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DesignNews

Exploring Electronic Circuits with Breadboards, AI Circuit Analysis, and Simulators

# DAY 5: Exploring Circuit Simulators – Part 2: Tinkercad Circuits

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- Turn on your system sound to hear the streaming presentation.
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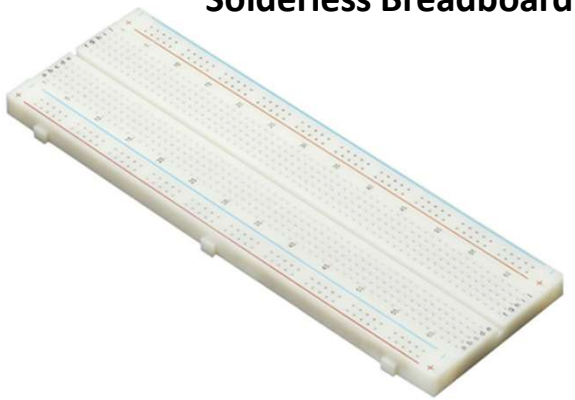
# Dr. Don Wilcher

Visit ‘Lecturer Profile’ in your console for more details.

# Course Kit and Materials

**Adafruit Parts Pal Kit**

**Solderless Breadboard**



**Jumper Wires: Male to Male**

**Solderless Breadboard Power Supply**

# Research Perspective

"Breadboards are widely used in early-stage circuit prototyping since they enable users to rapidly try out different components and to change the connections between them" (Zhu et al., 2020).

# Agenda:

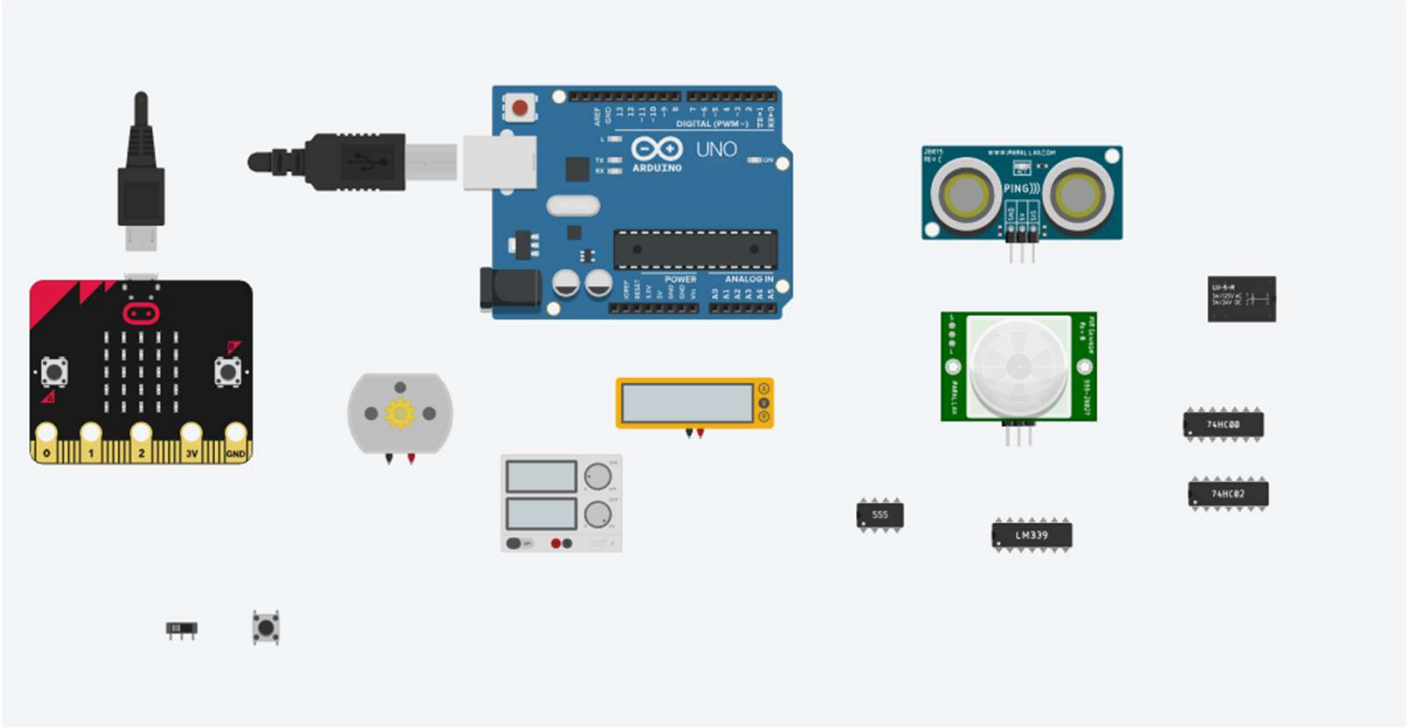
- What is Tinkercad Circuits?
- Why Tinkercad Circuits?
- Hands-On With Tinkercad Circuits

# What is Tinkercad Circuits?

- Tinkercad Circuits is a free online simulator for designing and testing electronic circuits.
- The online simulator is popular among students and hobbyists.
- Tinkercad Circuits is available in 16 languages.
- The online simulator has a virtual lab bench consisting of
  a) electronic test instruments
  b) analog electronics components
  c) digital electronics components
  d) electric switches
  e) electromechanical relays
  f) motors
  g) sensors
  h) Arduino Uno and Micro:bit boards

## What is Tinkercad Circuits?. . .

The online simulator has a virtual lab bench consisting of:



