What it means to be a hacker

- Create & Share
- Freedom of inquiry
- Hostility of secrecy
- Sharing as ideology and strategy
- The right to fork
- Emphasis on rationality
- Distaste of authority
- Playful cleverness
Why we need an incubator

- Microbes like a certain temperature
- Temperature dependent:
  - Enzyme reactions
  - DNA interactions
  - Cell state
Function

- Heat isolated enclosed cabinet, with see-through window
- Heat source
- Temperature controller
- Temperature indicator
- User interface to set temperature

http://biohackacademy.github.io/biofactory/class/1-incubator/requirements/
Design constrains:

- 9 cm petri dishes
The Biohack Academy design

http://biohackacademy.github.io/biofactory/class/1/Incubator-Sketchup.skp
# Bill of Materials

<table>
<thead>
<tr>
<th>#</th>
<th>Amount</th>
<th>Description</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>3mm MDF</td>
<td>Outer structure</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>Expanded polystyrene (EPS) 5 plates of 100 x 50 x 5cm</td>
<td>Insulation</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>3mm Acrylic sheet 25 x 35 cm</td>
<td>Window</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>100W infrared light bulb, fitting and power cord</td>
<td>Heating</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>12V 80 mm Axial Fan</td>
<td>Air distribution inside incubator</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>Light switch</td>
<td>Switch incubator on/off</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>Water proof temperature sensor</td>
<td>Measure inside temperature</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>4 section 7 segment display</td>
<td>Display temperature</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>MOSFET</td>
<td>Control fan speed</td>
</tr>
<tr>
<td>11</td>
<td>4</td>
<td>10K resistor</td>
<td>Pull up for buttons, thermistor and mosfet</td>
</tr>
<tr>
<td>12</td>
<td>1</td>
<td>Diode</td>
<td>Part of MOSFET circuit</td>
</tr>
<tr>
<td>13</td>
<td>2</td>
<td>Buttons</td>
<td>User interaction panel</td>
</tr>
<tr>
<td>14</td>
<td>1</td>
<td>White LED</td>
<td>Light inside incubator</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>220 Ohm resistor</td>
<td>LED resistor</td>
</tr>
<tr>
<td>16</td>
<td>1</td>
<td>7.5 W power supply</td>
<td>Powering the Arduino and Fan</td>
</tr>
<tr>
<td>17</td>
<td>1</td>
<td>Jack Adapter</td>
<td>Power connector</td>
</tr>
<tr>
<td>18</td>
<td>1</td>
<td>Relay</td>
<td>Controlling the 100W light bulb</td>
</tr>
</tbody>
</table>
Powering an LED
LED circuit
Sensing the temperature

- 10K thermistor
Sensing the temperature
$V_{out} = V_{in} \left( \frac{R_2}{R_1 + R_2} \right)$
Selecting a heat source

- Lamp
  - Heat as a by product
- Microwave
  - Needs liquid to heat
- Infrared
  - 100W infrared
- Power resistor

\[ P = \frac{I^2}{R} \]

\[ 7W = \frac{(12V)^2}{R} \]

\[ R = \frac{144}{7} \approx 20 \Omega \]
Controlling the lamp
Relay schematic
Push buttons

Pull down resistors
- 10 K Ohm
Fan speed controller

- MOSFET
- Semiconductor
- N-channel
- 60V
- 30A
Controlling the fan
All of the electronics together
Schematic
Power Supply

\[ P = A \times I \]

*Power = Current \times Potential*

*Watt = Ampere \times Volt*

- 5 x 30 mA LEDs
- 1 x 250 mA Arduino
- 1 x 400 mA Fan
- 1 x 30 mA 7 segment display

- Total: 830 mA
- So a 1 Amp power supply should be enough
Arduino tutorial codes

- MOSFET code:
  - http://bildr.org/2012/03/rfp30n06le-arduino/
- 4 digit 7 segment:
  - http://dlnmh9ip6v2uc.cloudfront.net/datasheets/Components/LED/_7Seg_Example.pde
- Button code:
- Thermistor code:
Code logic

- Measure temperature
  - Turn lamp on when temperature is lower than target
  - Turn lamp off when temperature is higher than target
- Check whether a button is pushed
  - If left button is pushed increase target temperature
  - If right button is pushed decrease target temperature
- Display current temperature
  - In case left or right button is pushed, display target temperature for 5 seconds
Nice to haves

- PID control
- Magnetic door lock
- Lever switch that checks whether door is locked
- Sound alarm in case door is open for too long
- Webcam inside
PID control

Temperature

Time

- Ideal warm-up
- Typical warm-up
- Target temperature