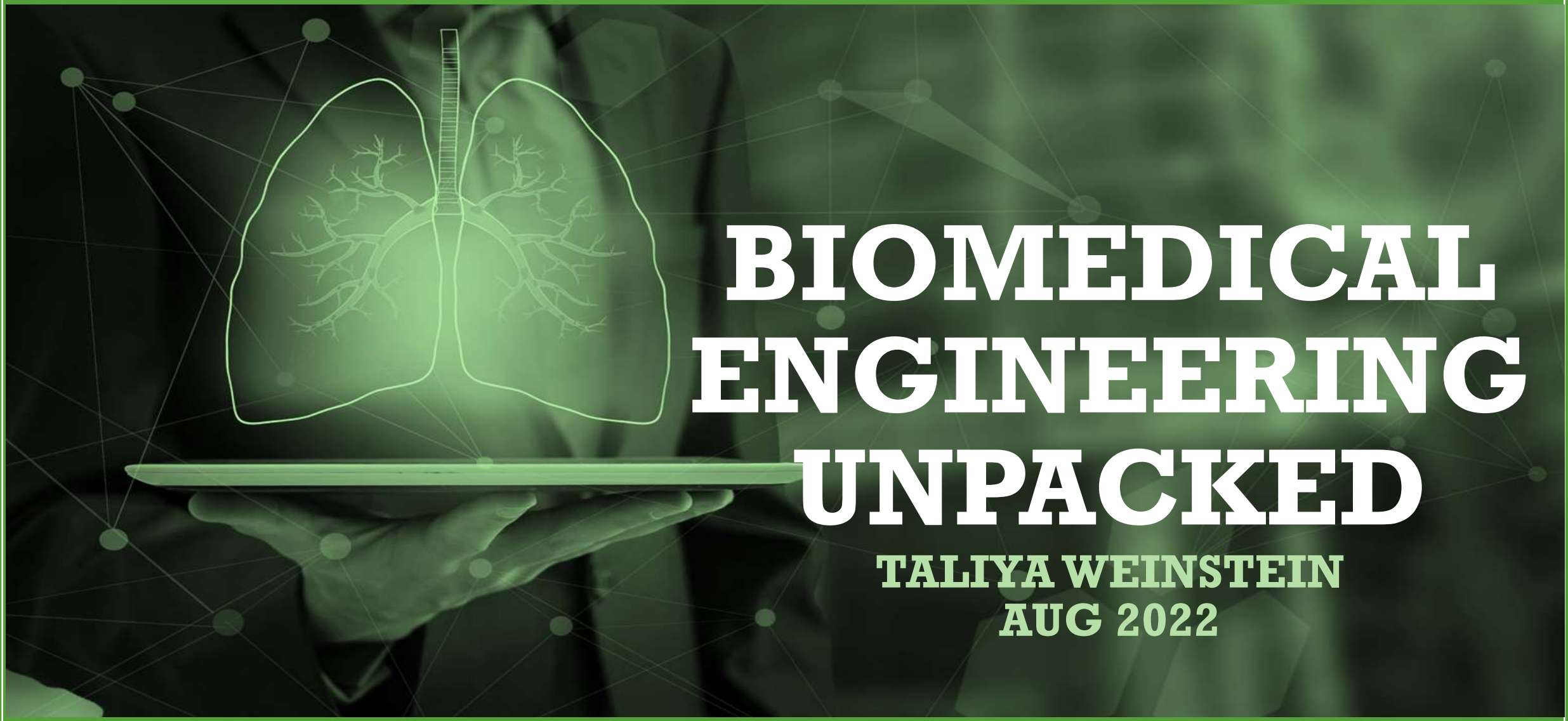


BIOMEDICAL ENGINEERING UNPACKED

TALIYA WEINSTEIN

AUG 2022

The Line Up

- Why should I consider engineering as a career?
- What does a career in engineering look like?
- What is biomedical engineering?
- What steps do I need to take to be a biomedical engineer?
- What is the engineering design process?
- How can I solve a biomedical engineering problem?

“Your Attitude Defines Your Experience”

- Engagement
- Curiosity
- Communication
- Willingness to try
- Excitement

The Kick Off

What is Engineering?

TeachEngineering (2018) What is Engineering? Available at: https://www.youtube.com/watch?v=H9VDkvgGmV0&t=2s&ab_channel=TeachEngineering (Accessed 17 July 2022).

Sure, but What is Engineering?

- "Engineering provides a platform to contribute to society by doing meaningful work. It allows for a more efficient future through the use of say, renewable energy or designing prosthetic limbs — the possibilities are endless!" – Hiba Abadir

Engineering Skills

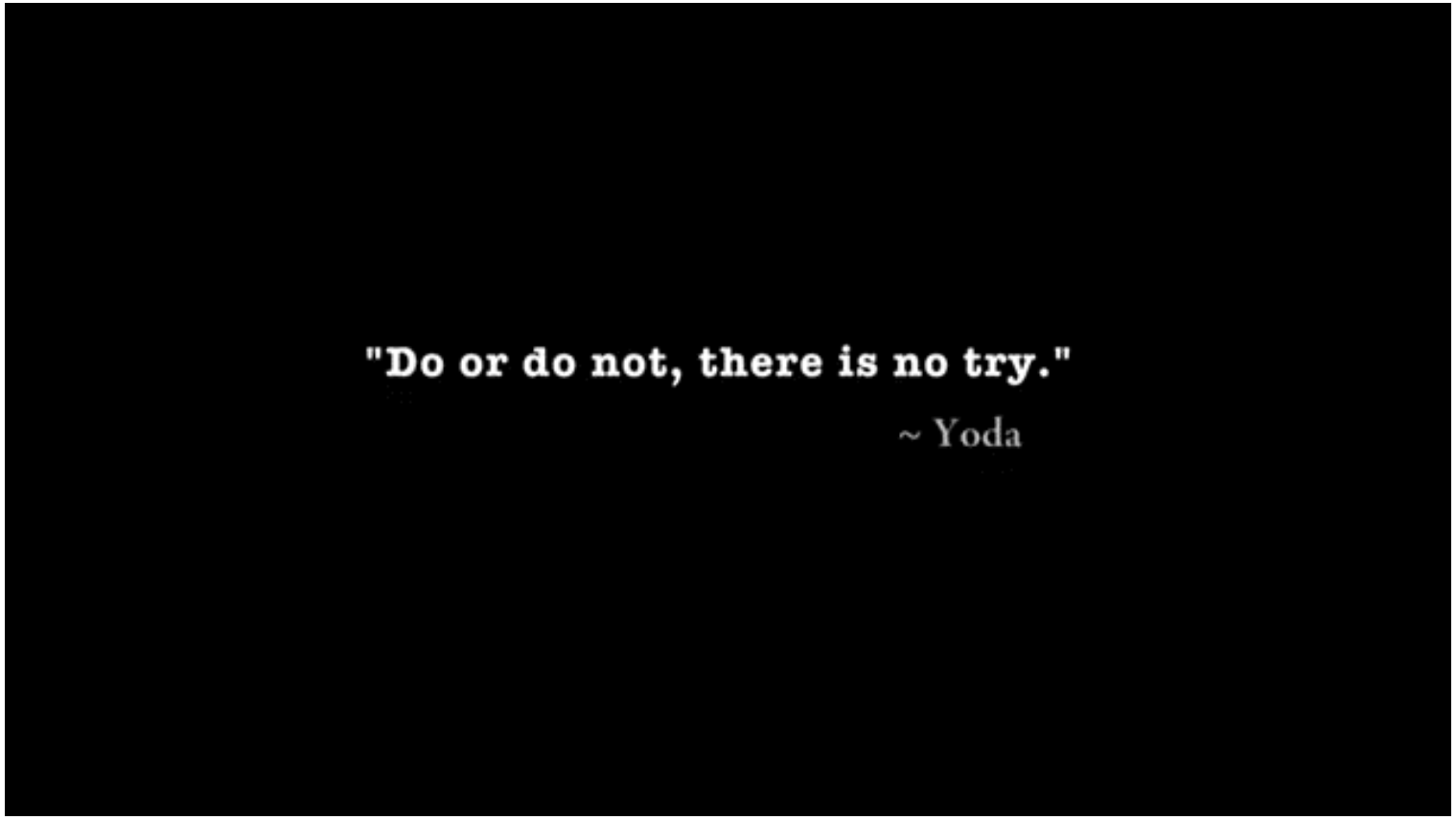
- Creativity
- Curiosity
- Pressure Management
- Communication
- Teamwork
- Analysis
- Problem Solving
- Technical Skills

Is Engineering Right for You?