# Question 1

**What groups are Tinkercad Circuits popular with?**

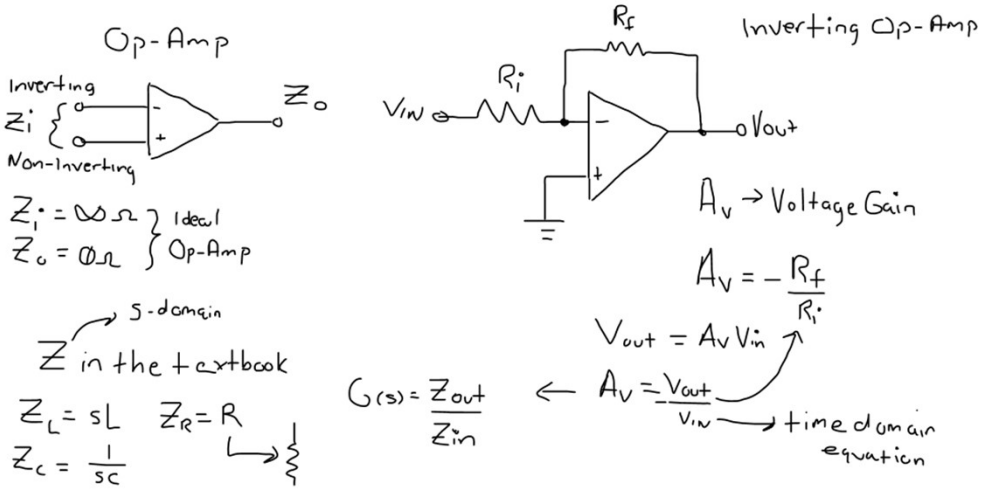
**a) students and engineers**
**b) engineers and hobbyists**
**c) engineers and educators**
**d) students and hobbyists**

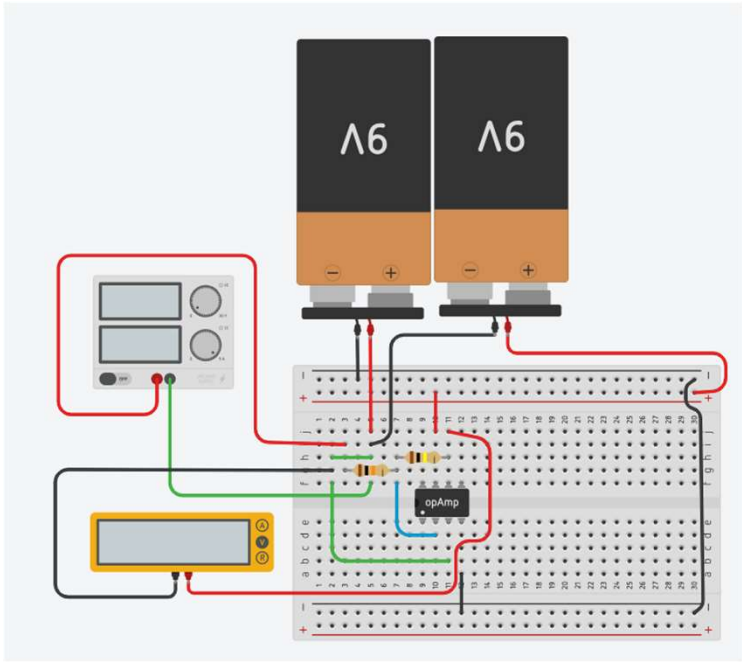
# Why Tinkercad Circuits?

- Design circuits: Place and connect electronic components to create a virtual circuit.
- Simulate circuits: Observe how components respond virtually before building a real-life circuit.
- Program: Use the interactive circuit editor to code virtual projects. Circuits are available in 16 languages.
- Use a breadboard view: The presented graphics provide a physical view of the electronic components used in real life.
- Use a Blocks + Text view: Explore coding possibilities using blockly code while the same programming concepts are presented in Python and C++.
- Electronic Circuit Schematic Generation: Placing electronic components onto a solderless breadboard automatically generates an electronic circuit schematic diagram for project documentation.
- Component List Generation: Automatically capture the circuit design's Bill Of Materials (BOM) for project documentation.

# Why Tinkercad Circuits?. . .

Design circuits: Place and connect electronic components to create a virtual circuit.



# Why Tinkercad Circuits?. . .

Program: Use the interactive circuit editor to code virtual projects.
Circuits are available in 16 languages.

Predictive Maintenance: Pushbutton Switch Fault Detection Partial Code

```
// Define pin numbers
const int pushButtonPin = 2; /
const int ledPin = 13; // LED
unsigned long lastPressTime =
bool lastButtonState = LOW; //

void setup() {
  // Set pushbutton pin as inp
  pinMode(pushButtonPin, INPUT
  // Set LED pin as output
  pinMode(ledPin, OUTPUT);
  // Initialize serial communi
  Serial.begin(9600);
}

void loop() {
  // Read the state of the pushbutton switch
  bool buttonState = digitalRead(pushButtonPin);

  // Check if the button state has changed
  if (buttonState != lastButtonState) {
    // Update the timestamp if the button is pressed
    if (buttonState == HIGH) {
      lastPressTime = millis();
    }
    // Print the button state and duration since the last press
    Serial.print("Button state: ");
    Serial.print(buttonState);
    Serial.print(", Duration since last press: ");
    Serial.println(millis() - lastPressTime);
    // Update the last button state
```

How the debugger works

1. Add breakpoints by clicking on the line numbers.
2. Hover over the variables while paused to see their value.
3. Use the buttons above to resume simulation or step one line at a time.

