NASA

TECHRISE

STUDENT CHALLENGE

Step 3: Plan Your Experiment
Design Flight Experiments

Plan Your Experiment Design

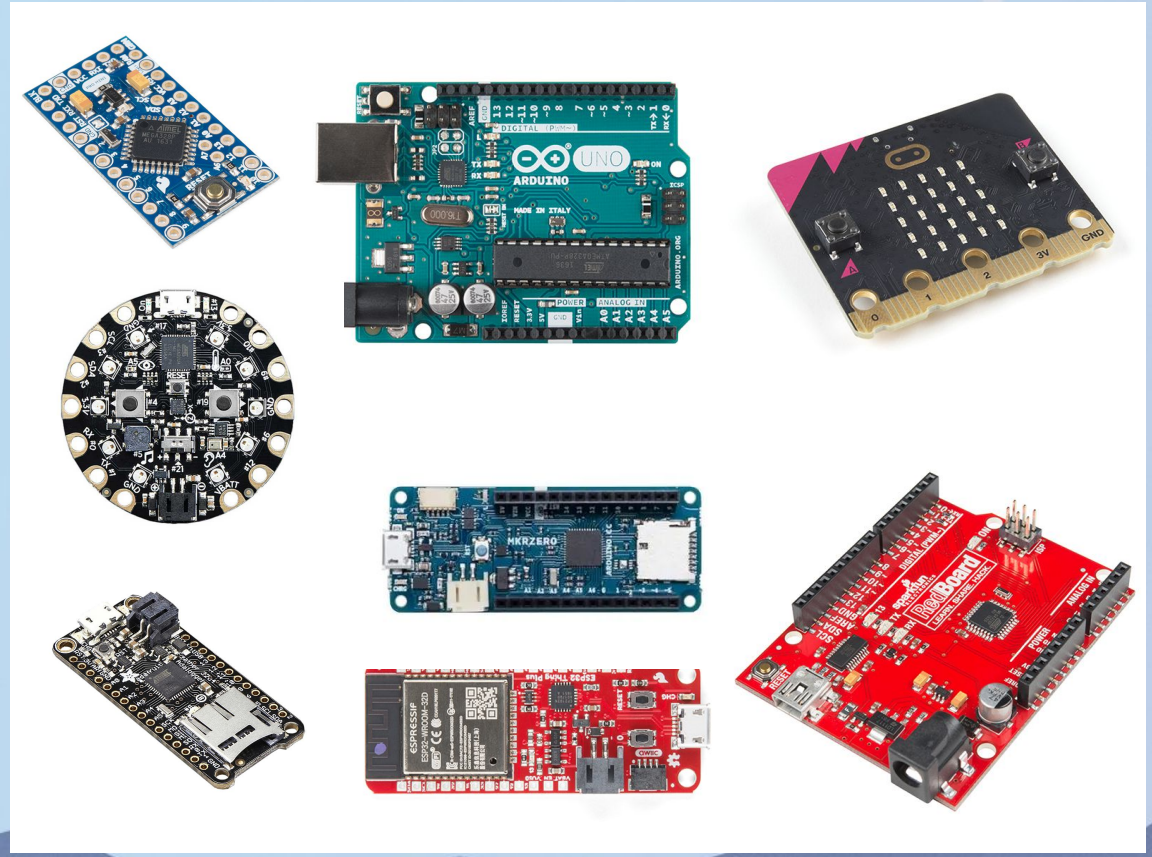
Now that you've thought about possible experiment ideas. We can think about how we actually make those experiments work. On the flight, there will not be anyone to press start on the experiment. We can use microcontrollers to automate them.
Let's learn how to take your experiment idea and put it to work in the sky.

First, we will learn about microcontrollers and helpful hardware components.

Next, we will use a hardware component menu to plan out an experiment design.

