### Time Line

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Days 1&2 – Temperature Sensing Lunchbox

Description: This temperature sensing lunchbox project will introduce you to complex circuits, sensors, beginning programming, and needlework. You will be able to use your existing knowledge of circuits, conductivity, and crafting to create this unique project. When completed, your lunchbox will use LED lights to tell you when the temperature inside has dropped. The steps listed are to act as a guide; timing may vary for your students.

Objectives

Students will:

- Learn how to use an electronic sensor
- Learn how to use a micro-processor
- Learn beginning programming
- Learn how to sew circuits with conductive thread

Preparation

- Assemble materials into kits for each pair of students, so they can be easily passed out when ready to do the activity.
- Set up Codebender on class computers.
- If needed reserve computer lab.

Supplies for Student Groups

- Arduino LilyPad
- Temperature Sensor
- Three LED lights (Red, Yellow, Green)
- Mini USB
- Battery
- Conductive thread
- A computer with a USB connection and Arduino programming software (Codebender) installed.

Bell Ringer Questions

5 Minutes

- What can happen if food gets warm? Foods like sushi? or macaroni salad?

Today we will start building a lunch box with a built in temperature sensor.
**Step 1: Label and Color Code Worksheet**

**10 Minutes**

The first step of this project is to label and color code all parts of the schematic worksheet in the project design. Normally if you were designing your own project, the first step would be to draw out your project on paper. It allows you to visualize your project and begin to plan how you would go about positioning the components and sewing them together in a way that creates a functional circuit. However, because class time and supplies are both finite, we have designed a working schematic for you. It is critical that you draw out all components (this can be tricky as this is a three dimensional project) and properly label positive, negative, and other connections to ensure that your circuit and programmed components will all work once you have completed sewing them together.

**Directions:** Label all parts of the worksheet. Make the positive and negative wires different colors. **Please note: The temperature sensor goes on the inside, so it appears upside down in this diagram.**

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**Step 2: Draw Your Schematic on Your Lunch Box**

**10 Minutes**

After you have labeled everything on your worksheet, it is time to draw your design schematic onto your lunch box. This will help you plan where each component will go and help you avoid crossing wires. Because the temperature sensor goes inside the lunch box, you will need...
to figure out how to place things on two sides of your lunch box. It helps to first draw everything on the outside of the lunch box. It does not need to be a perfect picture, but it does need to clearly tell you where to sew the pieces.

Directions: Draw your schematic on the outside of your lunchbox and have your teacher approve your schematic.

Please note: Designs may change throughout the project.

Students should peer check their drawings to ensure they are correct.

**Step 3: Sewing on the Components**

**40 - 60 Minutes**

After you approve their drawings on the lunchbox, it is time to start sewing the lunchbox components in place. The first piece we sew into place is the Microprocessor. We will sew the negative lead into place first. Sew through the negative lead three times, making sure your stitches are tight.
Step 4: Sew in the Button

We are going to connect all the negative lines. The negative lead from every single component connects on one line so we will sew them into place now. Sew from the negative lead of your Microprocessor to the negative lead of your Button. Sew through three times. Tie off string and cut. Notice that the schematic drawing and my sewing do not line up perfectly. That is ok. You may also notice an error in your drawing (like where you drew a lead connecting is not where it will connect now that you placed the microprocessor). That is ok. You can adjust your drawing at any point.

![Image of a button being sewn in]

Step 5: Sew in the Lights

Rethread the needle, tie a knot at the end, and sew from the negative lead of the Button to the negative lead of each of the lights in order from green (at the bottom) then to yellow (in the middle) and finally red (at the top).

![Image of lights being sewn in]
Step 6: Sew in the Sensor

Next we sew into place the temperature sensor. The temperature sensor is sewn onto the inside of the lunch box. This makes sense because it needs to read the temperature inside the lunchbox, not outside. To sew on the temperature sensor, you will first sew from the negative lead of the red light bulb to the negative lead of the temperature sensor. For everything you sew you should stitch through it three times. This will ensure that you have a good connection. Once you have sewn the negative lead of the temperature sensor down, you should tie a knot and cut your thread.
Step 7: Connect the Sensor to the Microprocessor

Now we sew in the rest of the temperature sensor. You will sew from the positive pin of the sensor to pin number A4 on the Lilypad. Sew and tie off with a knot. Then sew from the S pin on the temperature sensor to pin number A5 on the Lilypad. Tie a knot and cut.

Step 8: Sew in the Positive Leads

At this point we will be following the same steps to sew down all the positive lines of all our components. Each component needs to be sewn through three times and tied off with a knot before cutting the line. Below is the list of pins that should be sewn to from each component.

- Button S to Lilypad 2
- Green light bulb (bottom bulb) to Lilypad 9
- Yellow light bulb (middle bulb) to Lilypad 10
- Red light bulb (top bulb) to Lilypad 11

When all of those are sewn down, your lunchbox should look like this:
Day 3 – How to Code Your Lunch Box

Content – Codebender Video

10 Minutes

Show the following video to introduce Codebender

https://www.youtube.com/watch?v=wsXDtCsIXro

Codebender is an IDE – an Integrated Development Environment. It is where you will write your programs (called Sketches in Arduino) and where you will load them onto the Arduino board.