# Question 2

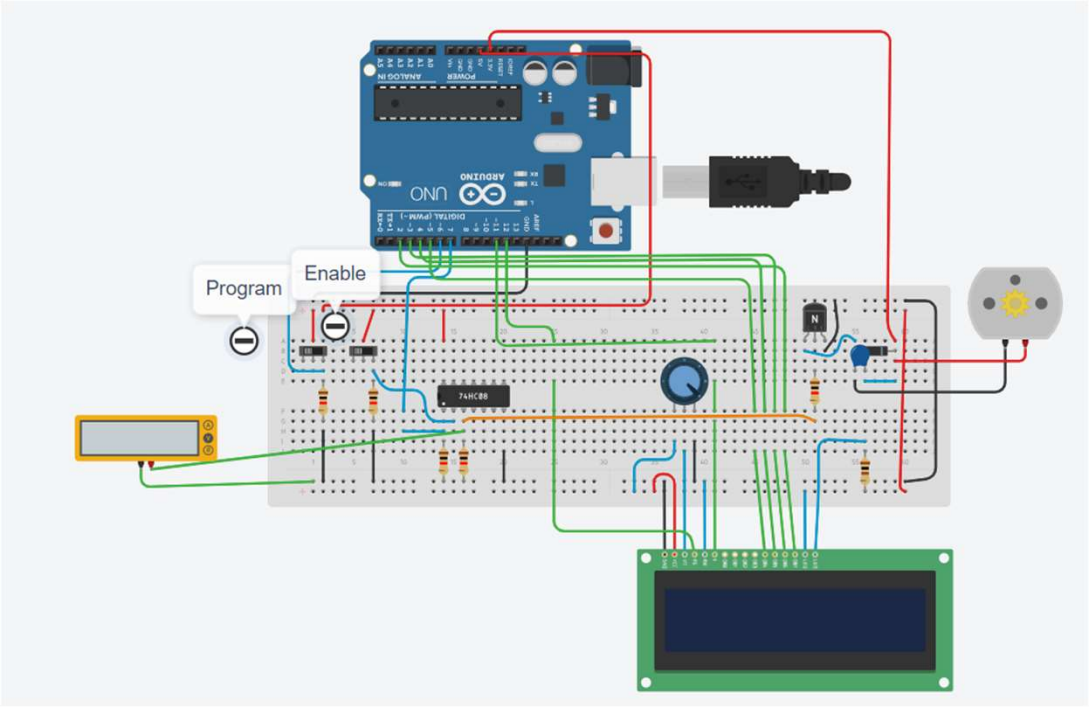
**How many languages are available for Tinkercad Circuits?**

**a) 10**
**b) 12**
**c) 13**
**d) 16**

# Why Tinkercad Circuits?. . .

Program: Use the interactive circuit editor to code virtual projects.
Circuits are available in 16 languages.

DC Programmable
Motor Controller



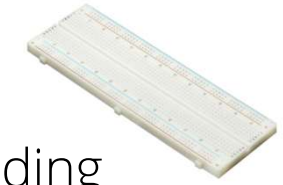
# Why Tinkercad Circuits?. . .

Program: Use the interactive circuit editor to code virtual projects.
Tinkercad Circuits are available in 16 languages.

DC Programmable Motor Controller Partial Code

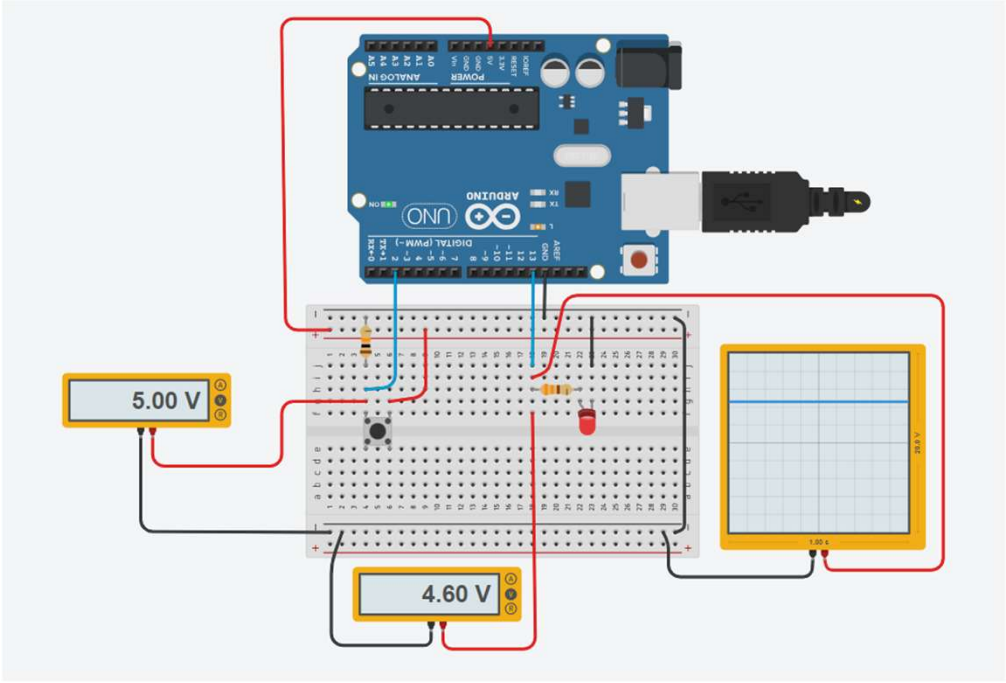
```
#include <LiquidCrystal.h>
// initialize the library with the numbers of the interface pins
LiquidCrystal lcd(12, 11, 5, 4, 3, 2);
// constants won't change. They're used here to
// set pin numbers:
const int ProgramPin = 6; // pin number for PROGRAM input control

const int OUTPin = 7; // pin number for OUTPUT control signal
// variable will change:
int ProgramStatus = 0; // variable for reading Program input stat

void setup() {
// initialize the following pin as an output:
pinMode(OUTPin, OUTPUT);
// initialize the following pin as an input:
pinMode(ProgramPin, INPUT);
// set up the LCD's number of rows and columns:
lcd.begin(16, 2);
// set cursor for messages andprint Program select messages on th

lcd.setCursor(0,0);
lcd.print( ">1.Closed(ON)");
lcd.setCursor(0, 1);
lcd.print ( ">2.Open(OFF)");
}

void loop(){
// read the status of the Program Switch value:
ProgramStatus = digitalRead(ProgramPin);
// check if Program select choice is 1.ON.
if(ProgramStatus == HIGH) {
```

# Why Tinkercad Circuits?. . .



Simulate circuits: Observe how components respond virtually before building a real-life circuit.