1) Do you want to make the world a better place?
2) Do you have creativity and imagination?
3) Are you able to process detail?
4) Do you enjoy problem solving?
5) Can you work in a group?
6) Are you able to communicate your ideas?
7) Do you want to use math/ science as a tool for solving real world problems?

Any Questions?

What is Biomedical Engineering?



National Science Foundation (2011) What does a biomedical engineer do? Careers in Science and Engineering. Available at: https://www.youtube.com/watch?v=XNXY6TfaUO4&t=93s&ab_channel=NationalScienceFoundation (Accessed 17 July 2022).

Breaking Down Biomedical Engineering

Biomedical Subdisciplines

Biomechanics

Biomedical Subdisciplines

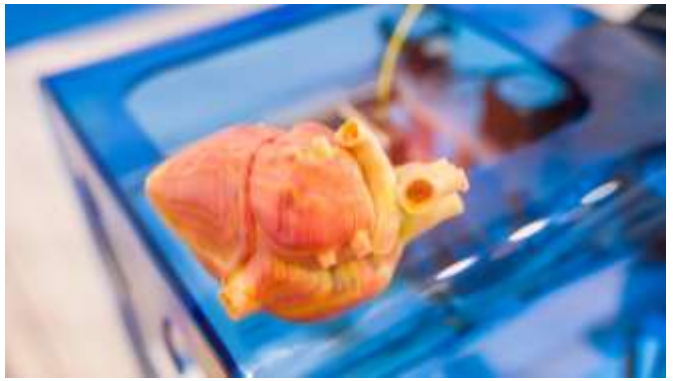
Biomechanics

Neural Engineering

Biomedical Subdisciplines

Biomechanics

Neural Engineering



Biomaterials and Regenerative Engineering

Biomedical Subdisciplines

Biomechanics

Neural Engineering

Biomaterials and Regenerative Engineering

Medical Physics

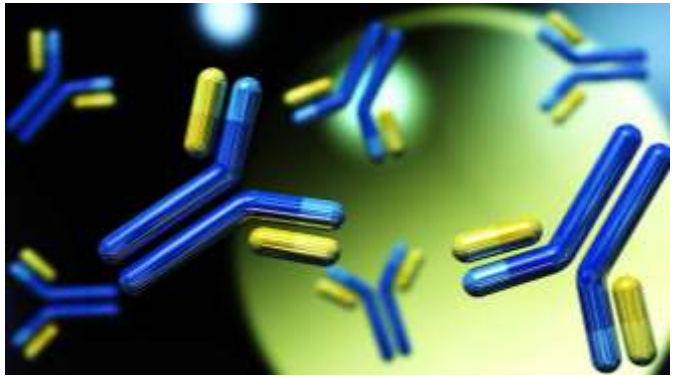
Biomedical Subdisciplines

Biomechanics

Neural Engineering

Biomaterials and Regenerative Engineering

Medical Physics



Computational Biomedical Engineering

Biomedical Subdisciplines

Biomechanics

Neural Engineering

Biomaterials and Regenerative Engineering

Medical Physics

Computational Biomedical Engineering

Medical Devices and Instrumentation

Biomedical Engineering Considerations

- Financial Cost
- Time to develop
- Human Safety
- International Medical Standards
- Whether People Will Adopt the Solution

Biomedical Career Options

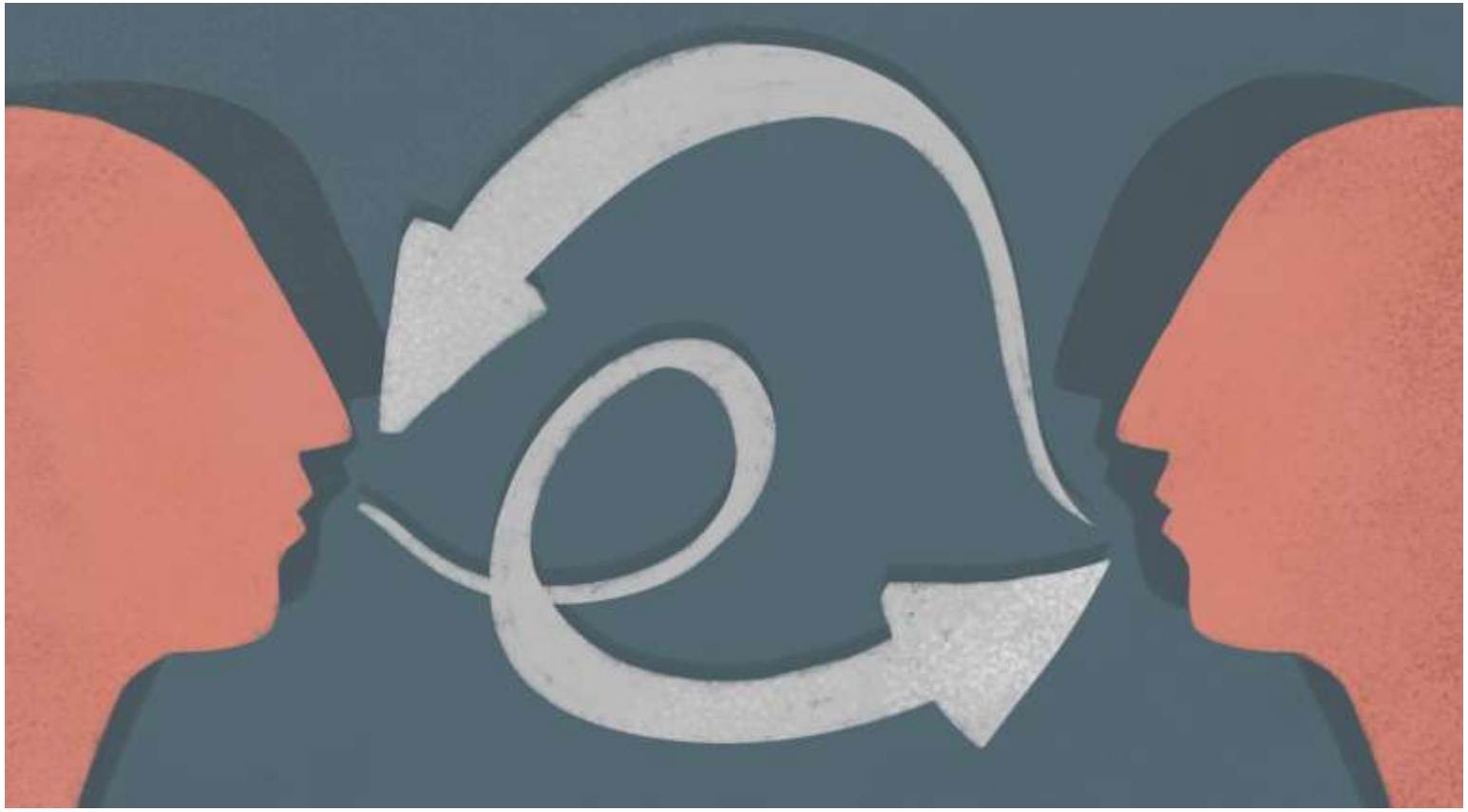
- Industry
- Academia / Researcher
- Government
- Start-ups
- Venture funding
- Medical equipment sales

Any Questions?

Let's Discuss!