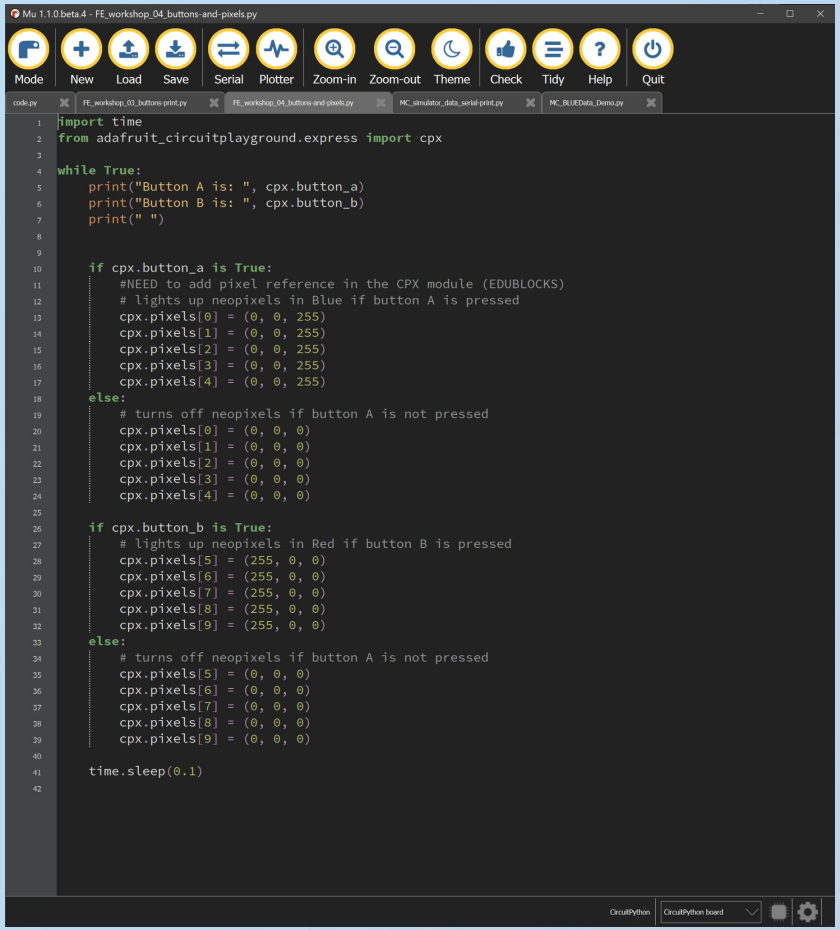
What is a Microcontroller?

- Embedded programmable computers
- Examples include:
  - Arduino
    - Uno
    - Mini
    - Zero
  - Adafruit Circuit Playground
  - BBC Micro:bit
  - Sparkfun Redboard
  - ESP32 Boards
  - Itsy Bitsy
  - Many more!
- Development boards are designed to quickly develop hardware prototypes!



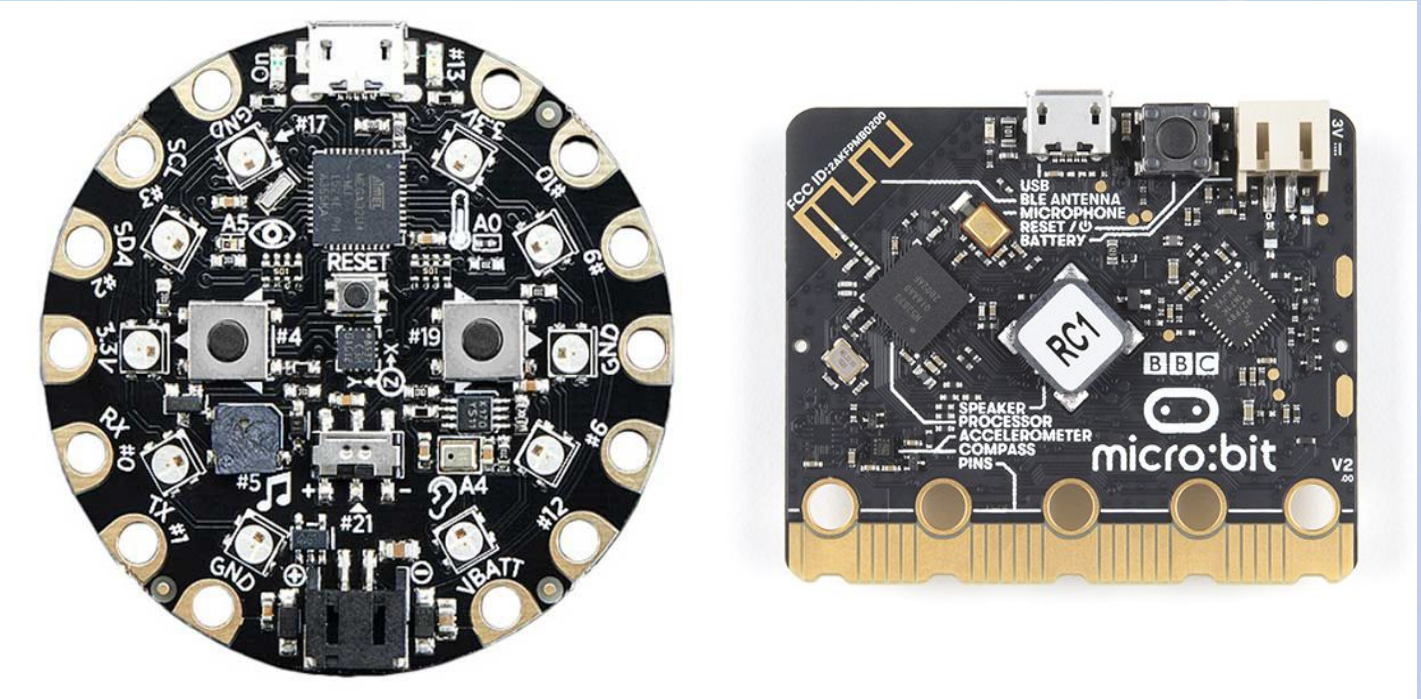
What is Code?