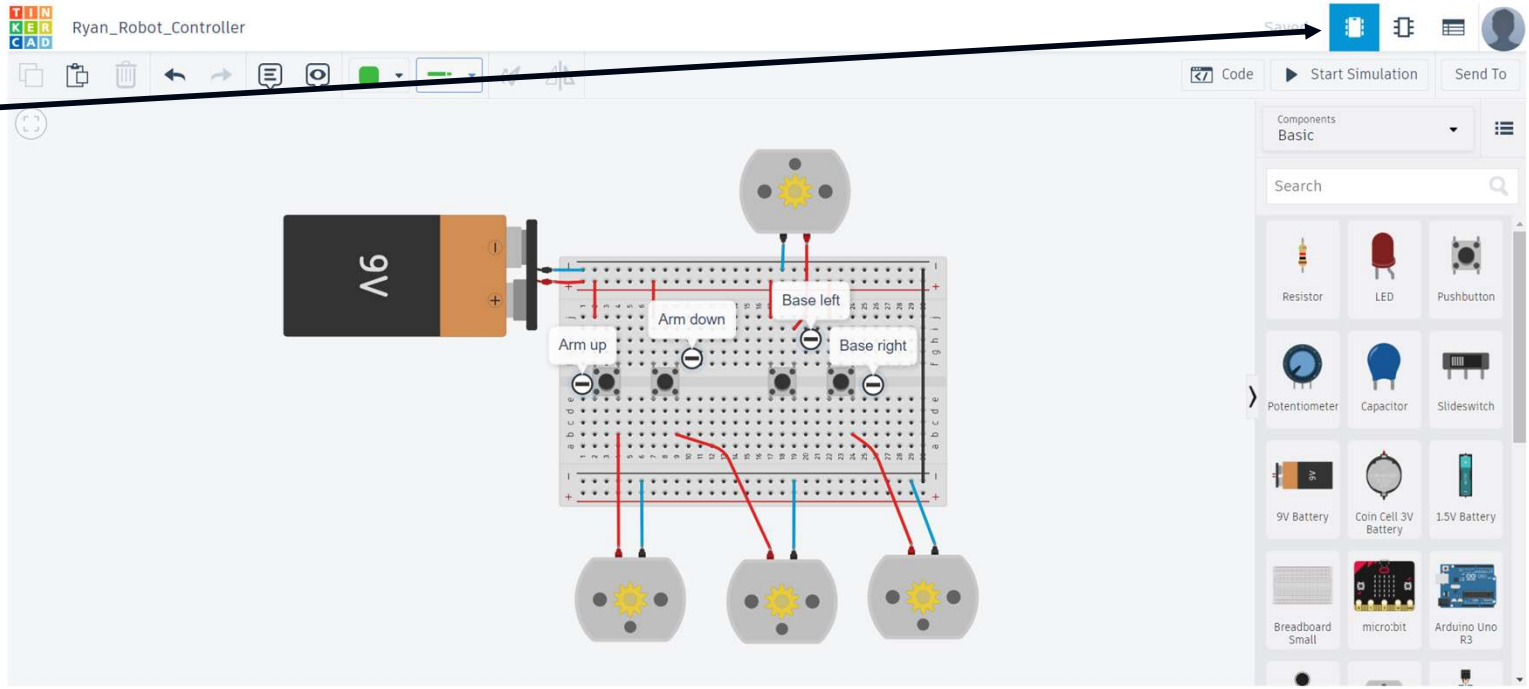
Predictive Maintenance: Pushbutton Switch Fault Detection Model



# Why Tinkercad Circuits?. . .

Use a breadboard view: The presented graphics provide a physical view of the electronic components used in real life.

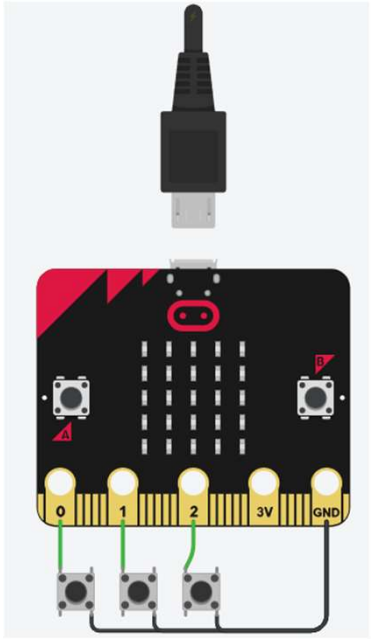
Breadboard view



# Why Tinkercad Circuits?. . .

Use a Blocks + Text view: Explore coding possibilities using blockly code while the same programming concepts are presented in Python and C++.

