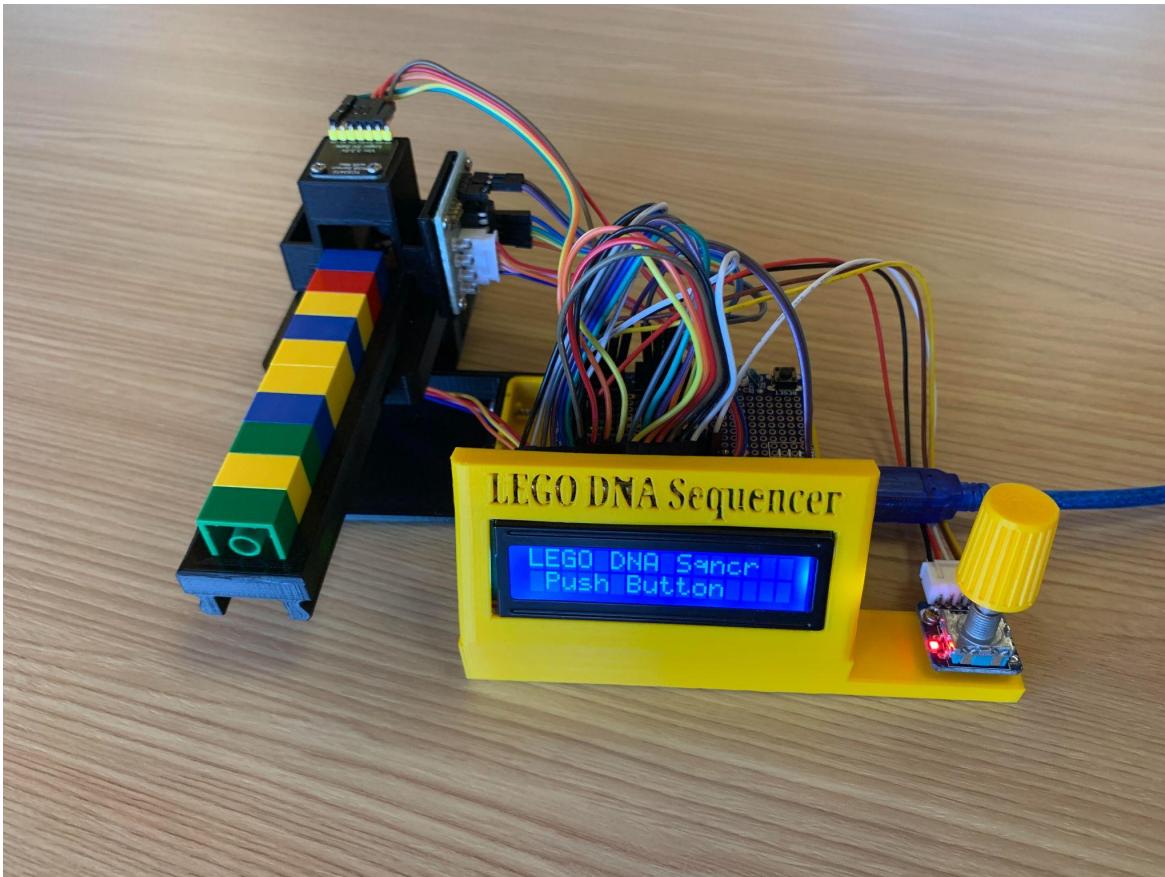


# LEGO DNA Sequencer

## User Manual

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The purpose of this LEGO DNA Sequencer User Manual is to provide instructions for the operation of this easy to use colorful tool for explaining the complex DNA sequencing operation



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# Overview

The purpose of this document is to provide a complete Users Manual that describes the operation of the LEGO DNA Sequencer. A companion document, LEGO DNA Sequencer and DIY Construction, includes additional information about the operation of the system including troubleshooting.

DNA sequencing determines the order of the four chemical building blocks - called "bases" - that make up the DNA molecule. The building blocks are composed of A (adenine), C (cytosine), G (guanine), and T (thymine). These building blocks are represented by LEGO® 2x2 bricks of **Red for G**, **Blue for T**, **Green for A**, and **Yellow for C**. Actual DNA sequencing is greatly simplified in this model by using genomes of only 10 building blocks to identify a species.