Because the codebender software runs from a browser, your code will be available to you wherever you are. We say the code is in “the cloud”. This is convenient for those of you who work various places. Plus the code is easy to share with others.
Activity – Getting to Know Codebender

30 Minutes

Preparation

- Watch Log In Video and make sure all computers are set up to use Codebender
- Watch Codebender Navigation video and make sure you know how to use the tool
- Watch Setting Up the LilyPad video and make sure you know how to do this

Highlighted portions are notes for video.

NOTES:

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/* Temperature Sensing Lunch Box
 * by Ben Leduc-Mills
 * LilyPad Simple, hooked to a temp sensor, soundPin, button, and 3
 * LED's - green, yellow, and red. Press button to set initial 'good'
 * temp (green), temp + 5 = yellow, temp + 25 = red
 * Modified by Vicki Allan 6/29/16
 */

// LED ASSIGNMENTS
int redLED = 11; //pin number for red led
int yellowLED = 10; //pin number for yellow led
int greenLED = 9; //pin number for green led
int myLED = 13;
int tempPin = A5; //pin for temp sensor
int soundPin = 3; //pin number for buzzer
int buttonPin = 2; //pin number for button
int powerPin = A4; // hardcoded as HIGH

int initTemp = 0; //variable to hold initial temp

// NOTES These definitions are included in the pitches.h file
// since we only need four values, it is easier just to type them
int NOTE_C4 = 262;
int NOTE_G3 = 196;
int NOTE_A3 = 220;
int NOTE_B3 = 247;
int REST = 0;

// medoy and noteDurations are used together.
int melody[] = {NOTE_C4, NOTE_G3, NOTE_G3, NOTE_A3, NOTE_G3, REST, NOTE_B3, NOTE_C4};
// note durations: 4 = quarter note, 8 = eighth note, etc.:
int noteDurations[] = {4, 8, 8, 4, 4, 4, 4, 4};
nint tuneLength = 8;

float giveMeFarhenheit(int value)
{
    // From data collected in 6/30/16
    float temperaturef = .7724 * value - 109.459;
    return temperaturef;
}
void setup()
{
    Serial.begin(9600); //begin Serial communication
    pinMode(redLED, OUTPUT); //set LED's to output
    pinMode(greenLED, OUTPUT);
    pinMode(yellowLED, OUTPUT);
    pinMode(buttonPin, INPUT_PULLUP); //buttons are inputs
    pinMode(tempPin, INPUT_PULLUP);
    pinMode(soundPin, OUTPUT);
    pinMode(powerPin, OUTPUT); //supply power for temp sensor
    digitalWrite(powerPin, HIGH);
}

void loop()
{
    int buttonState = digitalRead(buttonPin); //test for button push
    if (buttonState == HIGH)
    {
        digitalWrite(myLED, LOW);
    }
    else
    {
        //if button is pressed, set initial reading as base temp
        digitalWrite(myLED, HIGH);
        initTemp = analogRead(tempPin);
        Serial.print("My Init Temp: ");
        Serial.println(initTemp);
    }

    //keep testing current temperature
    delay(2000);

    int temp = analogRead(tempPin);
    Serial.print("Current Temp: ");
    Serial.println(temp);
    //float fTemp = (giveMeFarhenheit(temp));
    //Serial.println(fTemp);

    //green everything ok
    if(temp <= initTemp + 5)
    {
digitalWrite(redLED, LOW);
digitalWrite(yellowLED, LOW);
digitalWrite(greenLED, HIGH);
}
else if (temp <= initTemp + 25)
{
    digitalWrite(redLED, LOW);
digitalWrite(yellowLED, HIGH);
digitalWrite(greenLED, LOW);
}
else
{
    digitalWrite(redLED, HIGH);
digitalWrite(yellowLED, LOW);
digitalWrite(greenLED, LOW);
    playAlert();
}

// play a sound if your lunch has warmed up too much
void playAlert()
{
    for (int thisNote = 0; thisNote < tuneLength; thisNote++)
    {
        // to calculate the note duration, take one second
        // divided by the note type.
        // e.g. quarter note = 1000 / 4, eighth note = 1000/8, etc.
        int noteDuration = 1000 / noteDurations[thisNote];
tone(soundPin, melody[thisNote], noteDuration);

        // to distinguish the notes, set a minimum time between them.
        // the note's duration + 30% seems to work well:
        int pauseBetweenNotes = noteDuration * 1.30;
delay(pauseBetweenNotes);
        // stop the tone playing:
        noTone(soundPin);
    }
    delay(5000); // wait five seconds before playing the tune again.

}
90 Minutes

The last two class sessions should be used for students to finish their sewing, coding, and any troubleshooting to make a functioning temperature sensing lunch box.

Notes:
Draft Reference Worksheet for Code Bender

List of terms and what they mean

List of error messages and what they mean

General Navigation

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<td>This is a great place to get starter code or learn things you can do with Arduinos. For example, under “Basic” you can see our blink code. The fade code is also interesting as it allows the brightness of the LED to get dimmer and dimmer, and then reverse to get brighter and brighter.</td>
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<tr>
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Label and Color Code Worksheet

Directions: Color the negative wires red and the positive wires blue.

Label the following parts of the diagram:

- Sensor
- Button
- Lights
- Lilypad On Switch
- Lilypad USB Port