Gesture Control Device



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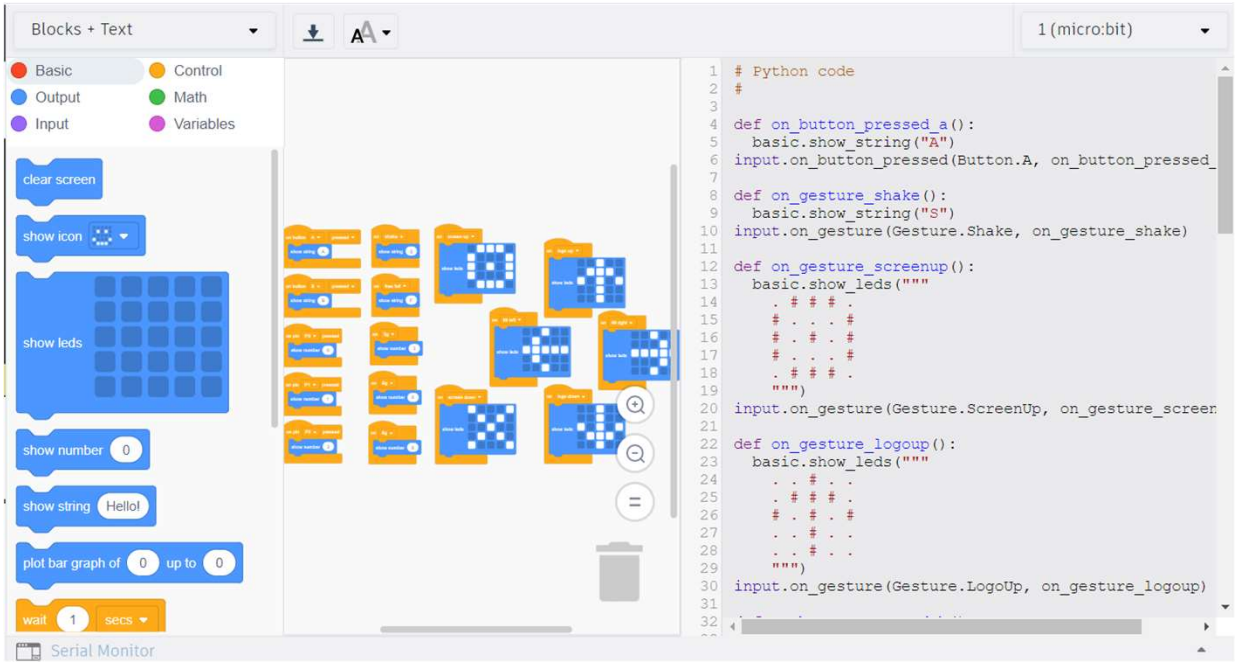
Gesture Control Code

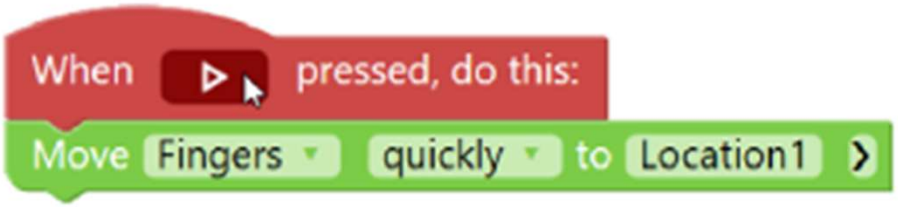


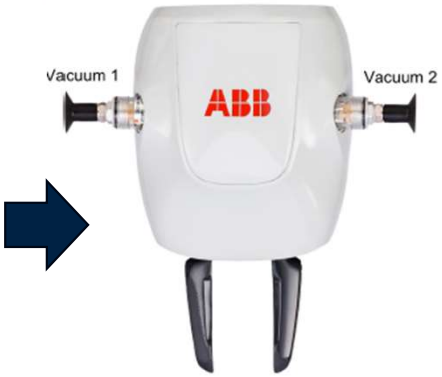
# Why Tinkercad Circuits?. . .

Use a Blocks + Text view: Explore coding possibilities using blockly code while the same programming concepts are presented in Python and C++.

ABB Wizard Easy Programming for Next Gen of Collaborative Robots

6 Tap the Play button to run the program and apply the codes to the controller.




Tinkercad Circuits Blockly Code aligns with Real World Machines

# Question 3

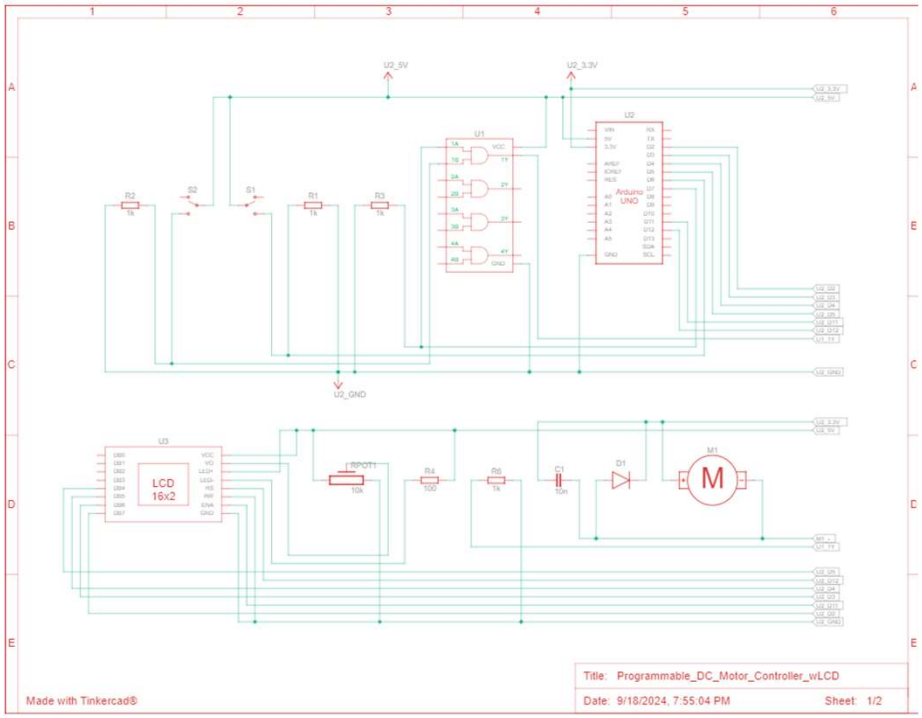
**Tinkercad Circuits Blockly code aligns with what real-world machine?**