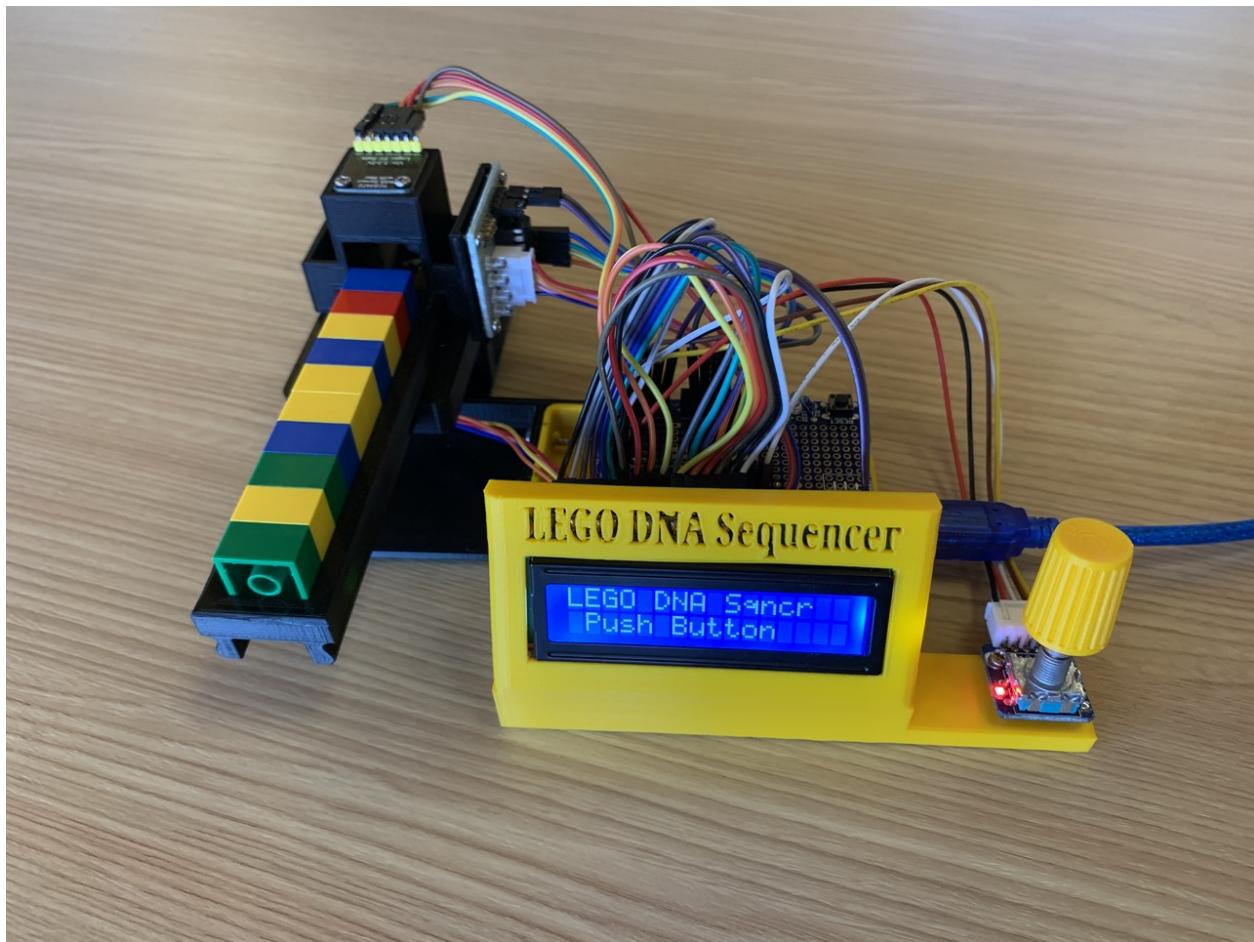
It is beyond the scope of this document to provide more details regarding actual DNA sequencing.

# Users Manual

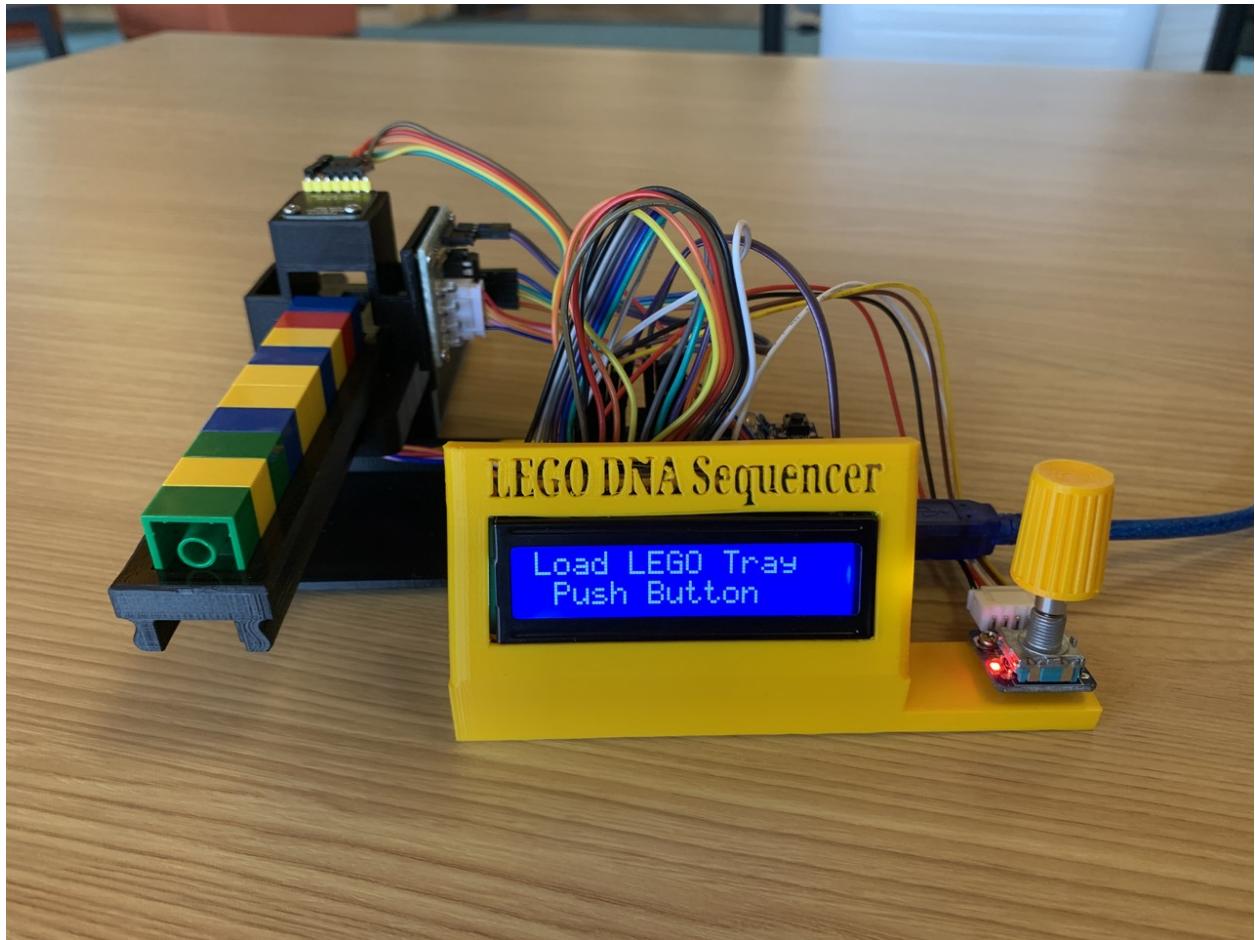
The LEGO DNA Sequencer is operated with a simple user interface. The UI includes an LCD display, a buzzer, and a rotary encoder / button which is much like a car radio knob.