- Code is the language we use to give instructions to microcontrollers (and computers in general)
- Computers only understand binary
  - 01000111010001011011
- Humans need language and code bridges this gap



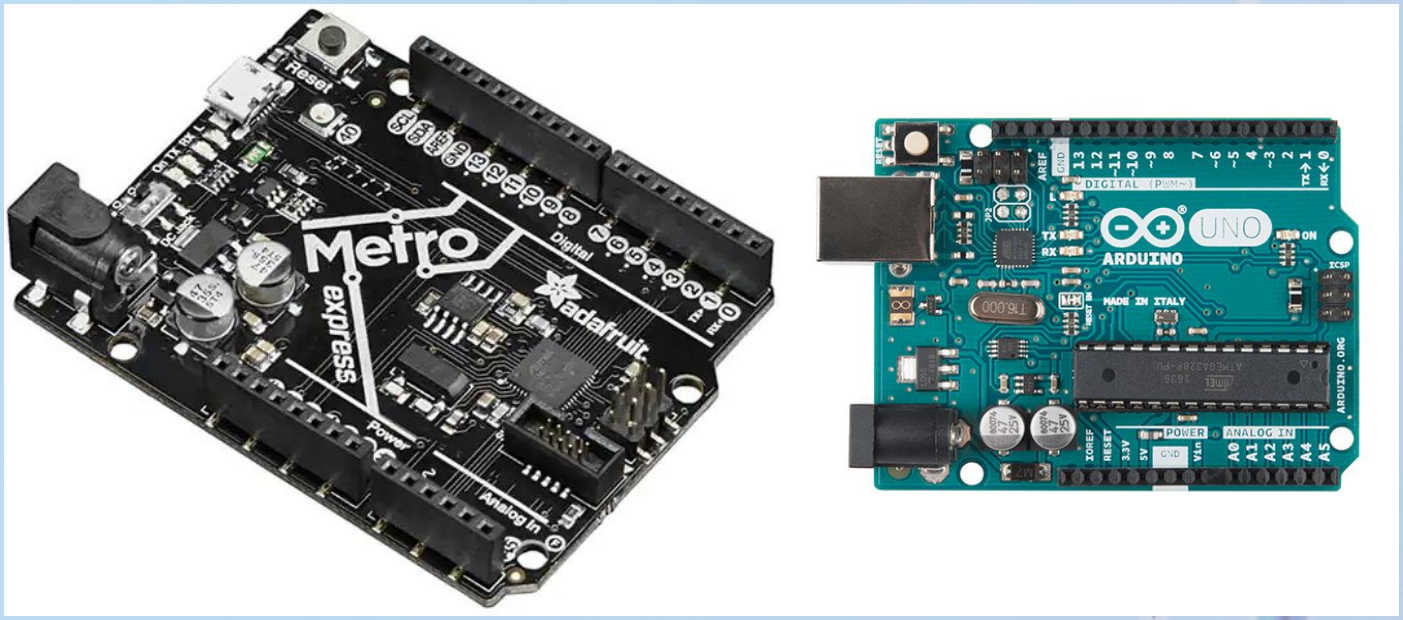
A closer look

- Microcontrollers like Adafruit Circuit Playground or BBC Micro:Bit are learning boards with a lot of extra hardware built-in
  - Buttons
  - Lights
  - Sensors
- These types of boards are good for learning to code, classroom demonstration, and “fast prototyping”



A closer look

- Microcontrollers like Arduino or Adafruit Metro provide input and output (I/O) with little or no additional hardware
- These types are generally used to build your own systems and prototypes



Microcontrollers are everywhere!