- What biomedical problems would you want to solve ?
- How would you approach solving them?
- What possible limitations are there currently to solving this issue?
- Can you brainstorm some ways of tackling these limitations?

Knowledge Exchange



How Can We Approach Problem Solving?

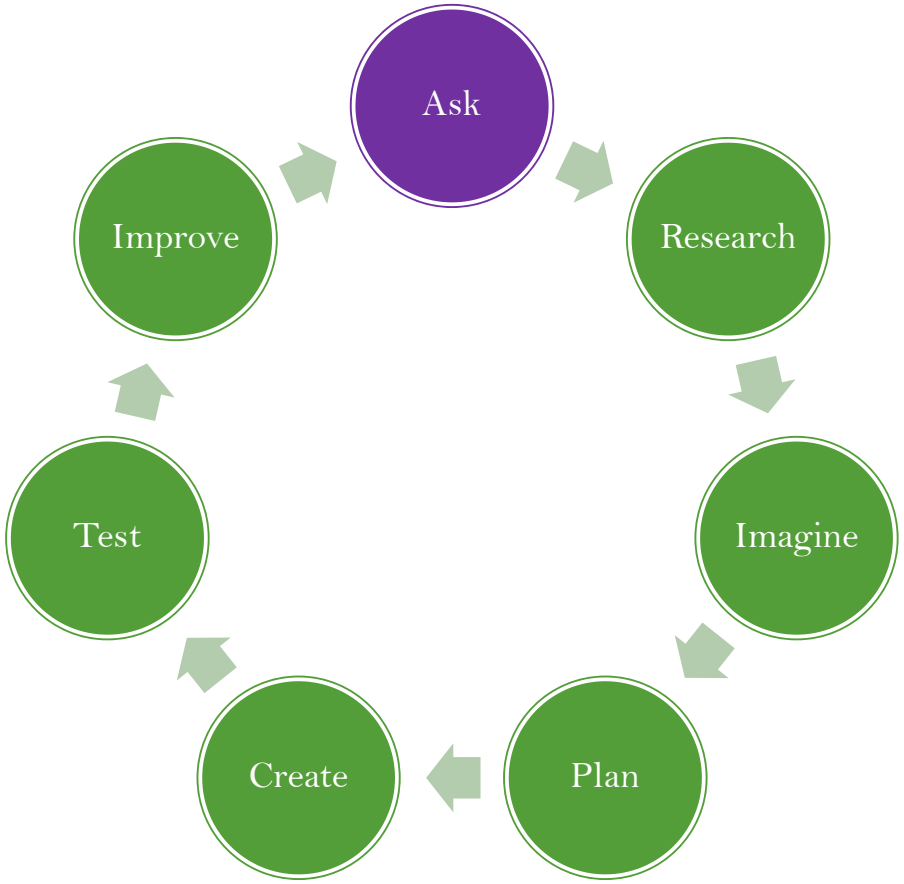
Engineering Design Process!