## Starting the System

Power on the system by connecting the USB cable from the Arduino into a USB power adapter. There is no ON/OFF switch. When the system is plugged in it will beep three times and display the following screen.

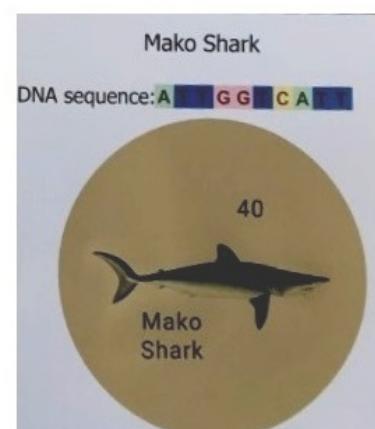
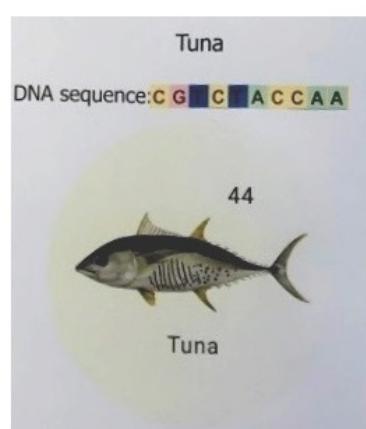
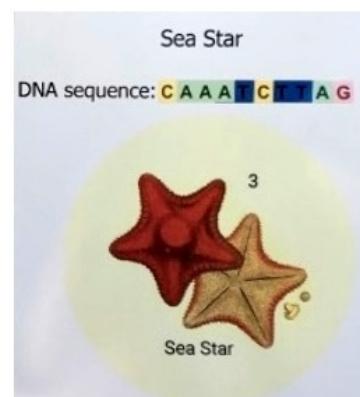
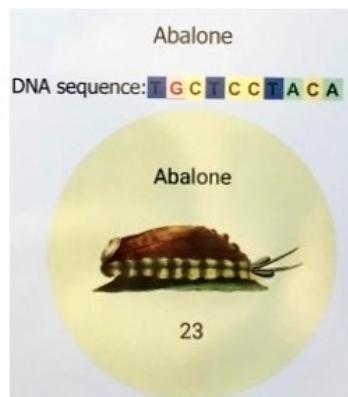
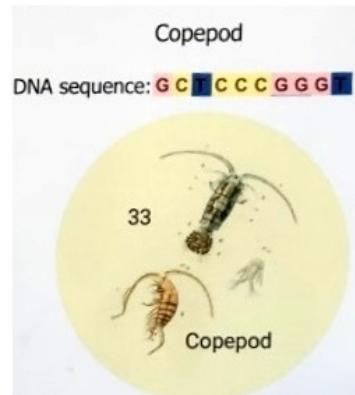
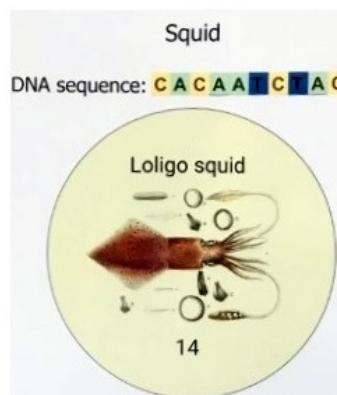


Push the button and you will be ready to perform DNA sequencing.



To operate the sequencer you will need to assemble 10 of the LEGO 2x2 bricks into a genome for sequencing. The system has 6 built in genomes that it will recognize as shown in the following illustration.