These small embedded computers are increasingly common in everyday consumer products.

- “Smart” Devices
- “Internet of Things”
- Digital Thermostats
- Remote Controls
- Garage Door Openers
- Automated Devices
- Electronic Toys
- Electronic Games

Hardware and Software Ecosystems

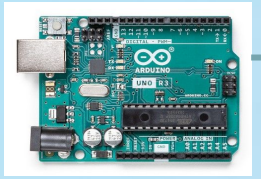
There are different hardware and software ecosystems for each microcontroller. When choosing a microcontroller it is important to be aware of what coding language it uses as well as what components are compatible with it.

Let’s take a look at what boards are compatible with what software (coding language).

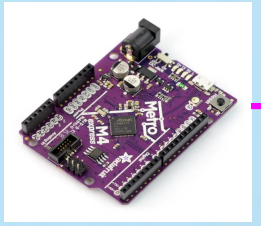
Hardware and Software Ecosystems

Hardware

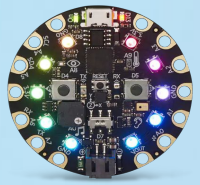
Arduino UNO / DUE



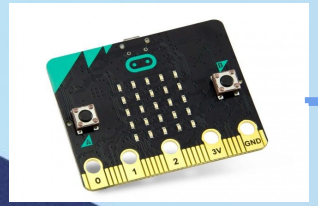
Adafruit Metro M4 Express



Adafruit Circuit Playground



BBC Micro:Bit

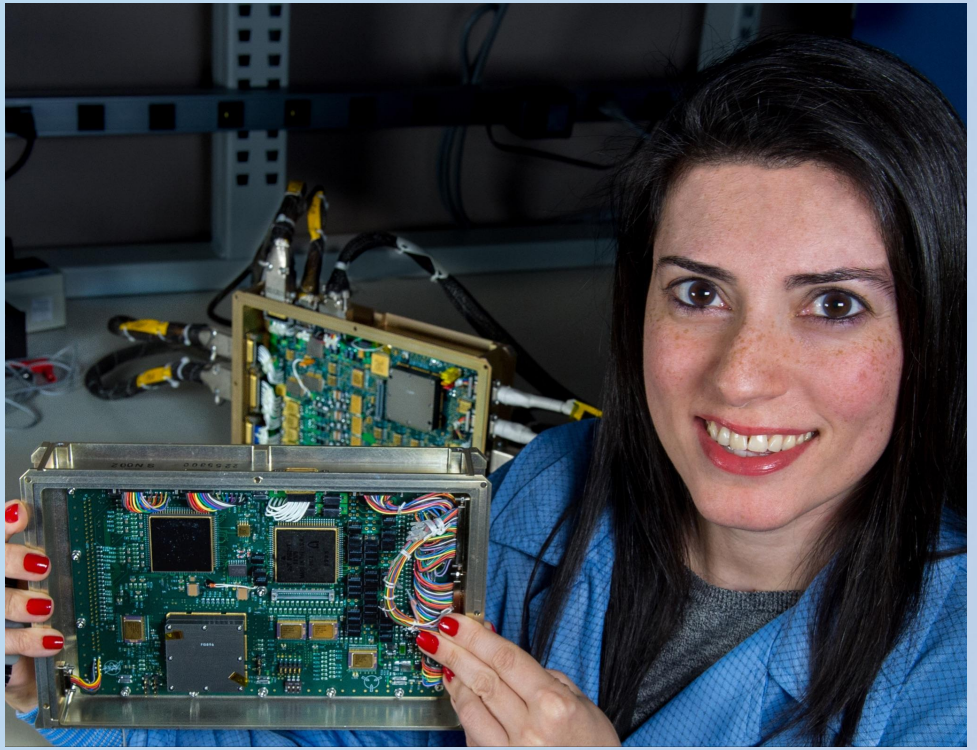


Software (Code Language)

- Arduino IDE / C++
- CircuitPython
- MicroPython
- Block Code (makecode.com)