Iterative Problem Solving

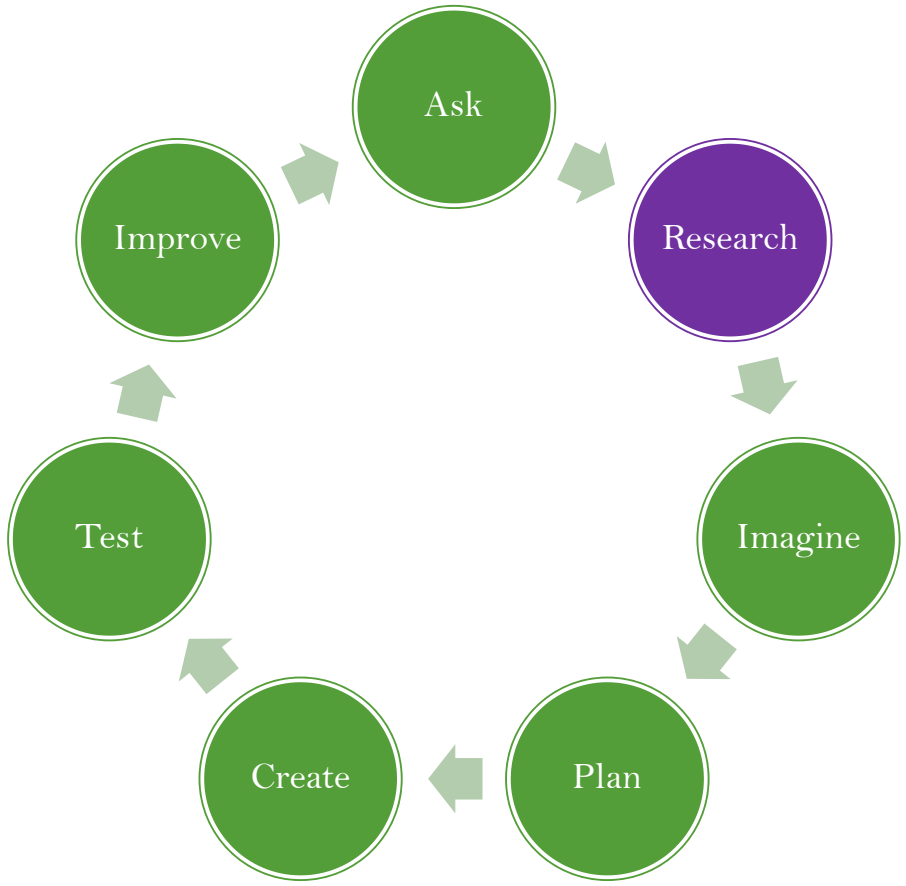
Iterative Problem Solving

Iterative Problem Solving

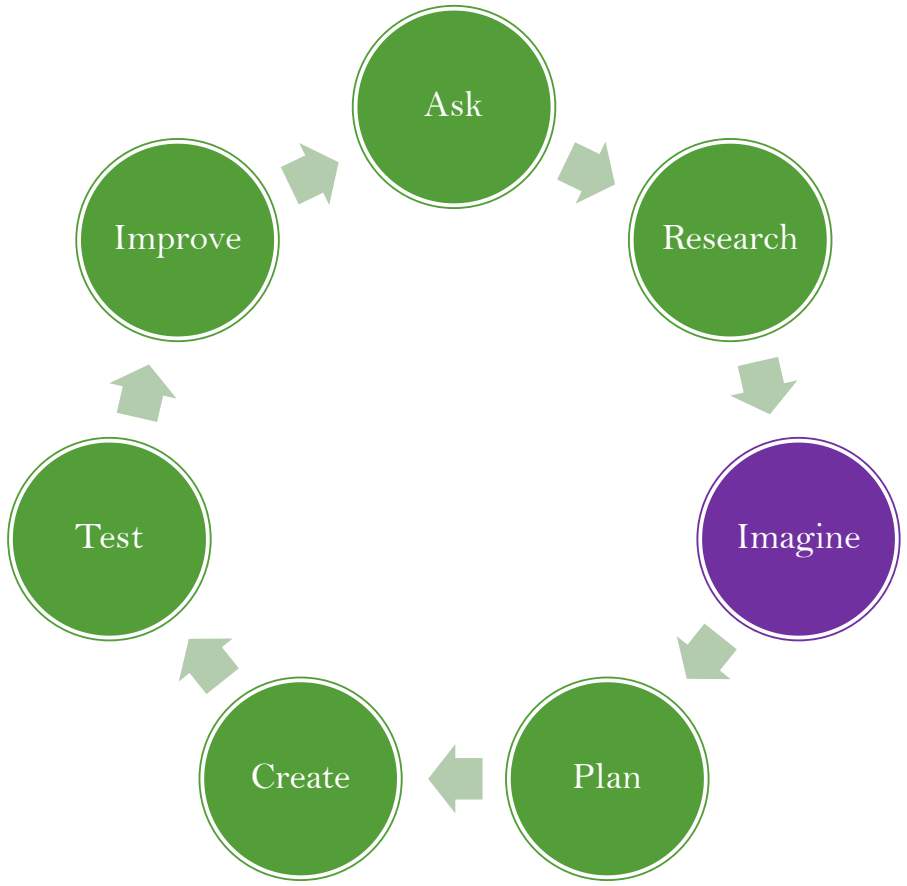
The Engineering Design Process



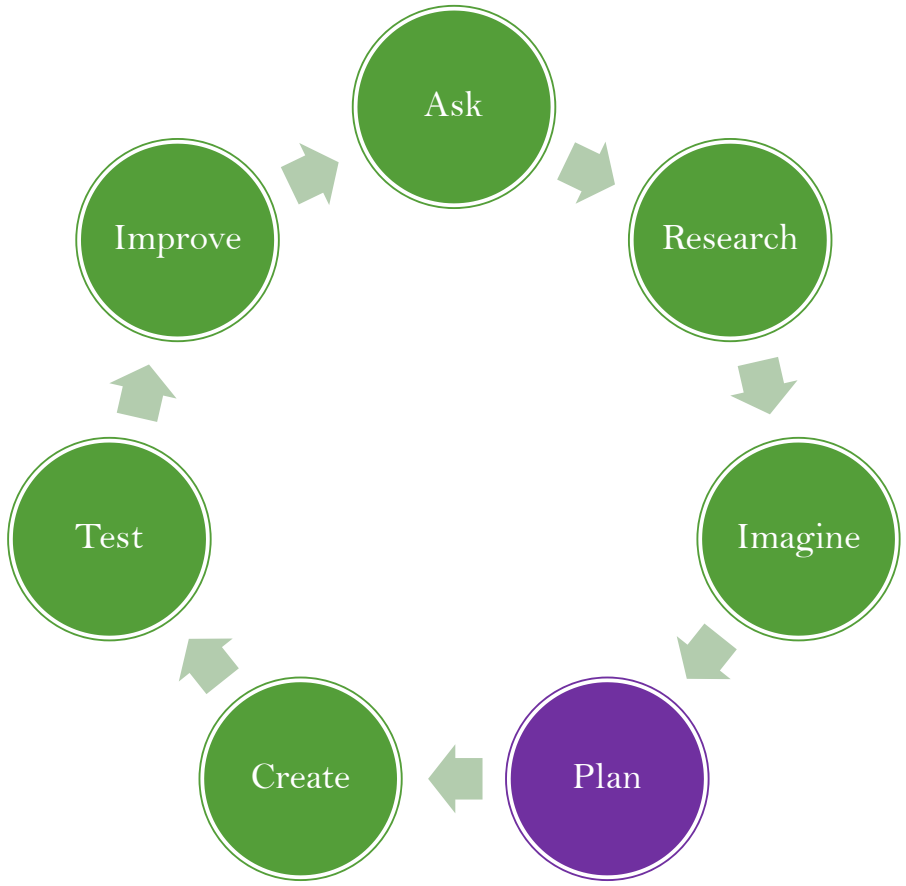
The Engineering Design Process



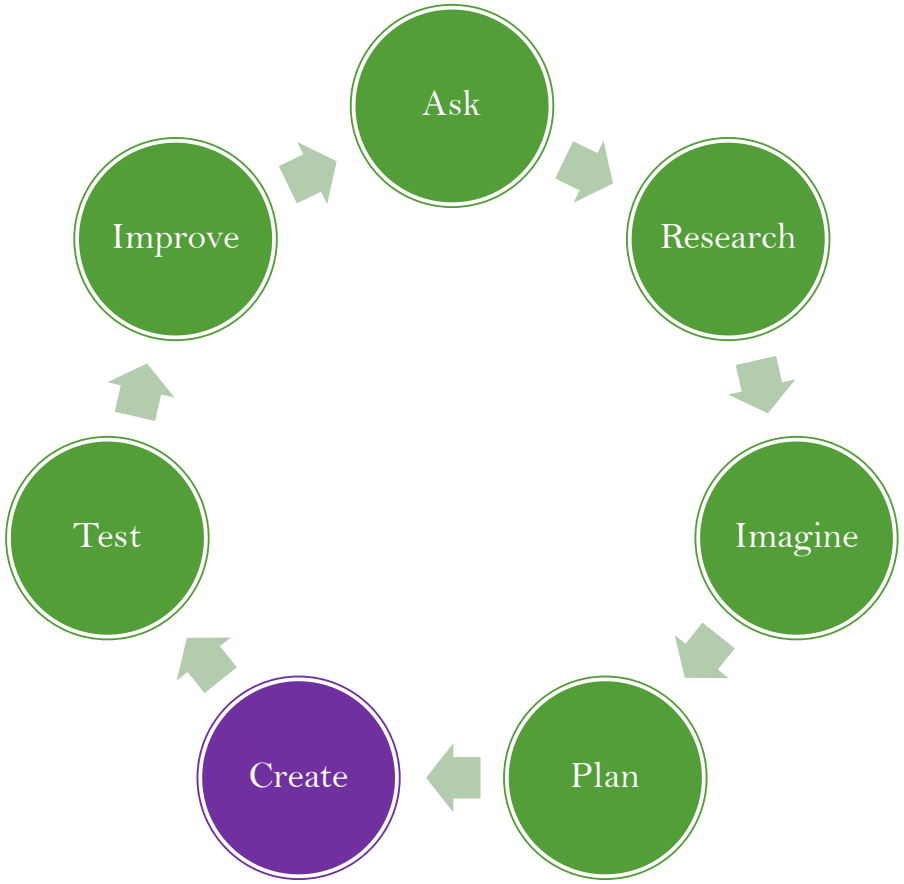
The Engineering Design Process



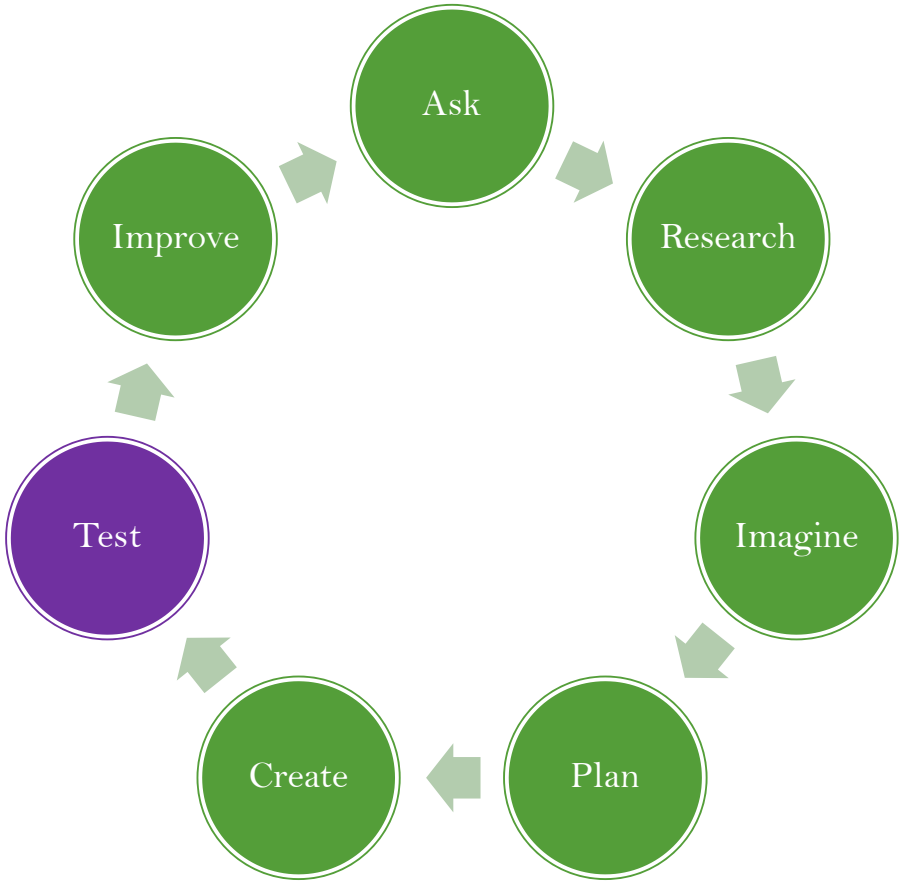
The Engineering Design Process



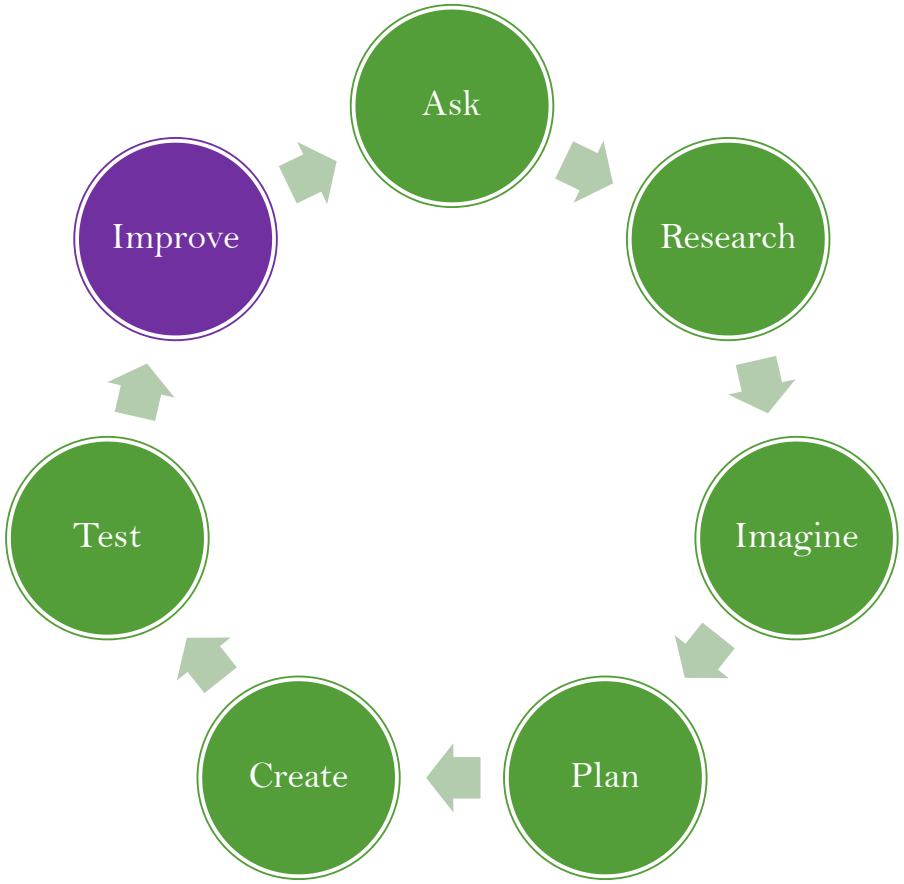
The Engineering Design Process



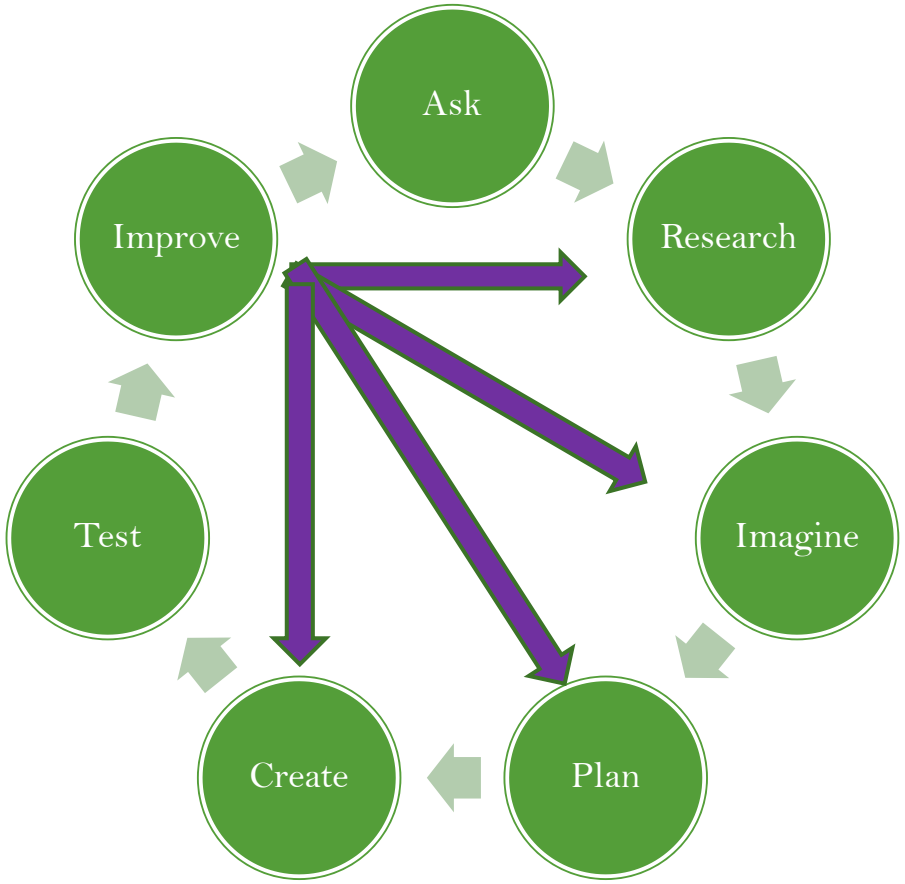