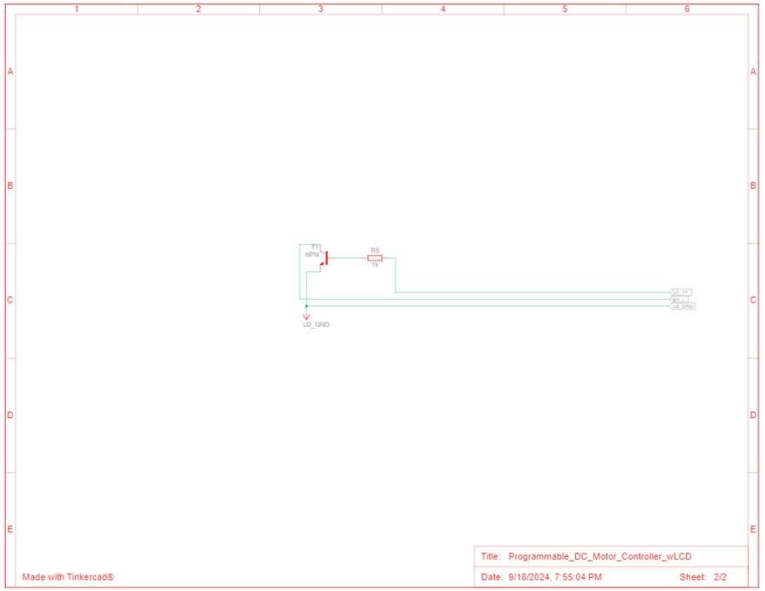
**a) Dishwasher**
**b) Autonomous Vehicle**
**c) Collaborative Robot**
**d) VCR**

# Why Tinkercad Circuits?. . .

Electronic Circuit Schematic Generation: Placing electronic components onto a solderless breadboard automatically generates an electronic circuit schematic diagram for project documentation.

DC Programmable Motor Controller Schematic View



# Why Tinkercad Circuits?. . .

Component List Generation: Automatically capture the circuit design's Bill Of Materials (BOM) for project documentation.

DC Programmable Motor Controller Component List View

Component List — Download CSV

| Name | Quantity | Component |
|---|---|---|
| U1 | 1 | Quad AND gate |
| S1<br>S2 | 2 | Slideswitch |
| R1<br>R2<br>R3<br>R5<br>R6 | 5 | 1 kΩ Resistor |
| U2 | 1 | Arduino Uno R3 |
| U3 | 1 | LCD 16 x 2 |
| R4 | 1 | 100 Ω Resistor |
| Rpot1 | 1 | 10 kΩ Potentiometer |
| Meter1 | 1 | Voltage Multimeter |
| M1 | 1 | DC Motor |
| D1 | 1 | Diode |
| C1 | 1 | 10 nF Capacitor |
| T1 | 1 | NPN Transistor (BJT) |

# Why Tinkercad Circuits?. . .

Component List Generation: Automatically capture the circuit design's Bill Of Materials (BOM) for project documentation.

DC Programmable Motor Controller CSV View

Download CSV

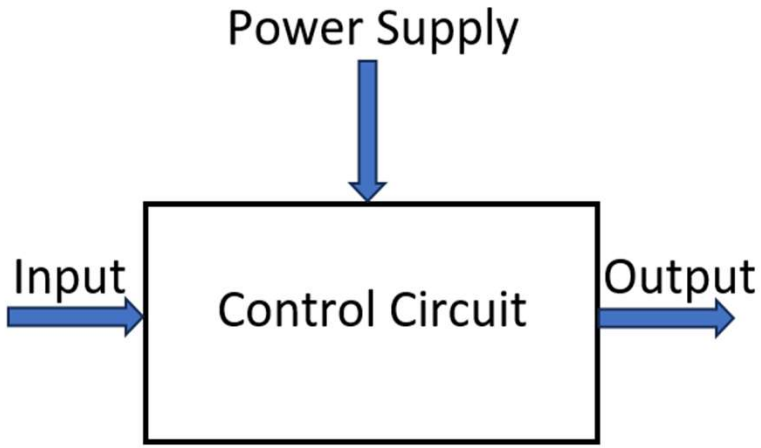
| Name | Quantity | Component |
|---|---|---|
| U1 | 1 | Quad AND gate |
| S1, S2 | 2 | Slideswitch |
| R1, R2, R3, | 5 | 1 kΩ Resistor |
| U2 | 1 | Arduino Uno R3 |
| U3 | 1 | LCD 16 x 2 |
| R4 | 1 | 100 Ω Resistor |
| Rpot1 | 1 | 10 kΩ Potentiometer |
| Meter1 | 1 | Voltage Multimeter |
| M1 | 1 | DC Motor |
| D1 | 1 | Diode |
| C1 | 1 | 10 nF Capacitor |
| T1 | 1 | NPN Transistor (BJT) |

# Hands-On With Tinkercad Circuits

Tinkercad Circuits allows the opportunity to build a virtual interactive model: A Minimum-Viable Prototype (MVP).

## What is an MVP?

An MVP is a design approach that helps quickly create, test, launch, and improve products.