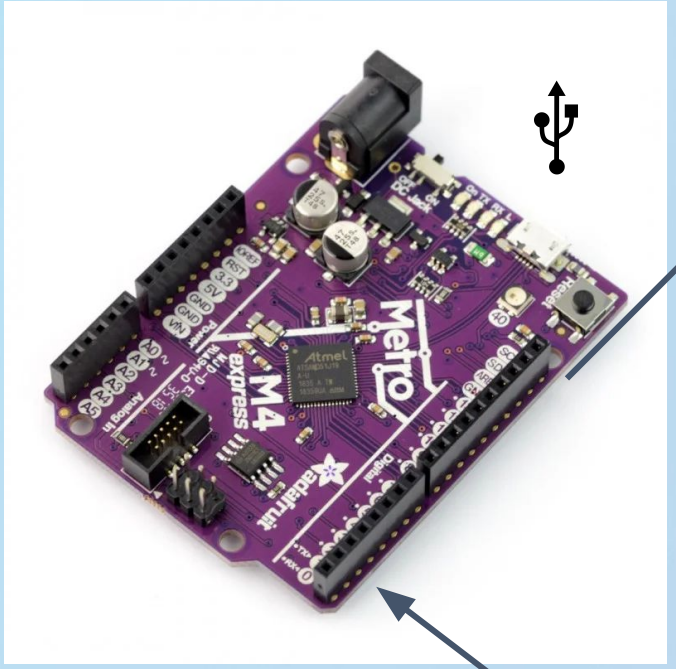
What does this have to to do with Science?

Because microcontrollers can be programmed to automate certain tasks, scientists and engineers use them to create instruments that automatically take measurements and record data… like in space, on the Moon, and on Mars!



Credits NASA/W. Hyrbyk

What is input and output?

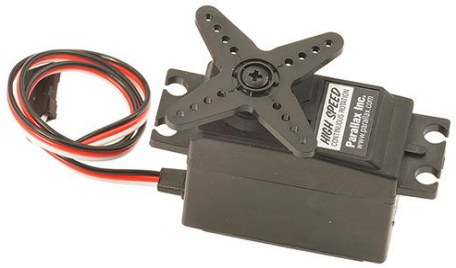


USB/Serial output
Digital/Analog output

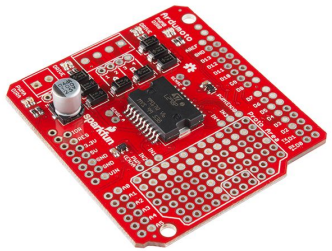
Digital or Analog input

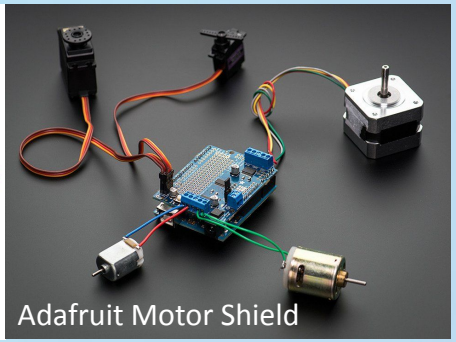
Hardware for space science...

What if your TechRise experiment in space requires something to move?


Angular servo


DC motor


Sparkfun Motor Shield


Adafruit Motor Shield


Solenoid

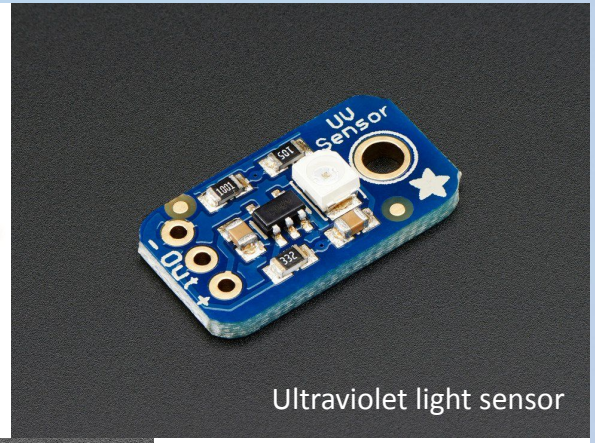

DC motor with gearbox


Submersible pump

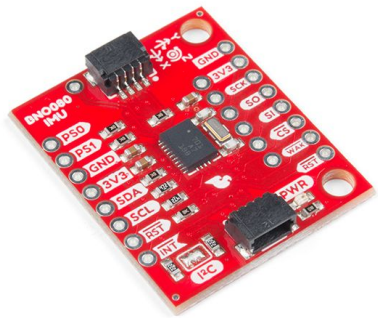
Hardware for space science...

