Blackstone Valley Regional Vocational Technical High School
Student Portfolio- Project Reflection

Date	**12-12-23**
Student Name	**Om Patel**
Subject	**Copier Jam - DE (11th)**
Instructor's Name	**Mrs. dos Santos**
Instructor's Signature	**Mrs. dos Santos**

In this project, I was challenged to create a circuit that can detect jams in a copier machine. A paper copier at a local company moves paper between three areas as it is making copies. However, because of this, the copier undergoes jams specifically when two adjacent areas have paper in them. To help this issue I must create a circuit that is capable of monitoring three input sensors, detecting a jam in the copier. If a jam does occur the system must stop the copier motor and activate a light that indicates that the copier is jammed, allowing a human to fix the issue. To start the copier after a jam there must be a fourth input that resets the system. I was constrained to only using three switches acting as paper sensors, connected to LEDs, a reset button, and two LEDs representing the motor and a signal indicating if the machine had a jam. I was also only allowed to use AOI logic and a singular active low D flip-flop.

To start this project, I first created a truth table. To create this truth table, I had three inputs labeled A, B, and C, each representing a sensor. Knowing that the jam LED only turns on when two adjacent inputs are on, I selected those to have a positive output in my table. This left me with an unsimplified logic expression; however, to simplify I used a technique called Karnaugh Mapping also called K-Mapping, which allows me to derive a simplified equation from a set of outputs. After setting up a K-Map, I proceed to group any hex, octet, quad, and pair configurations, even if they contain some 1s already grouped but not enclosed in a larger group, eliminating any excess inputs. This left me with a simplified logic expression. Based on this expression I can use AOI logic to help me design the decision-making portion of my circuit, only allowing a signal to be sent to the flip-flop when there are two adjacent pieces in the copier.

With my AOI logic created, I then tested it using MultiSIM, in which I found my logic works properly. I did this by placing down my placing down a VCC and a ground signal first, then connecting three SPDT switches. These are my inputs and with those I can link them into one output by using AND and OR gates. Once I placed my gates, I then looked back to my truth table to see when my system was supposed to be sending an output, allowing me to check my AOI logic. I then placed down my D flip-flop which was set up in a way that changes the output whenever a high signal is sent to the clock port. To do this I set up a D flip-flop normally, connecting power to PR, my output to my jam LED, and my inverse output to my motor LED. I then placed power into the D port as whenever there is a positive signal into that port and the clock signal rises the normal output turns on, allowing my jam signal to turn on only when it detects the two adjacent papers. However, to make my jam signal turn off, as it is connected to a flip-flop, it must use a reset switch. When the reset switch sends a low signal the flip-flop is forced to send a low signal to the output and a high signal to the inverse output. Knowing this I connected a switch to the CLR port. With this done my MultiSIM was complete, with the jam signal turning on when there is a jam, allowing someone to fix the issue, and the motor turning back on when the reset button is pressed.

With my MultiSIM designed, I then created a prototype of this circuit in TinkerCAD. I used this as it allowed me to visualize what a breadboard of this circuit would look like without the repercussion of physically making it. To create this simulation, I first placed down a breadboard, connecting it to power. I then placed down my major components, such as switches, LEDs, resistors, and ICs. I then powered and grounded what was necessary and then connected my wires between the components. My system was created with the same parts as I used in the MultiSIM, however, I used a button rather than a switch as it made the system more realistic. A button also allows the user to only use one action to reset the system rather than two, as with a switch you must turn it on and off. As I used a button, I did have to place an inverter to its signal as when the button is unactuated it usually sends an output of 0, when we want it to be sending an output of 1 constantly. With this adjustment made, I finished my circuit and tested it for the final time.

Ultimately, this project taught me the importance of planning when it comes to designing complex circuits. It also allowed me to practice my skills in deriving an equation using K-Mapping and using flip-flops. This project helped me enhance my technical knowledge and value my abilities in precision and problem-solving.

