Final Write-Up
Dice Straits: Syrena Prytko, Cassidy Williams, Donovan Sevilla

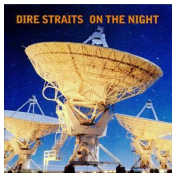
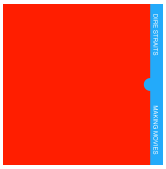
Album Name	Cube Visual	Album Name	Cube Visual
Dire Straits		Brothers in Arms	
Communiqué		On the Night	
Making Movies (diagonal)		Money for Nothing (diagonal)	

Table 1. Table shows the Dire Straits album covers used for the 6 faces of the music cube.

A very important aspect of the cube was its fairness. We wanted to create a die that would have a balanced center of gravity and would have an equal chance of rolling to any of the six faces. To ensure fairness and a balanced center of gravity, the circuit board had all the components soldered to the center of the board and the inside of the cube was 3D printed so that the circuit board could sit across the shell diagonal. We conducted two tests to measure the cube fairness: the random rolling test and the knife edge test. The random rolling test involved the cube being rolled a total of 50 times. The side it would land on was charted for all 50 sides and this test would measure if one face of the die was favored over the other. As observed in Table 2, the results show that the cube rolled randomly with a fairly even distribution. The knife edge test was used to measure the cube's balance on three orthogonal faces on a thin knife edge to see if it is balanced in every plane. This test came with issues as the cube itself was too large to balance properly on the knife edge. However, when trying to balance the cube it we observed that it would fall evenly to each side showing no imbalance of the cube's center of gravity. This test could be improved in the future by using a uniform edge of greater width that the cube can balance on.

Dice Face	Rolls
Dire Straits (self title)	9
Communiqué	6
Brothers in Arms	8
On the Night	9
Making Movies (diagonal)	10
Money for Nothing (diagonal)	8

Table 2. Table shows results from the Random Rolling Test performed to measure rolling fairness.

Most of the tools can be found in the box we left in the music lab to continue the work we completed this term. The battery we used was given to us from VJ, but future teams may need to purchase more batteries since they do lose their power over time. For the Ableton and Arduino IDE, it is critical that whoever continues this project in the future imports the following libraries:

1. ArduinoBLE by Arduino
2. Madgwick by Arduino
3. Adafruit BluefruitLE nRF51y Adafruit
4. BLE-MIDI by lathoub
5. MIDI Library by Francois Best, lathous
6. NimBLE-Arduino by h2zero
7. Seeed Arduino LSM6DS3 by Seeed-Studio
8. base64 by Densaugeo

The code used had specific functions that contributed to the overall function of the circuit board (e.g. function for Bluetooth connection). For these functions to work and be used, all the listed libraries need to be downloaded to the laptop in use. The shell can also be found in the box left in the music lab. The shell was made with Solidworks, had two different closures, and had one test print. The cube was printed in the music lab and all the necessary resources to print it can be found there.

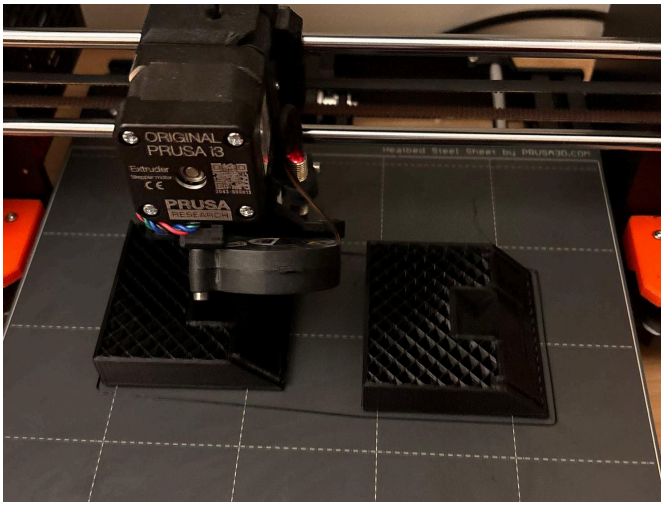


Figure 4. The image shows the first test print for the cube with two different closures. The printer used can be found in the Riley G11D music lab.

To understand what we did, it is very important that whoever takes on this project next understands Python code, understands circuit layouts, and knows how Li-ion batteries work. The Python code we used was long and compiling it took a long time. This is because specific libraries must be downloaded to the laptop in use to use the functions written into the code. Also, the computer being used needs to properly work with the libraries for the code to compile. To understand circuit layouts, you must know how microcontrollers function and understand how to read the data sheets of different circuit components. Knowing the data sheets is also important for understanding Li-ion batteries. Although the battery we used was 3.7 V, the data sheets for the microcontroller say 3.3 V and 5 V. This means that even though we used the 3.7 V battery, the microcontroller was built in with the ability to manage the input voltage making the 3.7 V battery functional in this situation.

The work that needs to be done next is to explore options on the rechargeability of the battery. By looking into how the USB-C import on the Xiao microcontroller could be used to recharge the Li-ion battery, the efficiency of the cube could be improved as the battery would not need to be replaced when it dies. Coding two cubes can also be created to use a combination of microcontrollers to vary the notes being played. Another way to vary the audio would be to create an 8-sided die. Instead of playing chords, this die can be used to play scales. The last future improvement that can be made is to improve upon the compacting the size and the fairness of the die. Increasing the compactness of the cube can help with organization of the circuitry and improve the fairness of the cube as weight will be more evenly distributed over a smaller cube volume. In addition to this, conducting more accurate, precise tests to test the fairness of the die would be very beneficial.