What if your TechRise experiment is designed to sense the environment?

VOC / CO2 sensor

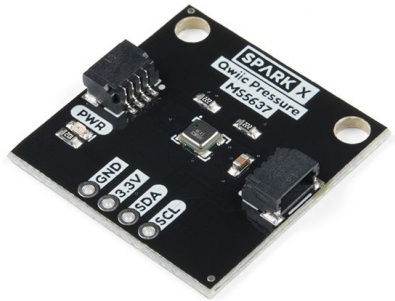


Ultraviolet light sensor



IMU Motion sensor

Adafruit Motor Shield

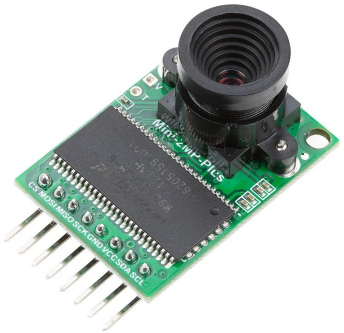


Barometric pressure sensor

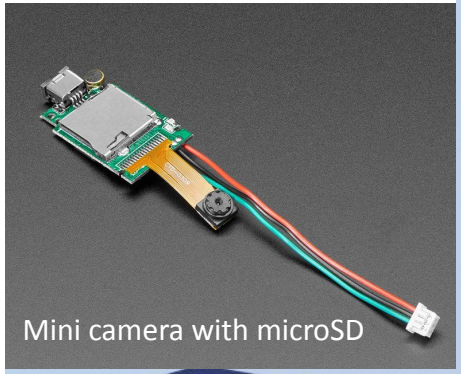
Hardware for space science...

What if your TechRise experiment needs a camera to take pictures?