The Engineering Design Process



The Engineering Design Process



The Engineering Design Process



Any Questions?

Activity Introduction: Pulse Monitoring

Activity: Ask Phase

- How can we measure pulse rate inexpensively and with minimal time investment?

<u>Constraints:</u>

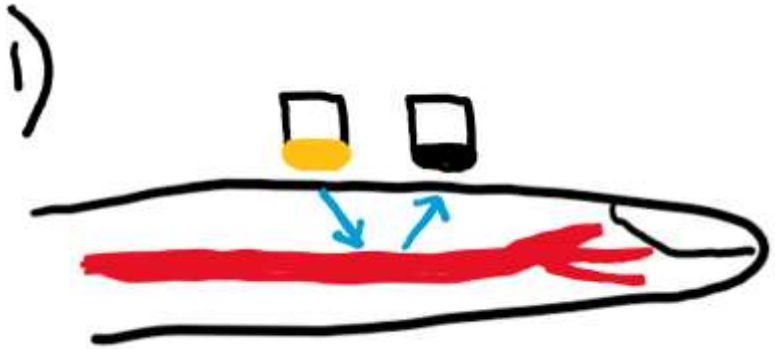
- Cost
- Development time of 2 hrs
- User friendly design and approach

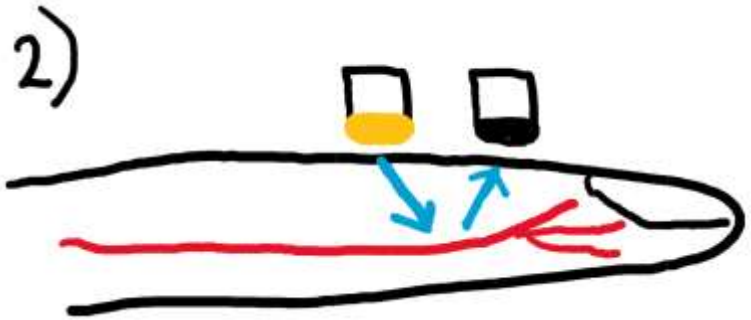
Activity: Research Phase

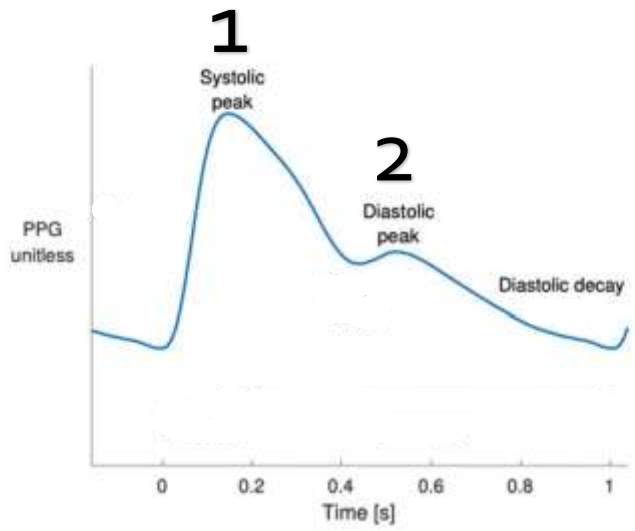
- How do smart watches measure pulse rate?