# LEGO DNA Sequencer



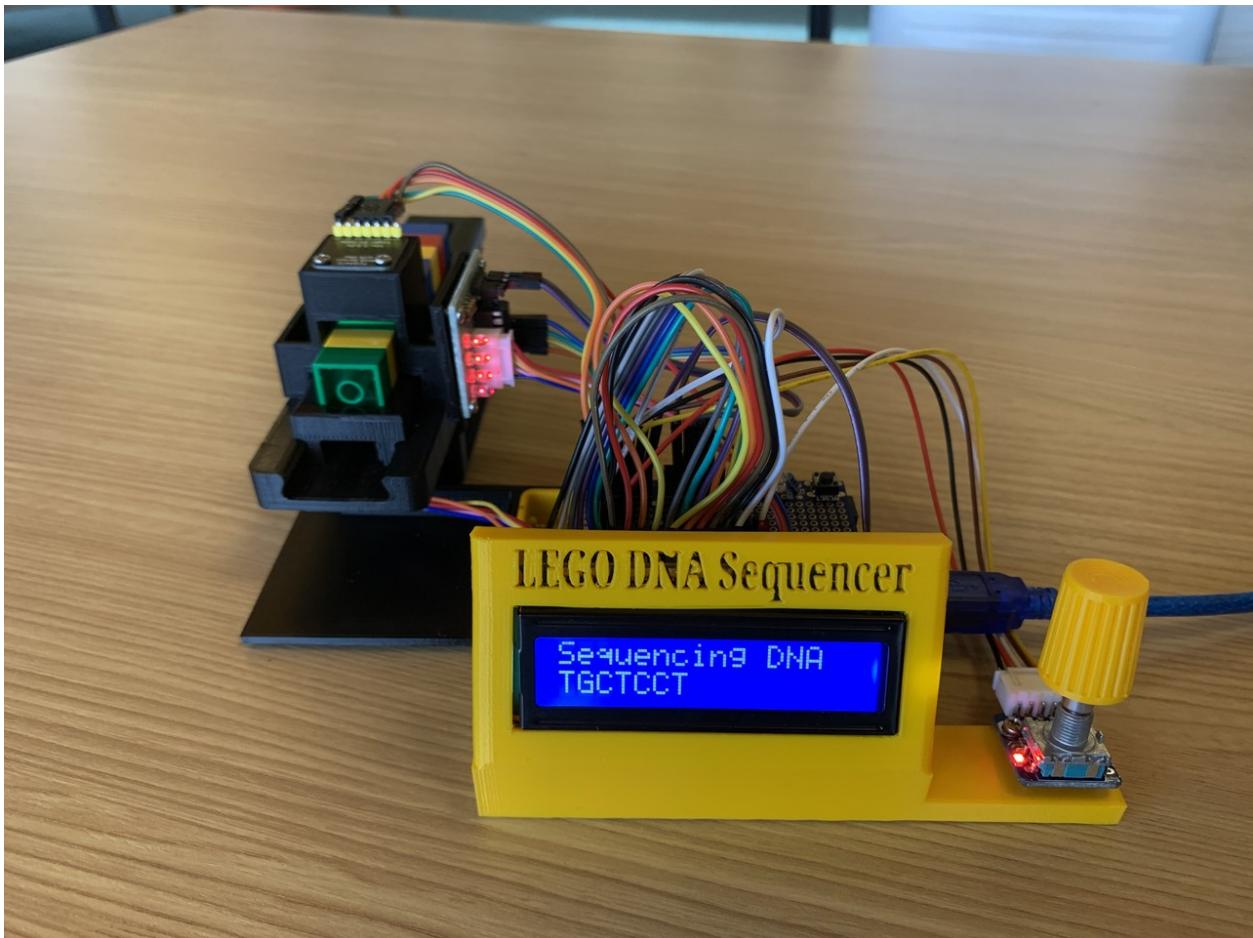
## Loading the LEGO Tray

When you have assembled a genome of 10 LEGO bricks, place them in the slot in the tray with the first brick in the sequence at the forward end of the tray. Note that the first brick will be inside the color sensor detection unit. The beginning of the second brick should align with the face of the color sensor.