TTL serial camera

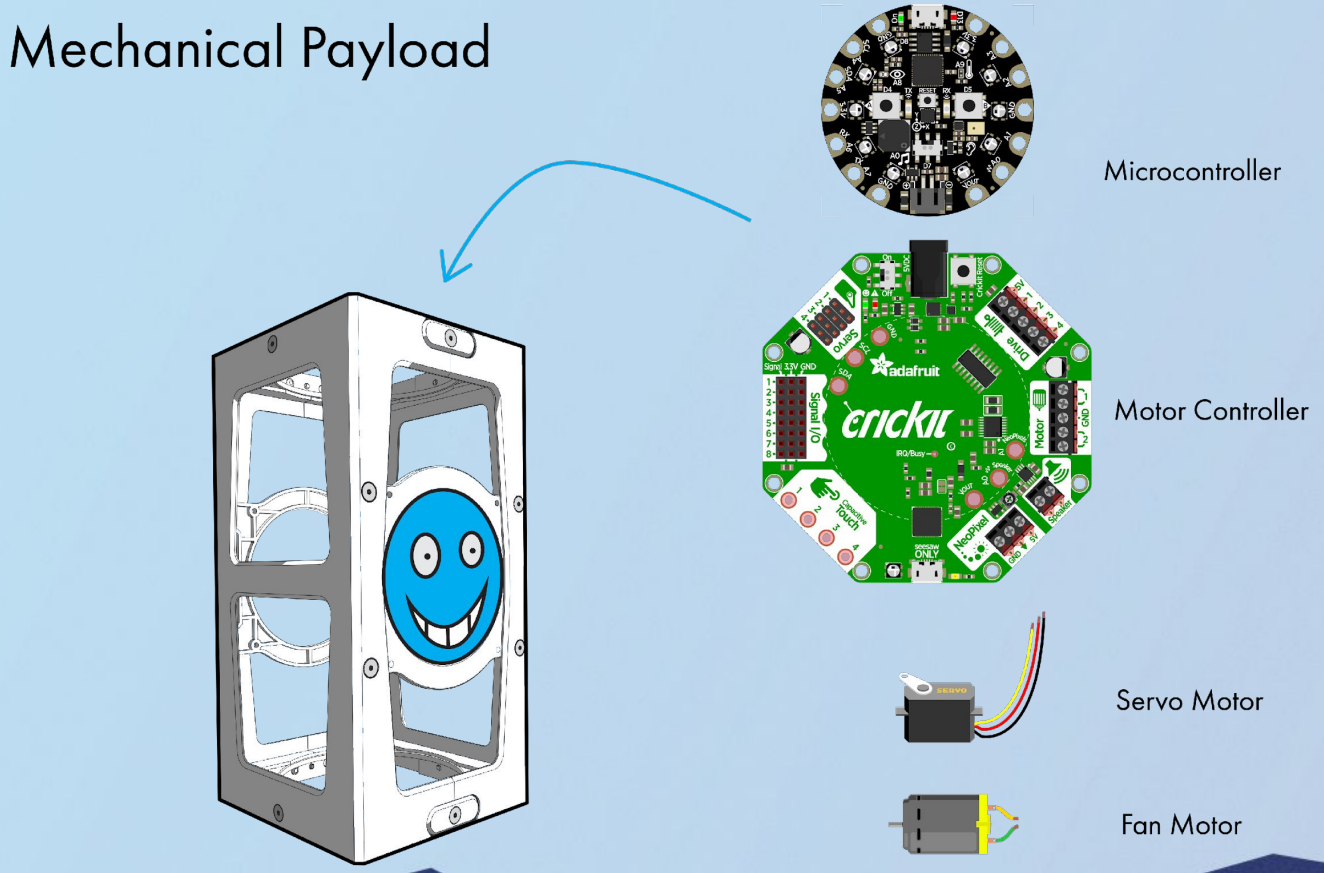

Arducam 5MP

32x24 Infrared sensor

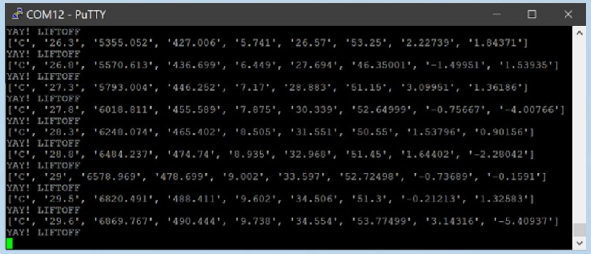

Mini camera with microSD

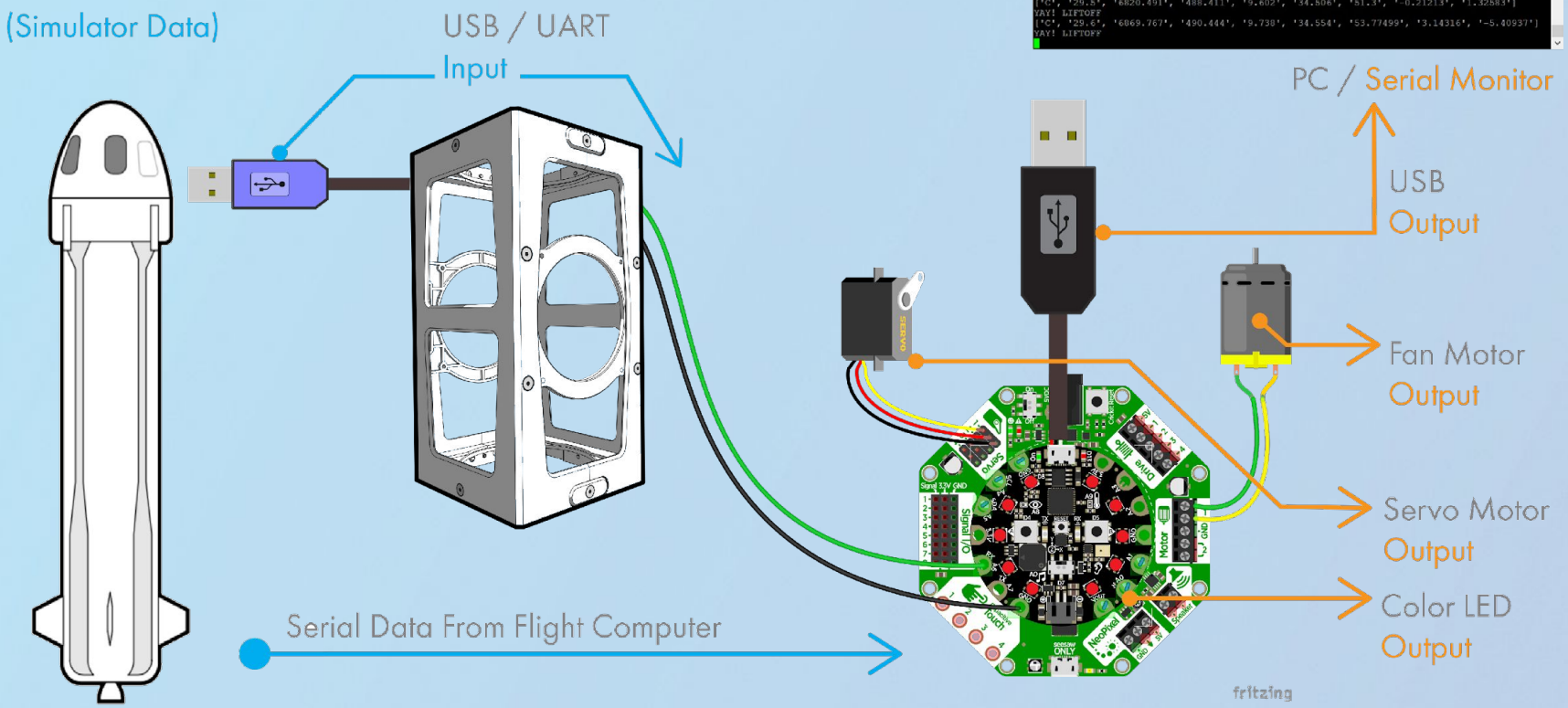
Sample Experiment Build

Now let's look at a sample experiment design. This will give you an idea of how to set up a design.



Payload Test Overview





Blue Origin New Shepard

Input / Output

Circuit Playground Express
& Crickit Companion Board

Explore Components Design Activity

Now it's time to design your experiment! Think about what components you would use to bring your experiment idea to life. From motors to sensors to microcontrollers, explore the components you would use.

With your team, use the Explore Components Design Worksheet to plan your experiment.

Explore Components Design Activity Worksheet

Plan Your Experiment Design Worksheet

Pick one TechRise experiment idea and plan out a design for it.

Plan Your Experiment Activity Procedure

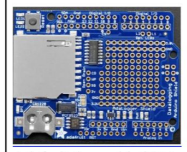
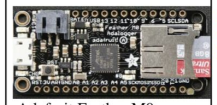
1. Now that you've brainstormed experiment ideas and understand the electrical components needed to build an experiment, choose one idea for your group, and plan the experiment's design.
2. Review the hardware component menu (below) and use the following questions as a guide to plan your experiment.

Choose one person in your group to record the answers to the following questions.

1. What is your experiment idea?
2. What data do you want to collect from your experiment?
3. How will you capture data? What will this data tell you?
4. What main components/hardware will you need to build your experiment? Use the hardware component menu below to help plan out the design for your experiment. Keep in mind you are welcome to use other components that you know of in the design and are not limited to only ones that you see in the list.
5. Sketch a drawing or diagram of your experiment plan (optional).