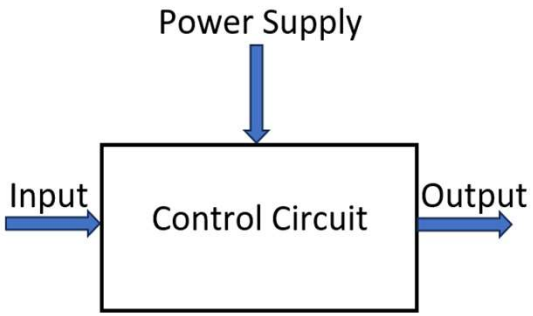
# Question 4

**What is an MVP?**

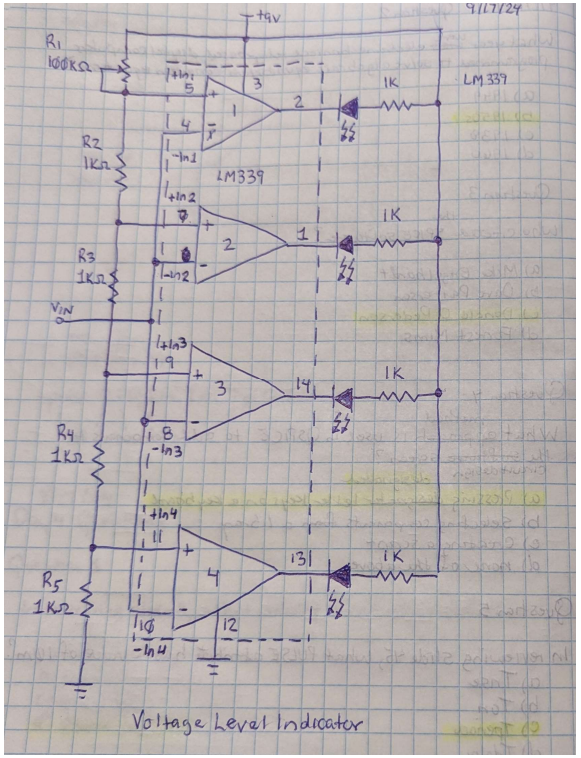
**a) Most Viable Product**
**b) Minimum Viable Product**
**c) Most Viable Prototype**
**d) Minimum Viable Prototype**

# Hands-On With Tinkercad Circuits. . .

A Minimum-Viable Prototype (MVP): Voltage Level Indicator.



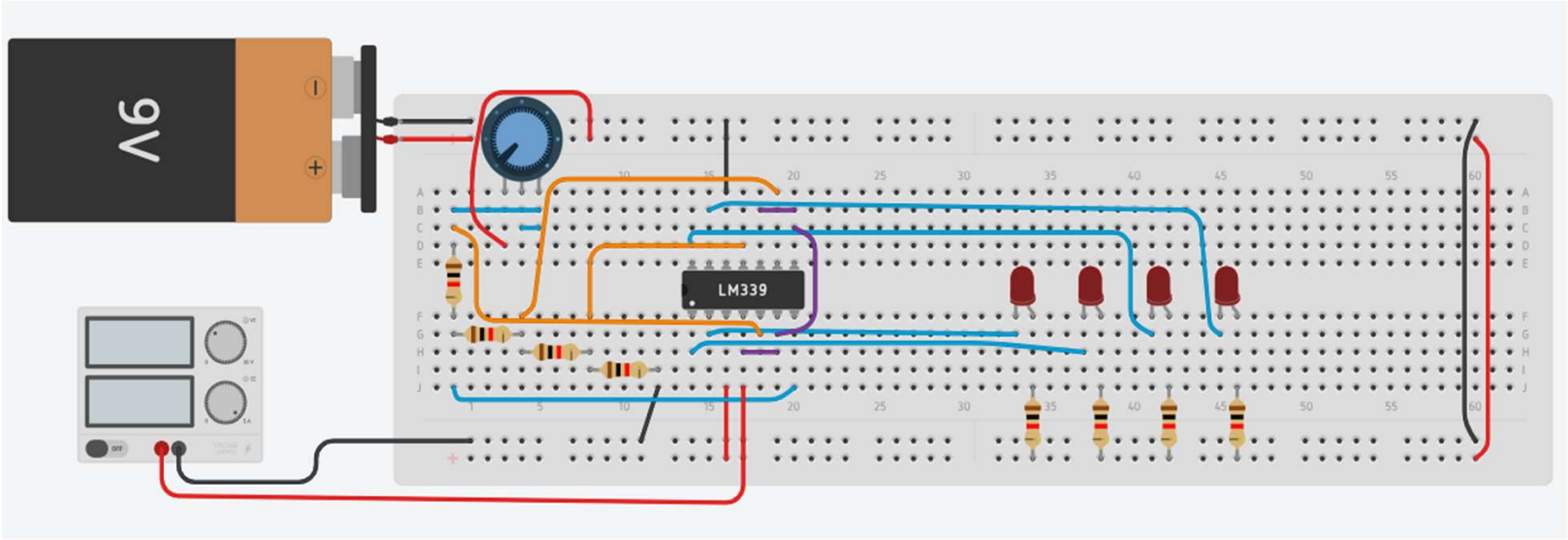

MVP Circuit Model
(Level 0)




Hand-Sketched
Electronic Circuit
Schematic
diagram
(Level 3)

# Hands-On With Tinkercad Circuits. . .

A Minimum-Viable Prototype (MVP): Voltage Level Indicator Virtual MVP



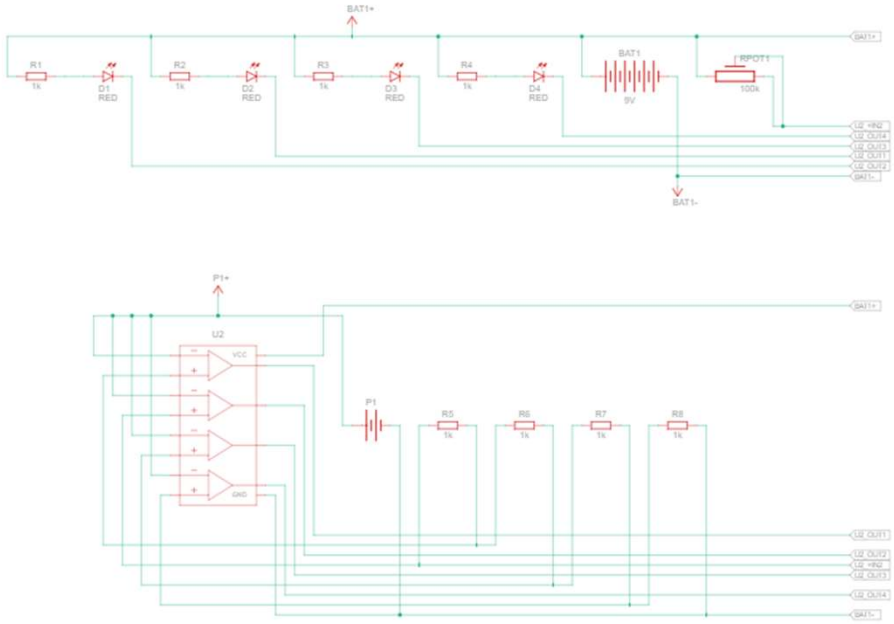

An Interactive Voltage Level Indicator Virtual MVP

# Hands-On With Tinkercad Circuits. . .

## A Minimum-Viable Prototype (MVP): Voltage Level Indicator Virtual MVP

Watch the Interactive Voltage Level Indicator Virtual MVP video clip:

https://youtu.be/qxsQXgbWRNE



An Interactive Voltage Level Indicator Virtual MVP:
Electronic Circuit Schematic Diagram