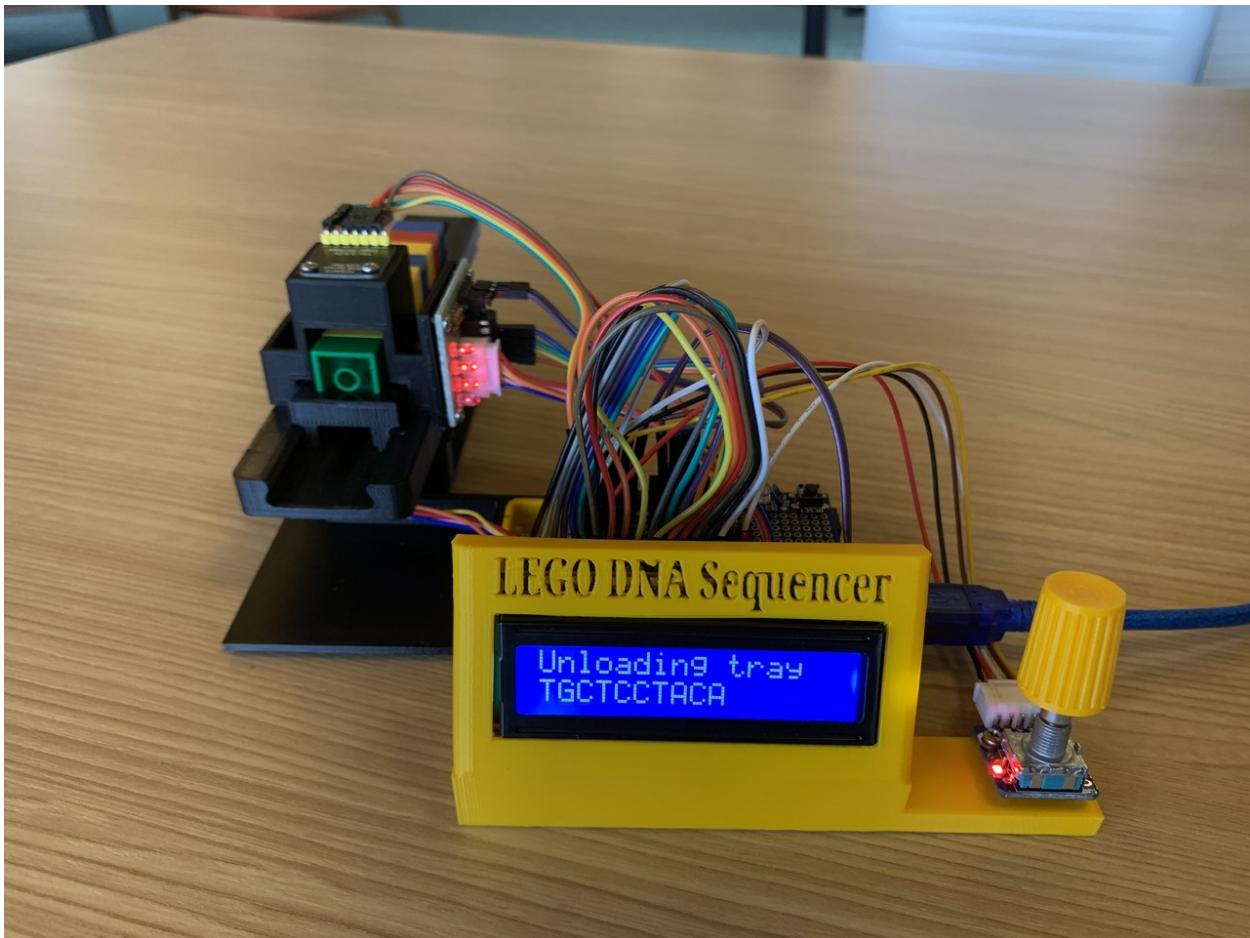
## Beginning the Sequencing

Push the button to begin sequencing. You will hear a buzzer click with each brick that is sequenced and the appropriate A, C, G, or T will be displayed.