Explore Components Design Activity Worksheet

HARDWARE/COMPONENT MENU

Hardware/Component	Description	Image/s	Possible Sources
Microcontroller	A programmable mini computer that can be used as the "brains" of an experiment to automate simple tasks by receiving data (input) and sending data (output). Microcontrollers perform repetitive functions and can be programmed to interact with the components below to build out your experiment. (A simple example could be a microcontroller programmed to receive data from a temperature sensor and to tell a fan motor to turn on if the temperature goes above a certain value.)	 Adafruit Metro M4  Arduino Uno	Metro M4 Source 1 Metro M4 Source 2 Metro M4 Source 3 Arduino Uno Source 1 Arduino Uno Source 2 Arduino Uno Source 3
Data Capture	Experiments that are designed to collect data will require an additional device to store, or log, information as text so it can be retrieved and analyzed following a successful flight. SD and MicroSD card readers are well suited for this task. These external storage devices connect to a microcontroller allowing the controller to write data as text to files stored on the removable SD cards. Some development microcontrollers have built-in card readers but most will need a second board, or "shield" dedicated to data storage.	 Data Logger  Adafruit Assembled Data Logging Shield for Arduino  Adafruit Feather M0 Adalogger	Open Log Source 1 Open Log Source 2 Open Log Source 3 Logging Shield Source 1 Logging Shield Source 2 Logging Shield Source 3 Adalogger Source 1 Adalogger Source 2 Adalogger Source 3
Motor	Component that converts electricity into rotational mechanical energy. Motors can be selected to automate tasks using a certain speed or torque. Some motors need to be geared to provide higher torque at lower speeds.	 DC Motor	DC Motor Source 1 DC Motor Source 2 DC Motor Source 3

Share Your Ideas With Your Class