Dr Yo (2019) How Smart Watch Monitor Heart Rate? | Photoplethysmography. Available at: https://www.youtube.com/watch?v=QTniLL0sQtA&t=83s&ab_channel=Dr.Yo (Accessed 17 July 2022).

PPG Unpacked







Any Questions?

Activity: Imagine Phase

- Possible solutions using our constraints?

Activity: Imagine Phase

Not Using PPG

- Very sensitive vibration sensor on wrist
- A miniaturised stethoscope that sticks onto your chest

Using PPG

- An clip-on earring based transmission PPG device
- A miniaturised light and detector face sticker with PPG abilities
- A finger based PPG

Activity: Imagine Phase

Not Using PPG

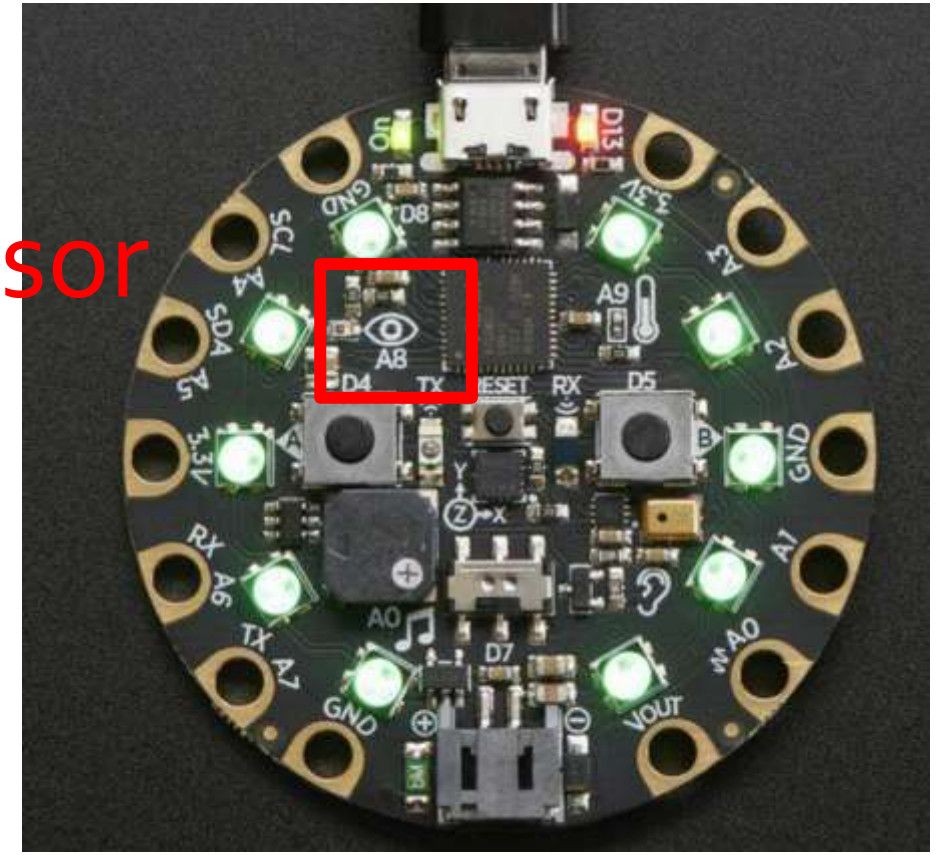
- Very sensitive vibration sensor on wrist
- A miniaturised stethoscope that sticks onto your chest
- A form of an ECG device

Using PPG

- An clip-on earring based transmission PPG device
- A miniaturised light and detector face sticker with PPG abilities
- **A finger based PPG**