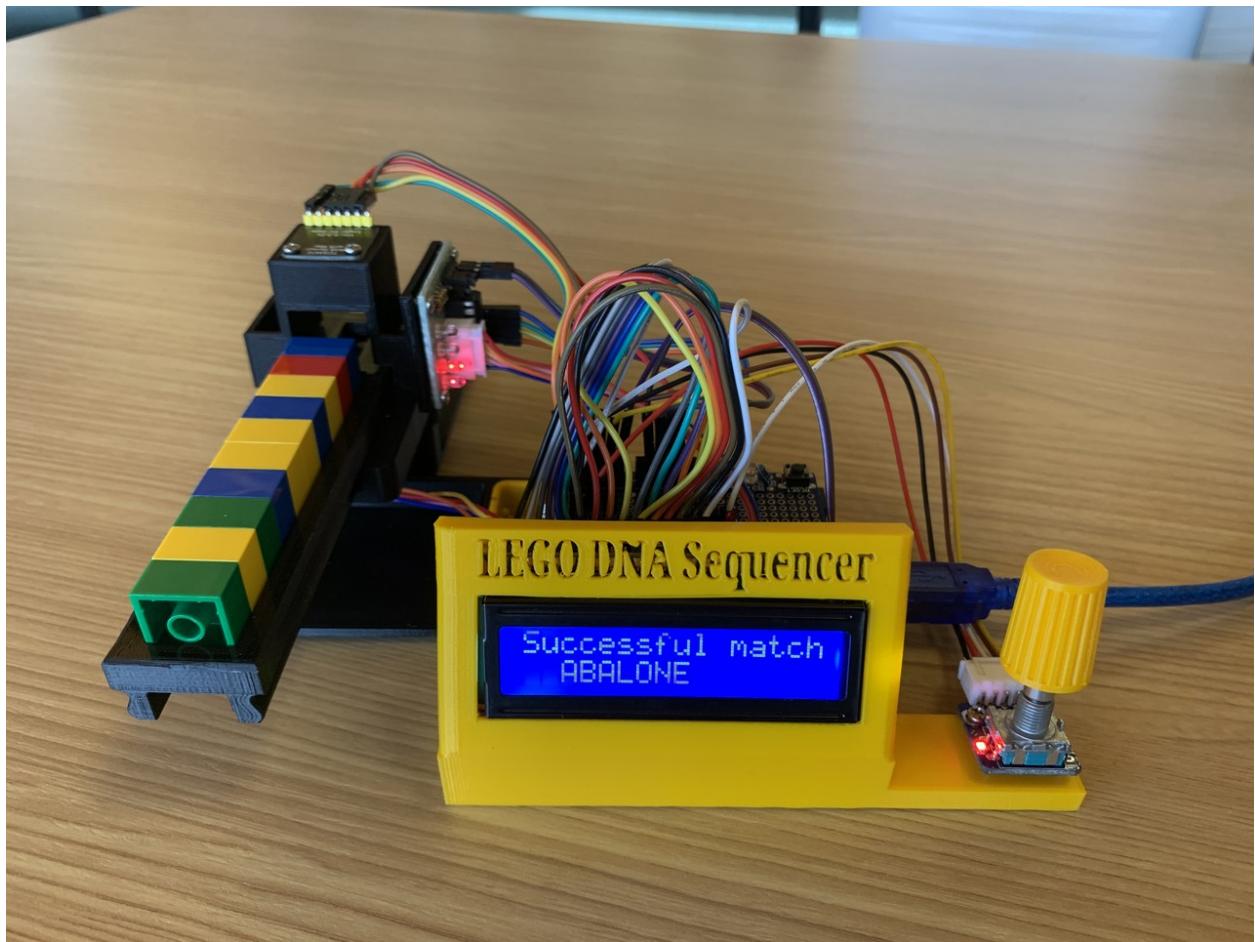


## Unloading the LEGO Tray

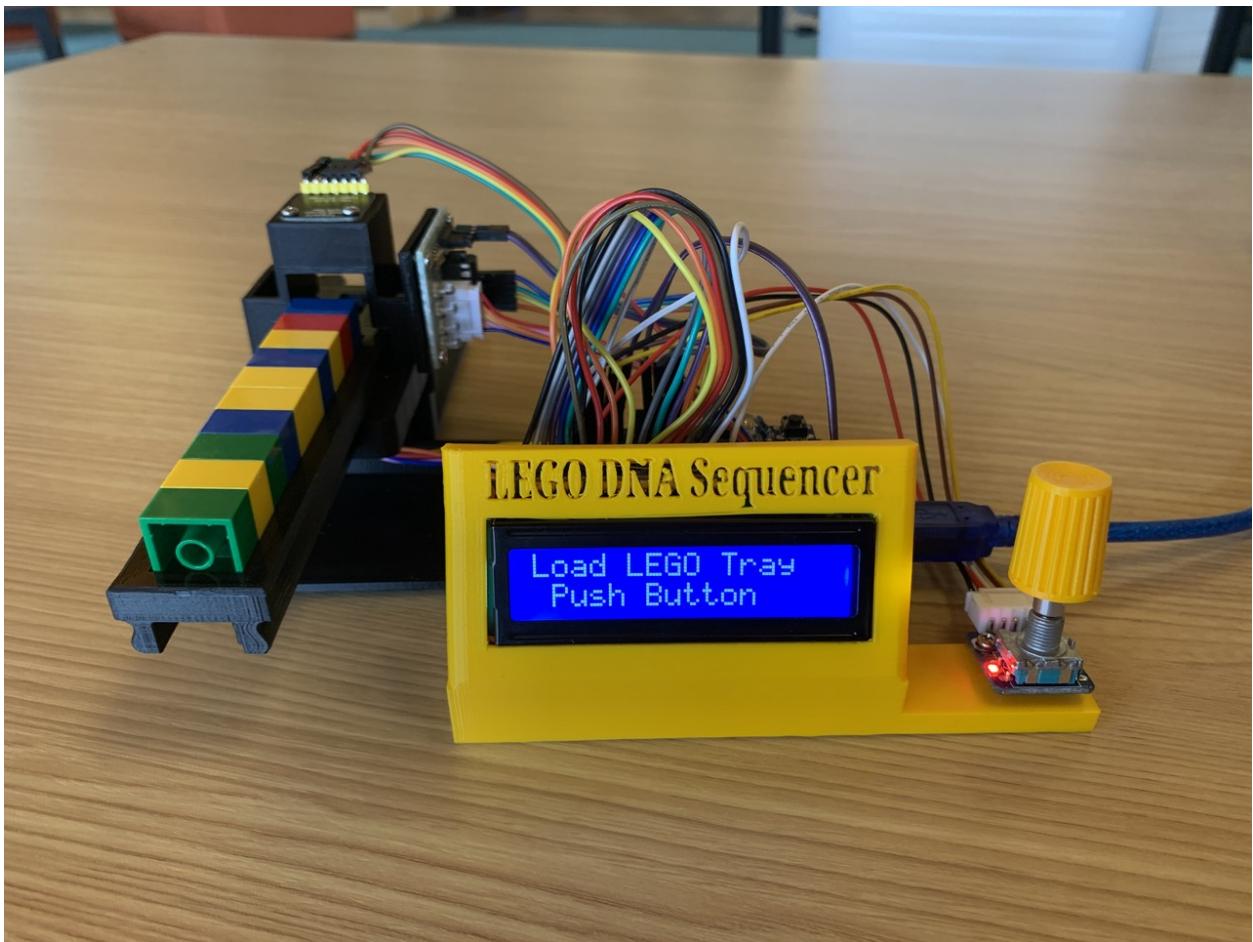
When all 10 of the bricks have been sequenced the LEGO tray will be unloaded, returning the tray to the initial position.



At that point you should see a “Successful match” and the name of the species that has been sequenced.

