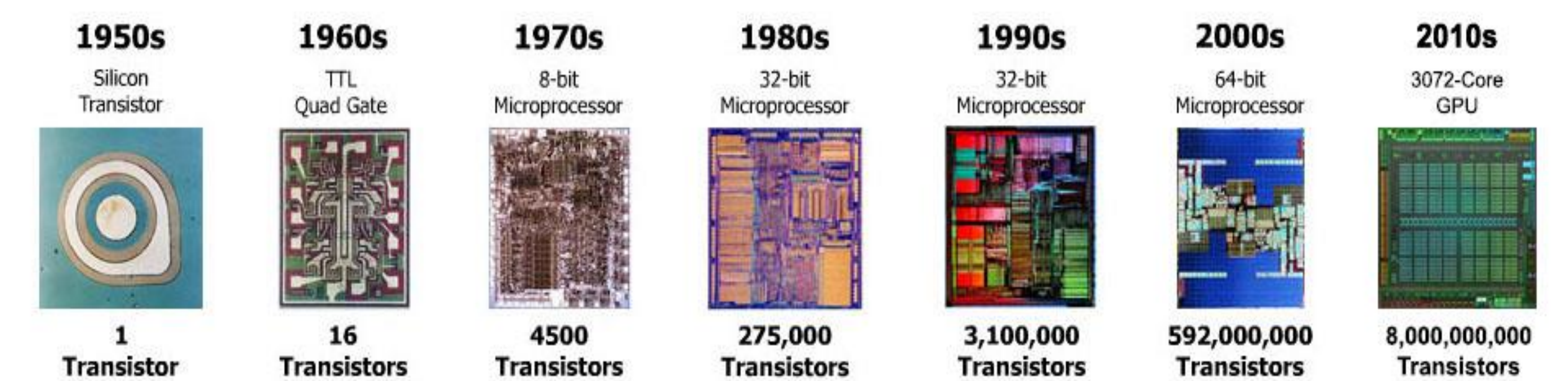
(2011, January 23). *XOR Gate*. logic.ly. <https://logic.ly/lessons/xor-gate/>

(2004, July 18). *Circuit Board*. Powered Template. <https://poweredtemplate.com/03422/0/index.html>

ACKNOWLEDGEMENTS

Dr. Mary Jo Geise for editing

TRANSISTORS THROUGH THE YEARS



RESULTS

To end our project, three manufactured gates (NOT, NOR, NAND) were used by Professor Craig Gunnett– a computer science professor at the University of Findlay– for instructional use in his Computer Organization course. The results of an interview with him about the gates' usefulness concluded that they were unique and beneficial for his students as most of them had not seen or touched logic gates before. Professor Gunnett noted that he even had a student come to his office to use them again! This interview indicates to us how useful and effective logic gates can be as an educational tool.