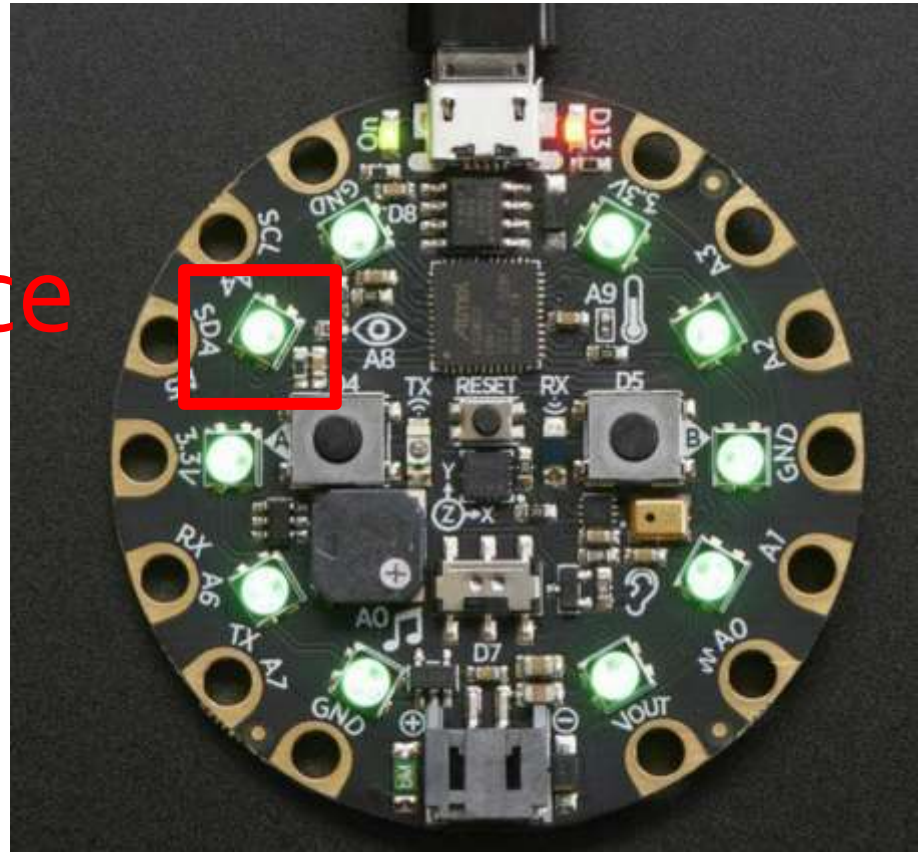
Activity: Plan Phase

Light Sensor



Activity: Plan Phase

Light Source



Activity: Plan Phase

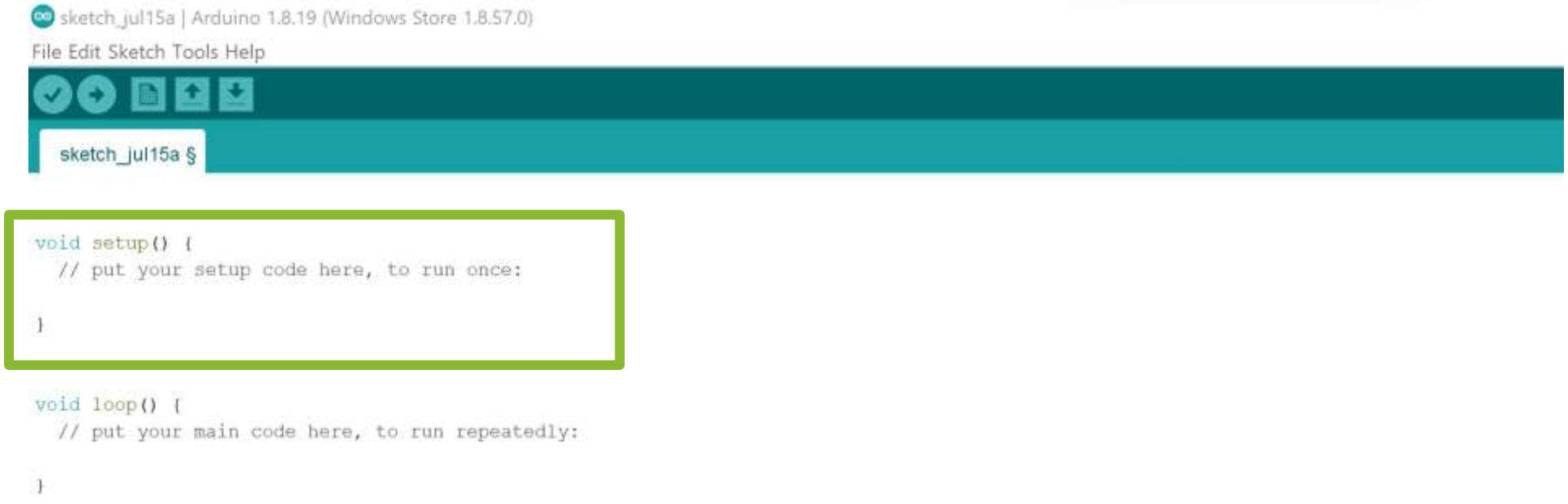
C++ Rules:

- End your coding instructions with ;
- Variables have limited scope { }
- Every bracket needs its partner
- Comments for code are represented with //

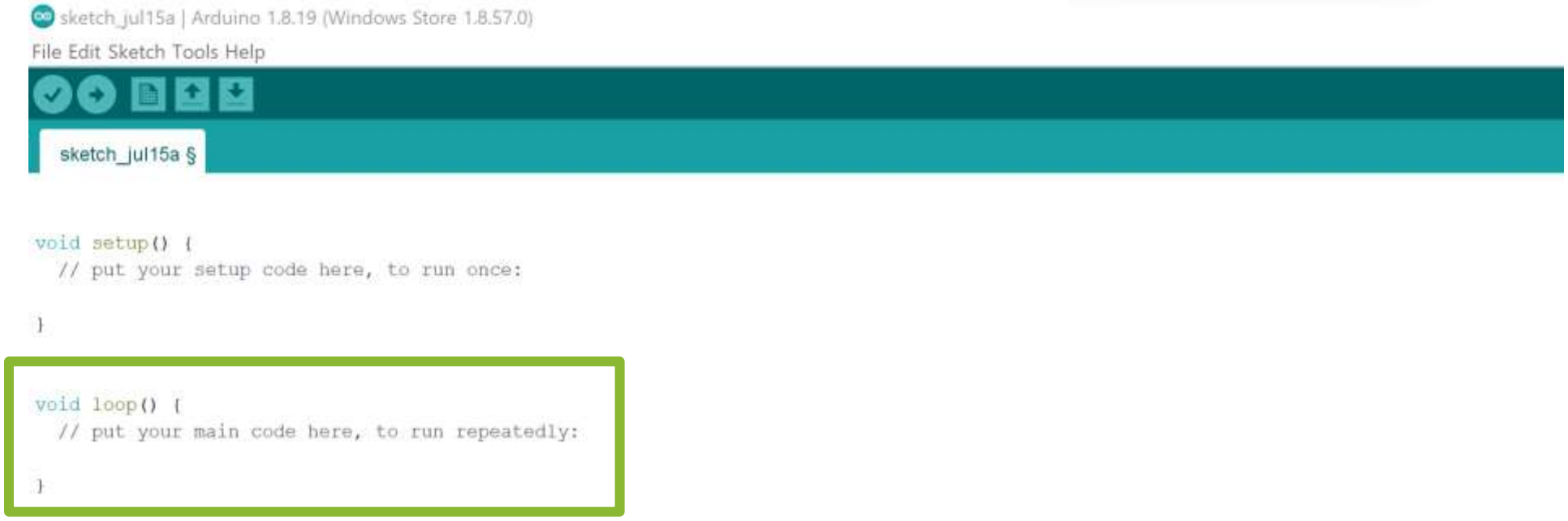
Any Questions?

Activity: Plan Phase

Activity: Plan Phase



Activity: Plan Phase

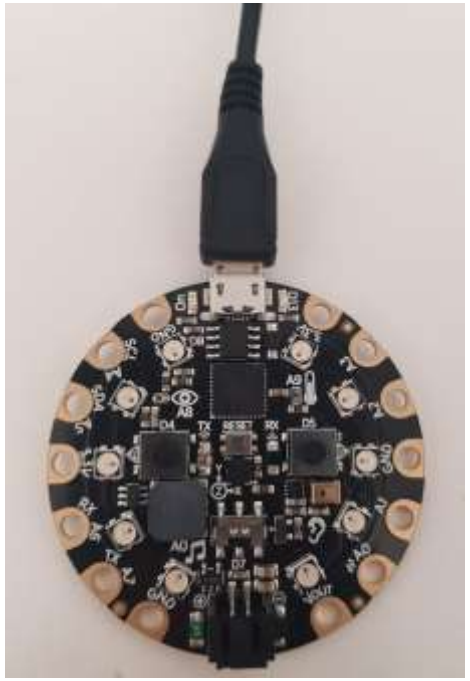


Group Creation

Activity: Create, Test and Improve

Getting Started:

- Connect Micro USB to Adafruit Board and USB to computer



Activity: Create, Test and Improve

Activity Breakdown

1) Getting the light source working
   - Controlling different light sources
   - Working with different colours
   - Controlling brightness