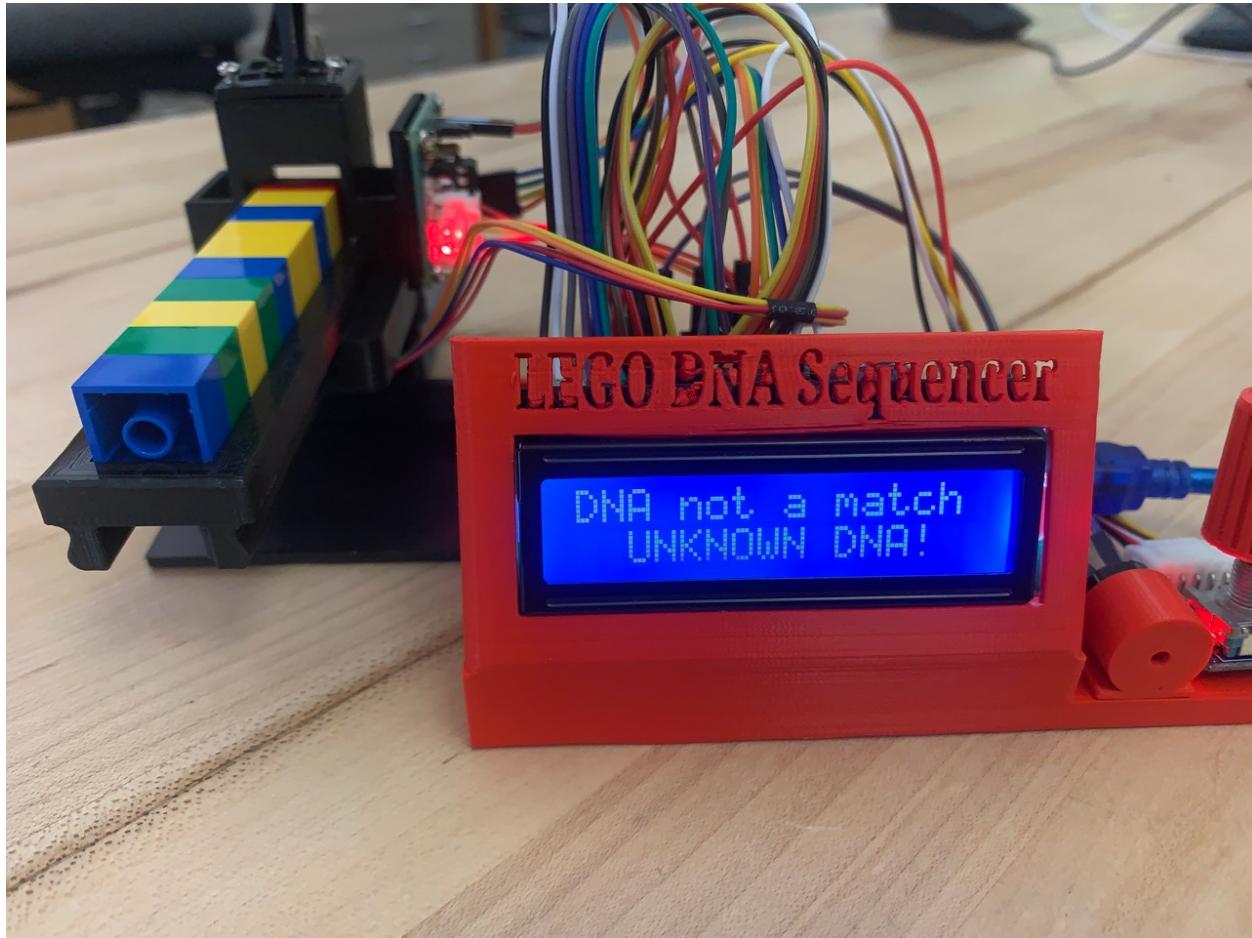


Pushing the button will ready the system to perform another sequencing operation.



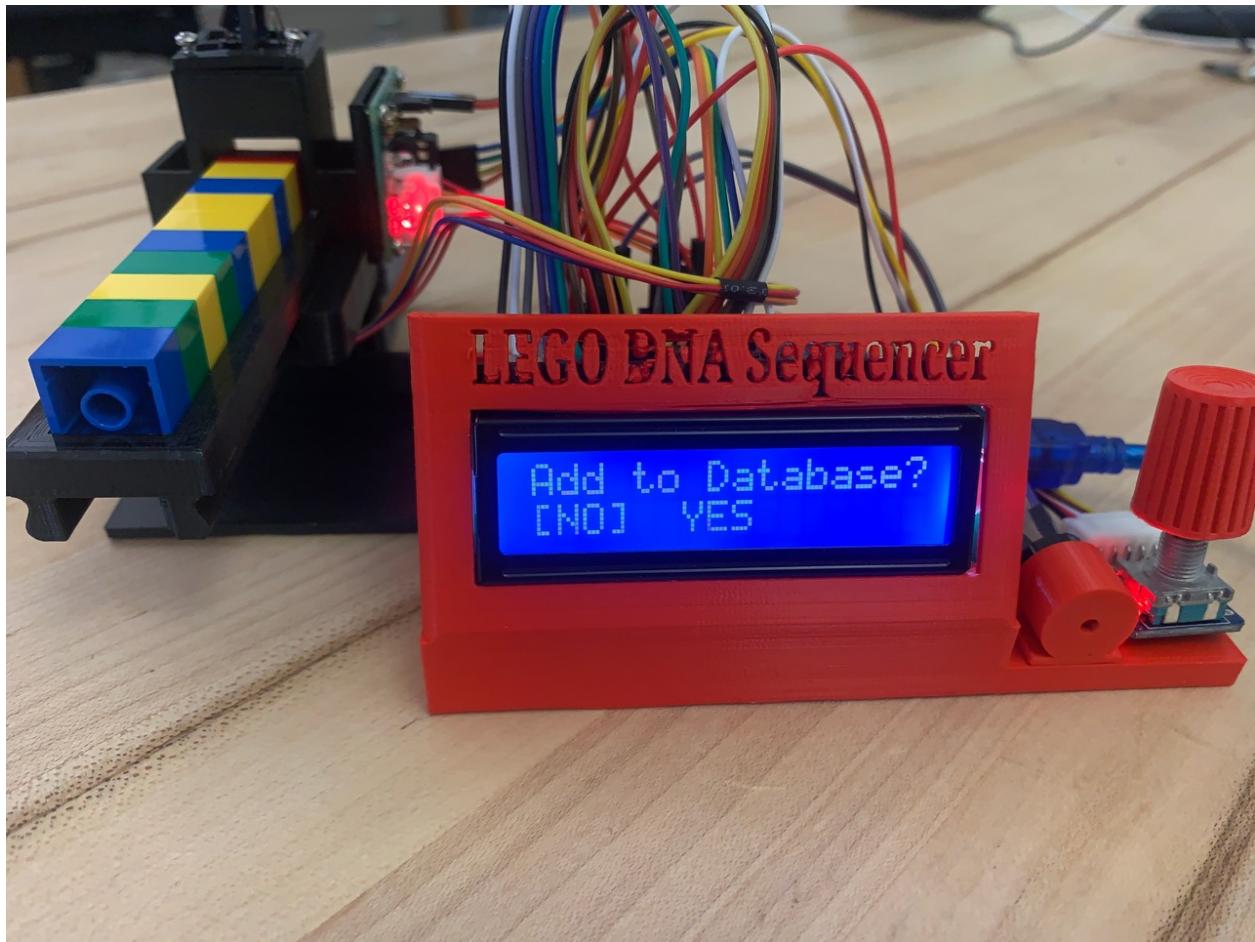
## UNKNOWN DNA

In the event that the bricks you have assembled do not match those of a known genome the system will display the following message.