Parts List: MultiSIM		Parts List: TinkerCAD	
VCC	2	Power Supply	1
Ground	1	Switch	3
SPDT Switch	4	Button	1
Dual D Flip-Flop	1	Dual D Flip-Flop	1
AND Gate	2	Quad AND Gate	1
OR Gate	1	Quad OR Gate	1
Inverter	1	Hex Inverter	1
Blue Probe	3	Blue LED	3
Green Probe	1	Green LED	1
Red Probe	1	Red LED	1
		220 Ohm Resistor	6

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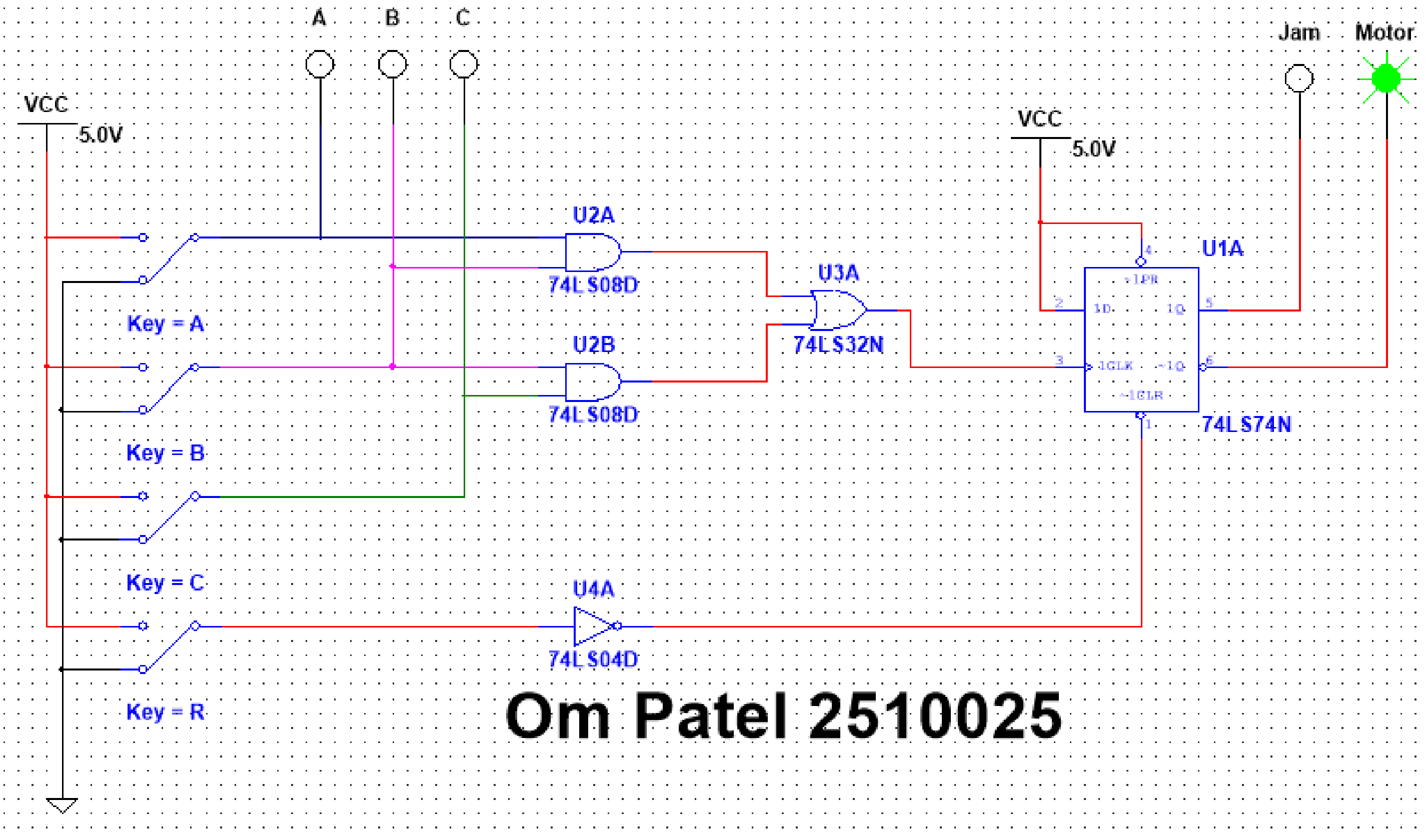
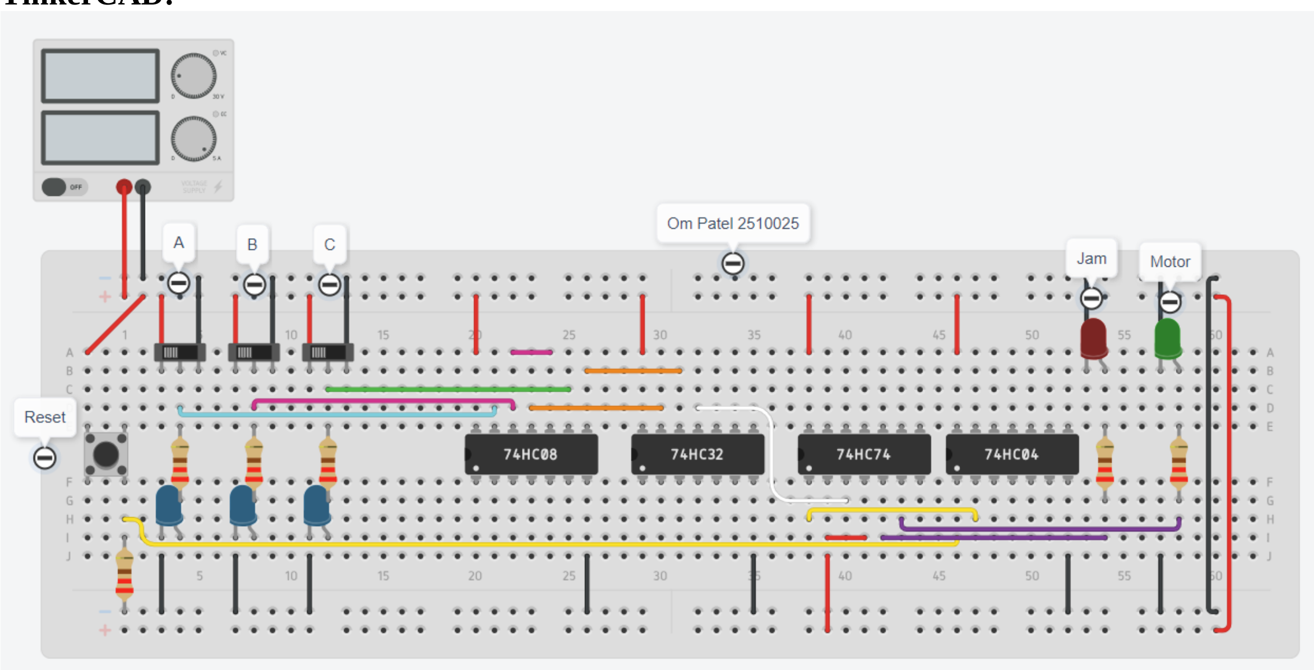
MultiSIM:



TinkerCAD:



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Technical competencies and academic skills demonstrated by completing this assignment.

Framework Standard	Description
2.C.02.23	Use schematics and symbolic algebra to represent digital gates as part of a solution to a design problem (logic symbols: AND, OR, NOT, NAND, NOR, XOR and X-NOR gates).
2.C.02.24	Create Boolean expressions and truth tables.
2.C.02.27	Formulate and use a Karnaugh Map and/or Boolean algebra to reduce logic equation.
2.C.03.01	Simulate a circuit.
Embedded Academics	**Description**
2.C.02.23	Determine the meaning of symbols, key terms, and other domain specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–12 texts and topics.
2.C.06.1.5	Interpret plans, diagrams, and working drawings in the construction of prototypes or models
4.C.04.07	See projects through completion and check work for quality and accuracy.
2.C.20.9-10	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text