# Hands-On With Tinkercad Circuits. . .

A Minimum-Viable Prototype (MVP): Voltage Level Indicator Virtual MVP

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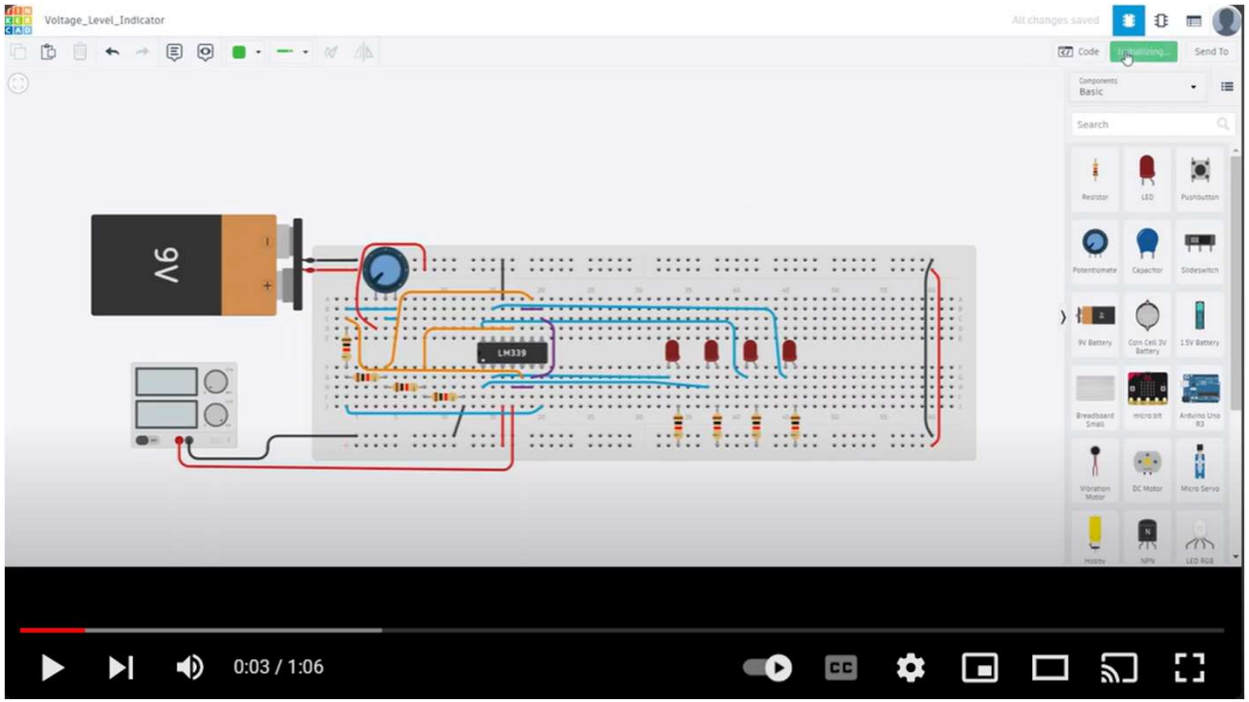
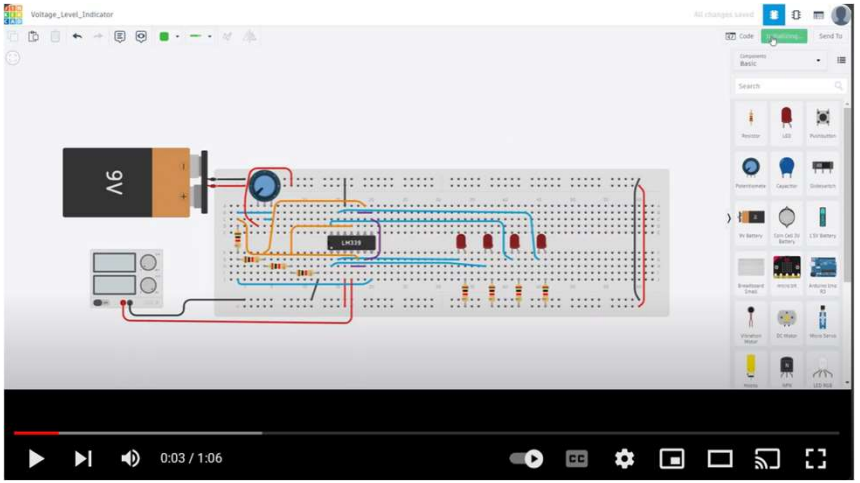


# Hands-On With Tinkercad Circuits. . .

## A Minimum-Viable Prototype (MVP): Voltage Level Indicator Virtual MVP

Here is a copy link to explore the Voltage-Level Indicator. Upon receiving the model, change the name immediately to prevent others from modifying your copy's design!

https://www.tinkercad.com/things/lzfXtMVp5lV-copy-of-voltagelevelindicator/editel?sharecode=pxEaVAQls04ZkJrrZ5pzrF0VnuYehWgLCs-N64iDqMM



# Question 5

**What MVP device was presented in the Hands-On With Tinkercad Circuits discussion?**

**a) Voltage Level Detector**
**b) Voltage Level Meter**
**c) Voltage Level Alarm**
**d) Voltage Level Indicator**

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