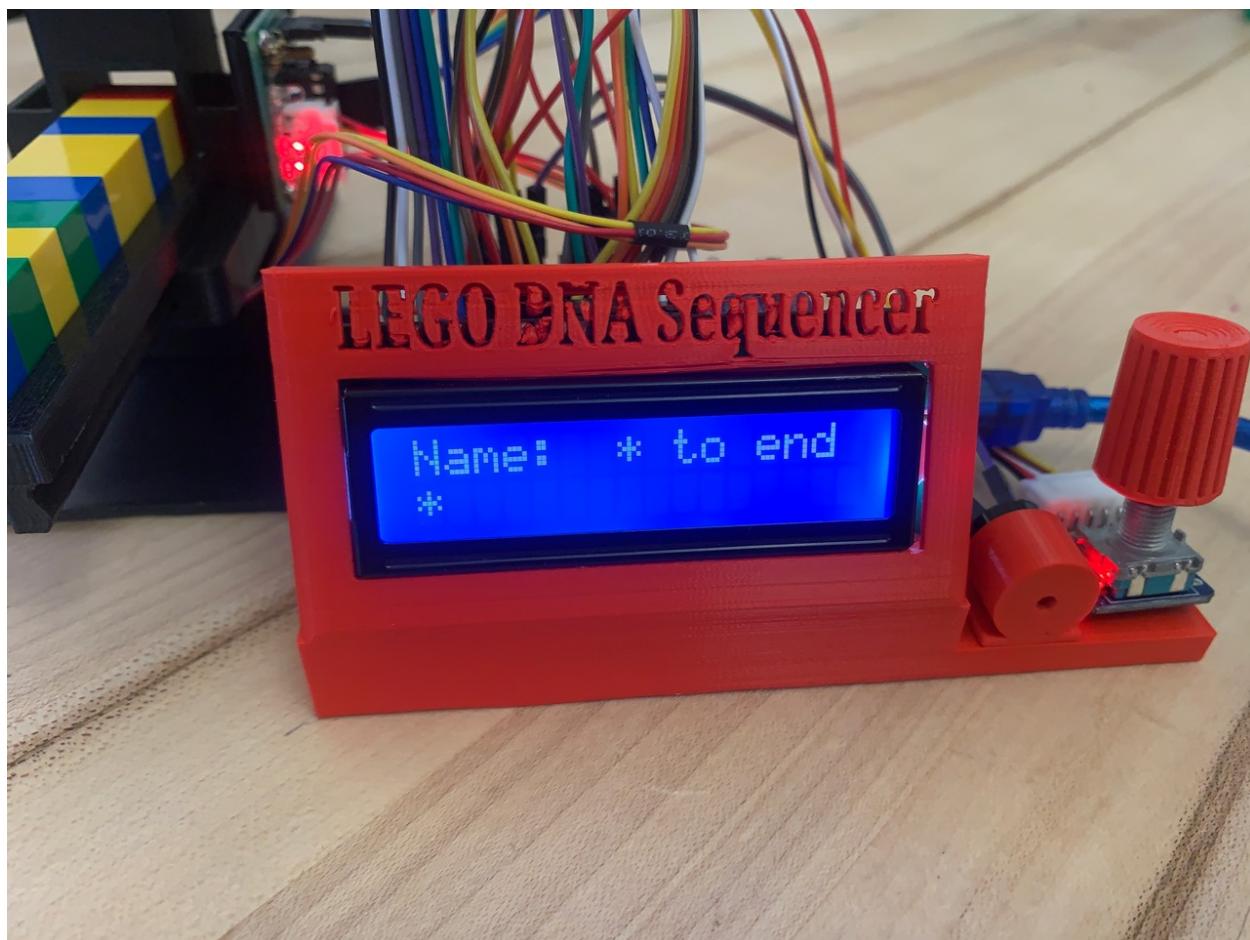


## Updating the Database with a new DNA

Push the button and you will be asked if you want to add the sequence to the database of known species genomes. Rotating the knob will move the selection back and forth between the choices of NO and YES. If you select NO, which is the default selection, the system will return to the state where it is ready to start another sequence operation.



If you selected YES to add the new sequence to the database, you will be prompted to enter a Name for the new genome. Rotating the knob will show you the characters that you can choose for the next letter of the name: A-Z, 0-9, and ‘ ‘.



To select a character for the name, press the button and the display will advance for you to enter the next character.



If you wish to delete a previous character, select the '<' character and push the button.



When you have completed entering the name, select the '\*' character.



You will then be prompted NO or YES to accept the database entry.



You should then be able sequence the same tray of LEGO bricks and see that your new genome is successfully matched.



## Credits

This project has been clearly inspired by the LEGO DNA Sequencer created by Sam Nicholls and Tom Blanchard at [Monster DNA Lab](#). It is a very well conceived open source project.

Peter Shum was a Post Doc at the Hopkins Marine Station of Stanford University and implemented the [MonsterLab Sequencer](#) for a Hopkins Open House Day in 2018.

Dr. Amanda Whitmire is the Head Librarian & Bibliographer of the Miller Library at the Hopkins Marine Station and has provided the facilities of her Fabrication Lab for this project.