2) Understanding how the light detector works

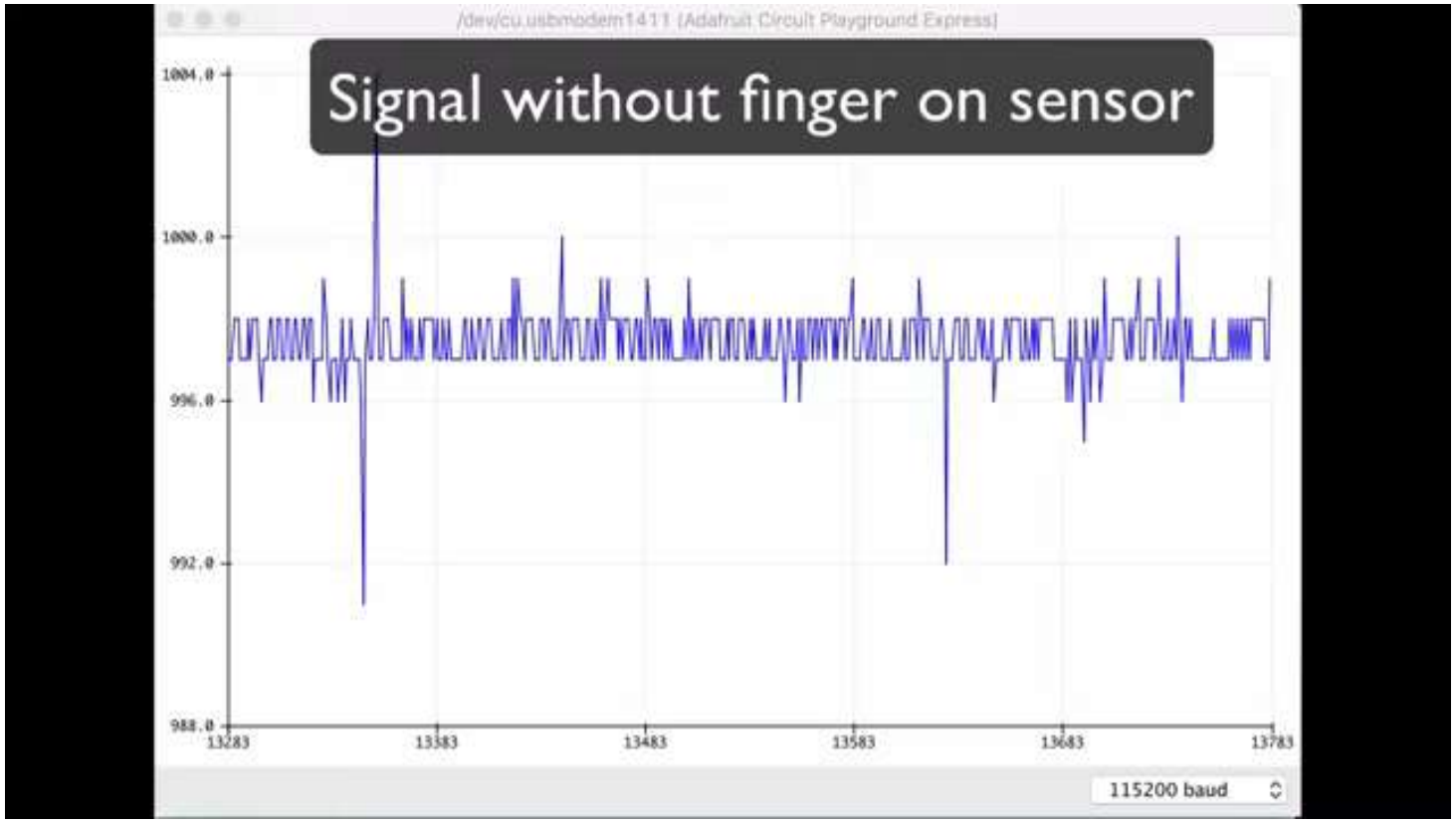
3) Plotting results

4) Putting it all together!

Any Questions?

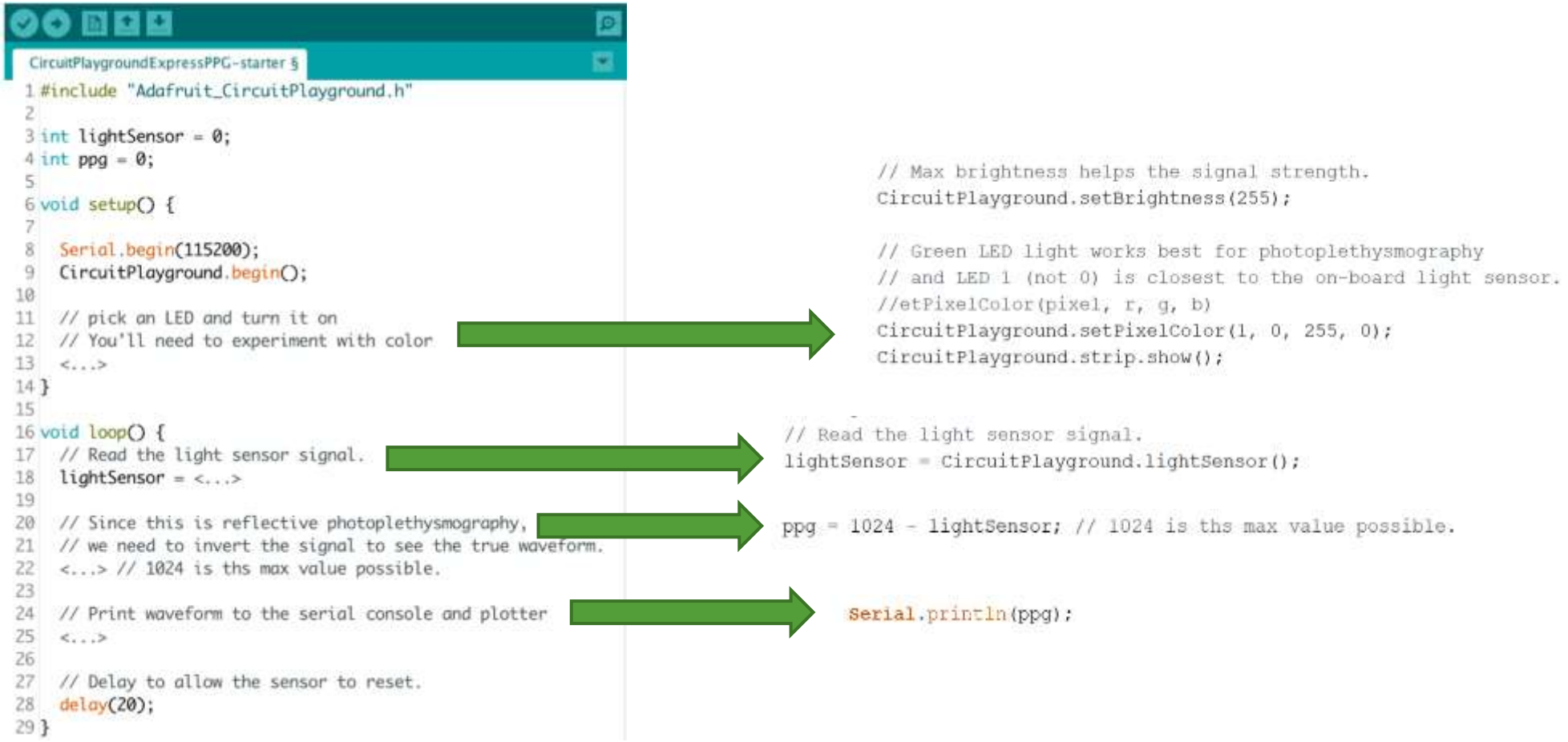
Getting on the Same Page

Getting on the Same Page



Jimmy Newland (2018) CPX as Pulse Sensor Demo Available at: https://www.youtube.com/watch?v=JuwK9bwggg0&ab_channel=JimmyNewland (Accessed 17 July 2022).

Getting on the Same Page



CircuitPlaygroundExpressPPG-starter §

```
#include "Adafruit_CircuitPlayground.h"

int lightSensor = 0;
int ppg = 0;

void setup() {

  Serial.begin(115200);
  CircuitPlayground.begin();

  // pick an LED and turn it on
  // You'll need to experiment with color
  <...>
}

void loop() {
  // Read the light sensor signal.
  lightSensor = <...>

  // Since this is reflective photoplethysmography,
  // we need to invert the signal to see the true waveform.
  <...> // 1024 is ths max value possible.

  // Print waveform to the serial console and plotter
  <...>

  // Delay to allow the sensor to reset.
  delay(20);
}
```

```
// Max brightness helps the signal strength.
CircuitPlayground.setBrightness(255);

// Green LED light works best for photoplethysmography
// and LED 1 (not 0) is closest to the on-board light sensor.
//etPixelColor(pixel, r, g, b)
CircuitPlayground.setPixelColor(1, 0, 255, 0);
CircuitPlayground.strip.show();
```

```
// Read the light sensor signal.
lightSensor = CircuitPlayground.lightSensor();
```

```
ppg = 1024 - lightSensor; // 1024 is ths max value possible.
```

```
Serial.println(ppg);
```

Any Questions?

Lets Reflect!

- What did you most enjoy about the activity?
- What did you find most challenging?
- How could you improve your approach in future?

Routes to Pursue Biomedical Engineering

High School

- Math and Science
- Biology and FS Math

University: South Africa

- Only Wits offer a biomed + electrical undergrad = 5 years
- Otherwise 4 year engineering
- 1-2 year postgrad also an option

University: Overseas

- Can do 4 year undergrad in biomedical engineering directly

Any Questions?

Wrap Up

- Engineering as a Field
- Biomedical Engineering
- Careers in Biomedical Engineering
- Approaches for Biomedical Problems
- Engineering Design Process
- Solving a Biomedical Problem

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