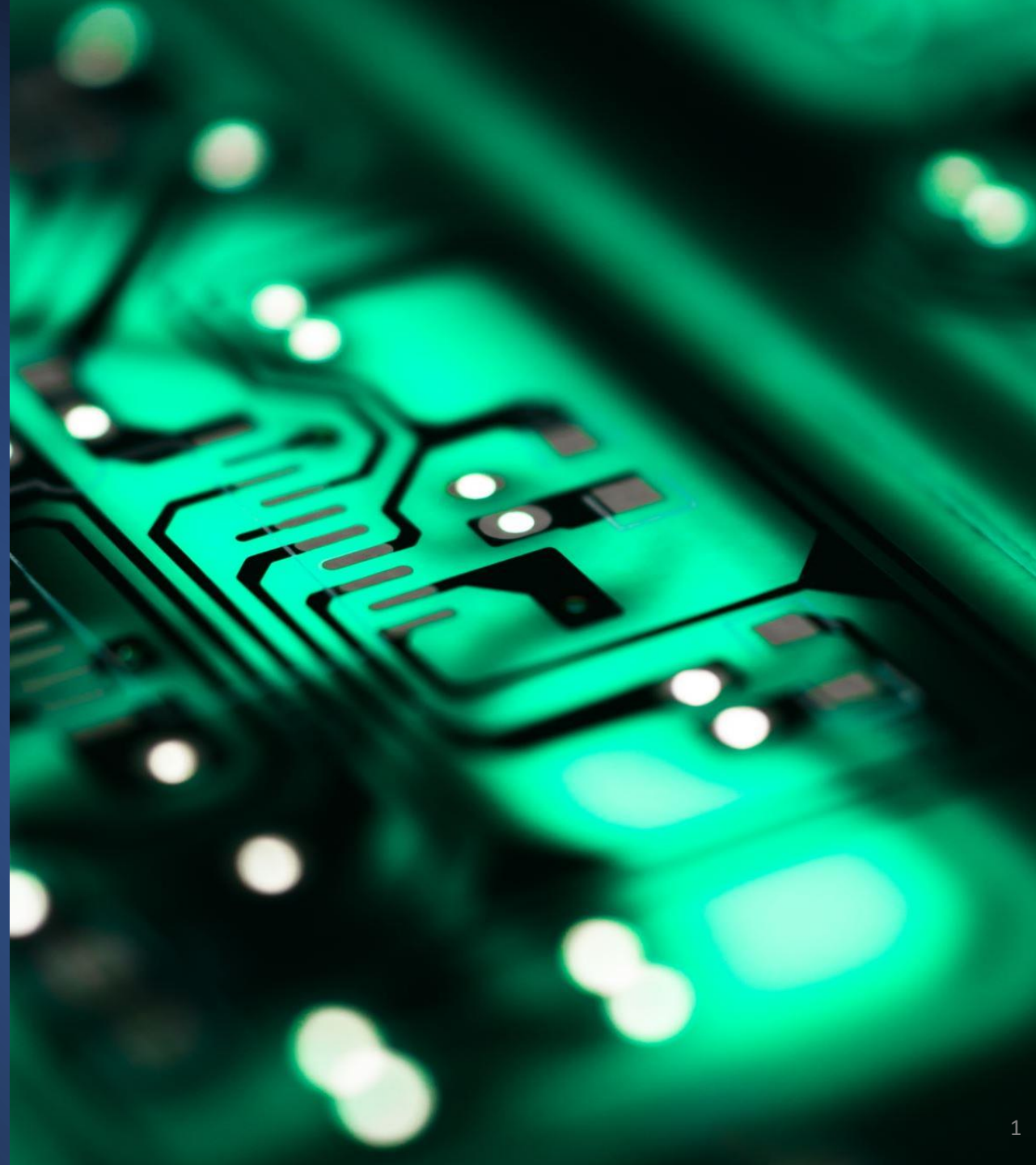


Andrew Brown, Preyusha Aryal,  
Reilly Wolfe

## Tangible Object Touchscreen

Client: Mitch Butzer,  
Advanced Input  
Systems



# Objective

- To develop software and build objects that interface via a touch screen with each other.
- Software is a GUI application that demonstrates the functionality of the objects as well as normal touch
  - The tangible objects:
    - Knob, Switch, Joystick, Puck





# Background

- A full touchscreen allows flexibility in applications
  - No return feedback though
- Objects allow for tangible feedback to user
- Example: Ultrasound Device

Knob Feedback		Ticks	
Interface Requirements:			
Clearance to avoid scratching		TBD	
Object Touch Ergonomics		Per item basis	
P-CAP glass interface			
Appearance Requirements:			
Surface finish		TBD	
-----			
Mechanical Requirements:			
Strength Requirements:			
Object attachment (Horizontal Force)		10 lbs	
Object attachment (Vertical Force)		10 lbs	
Spatial Requirements:			
Object size		1-2 inches	
Touch Screen size		12.1 inches	
Adhesion Requirements:			
Maximum temperature		110 F	
Minimum temperature		32 F	
Blind Touch Feedback			
Joy Stick Feedback		Resistance	
Switch Feedback		Break Over	Rubber boot
Knob Feedback		Ticks	

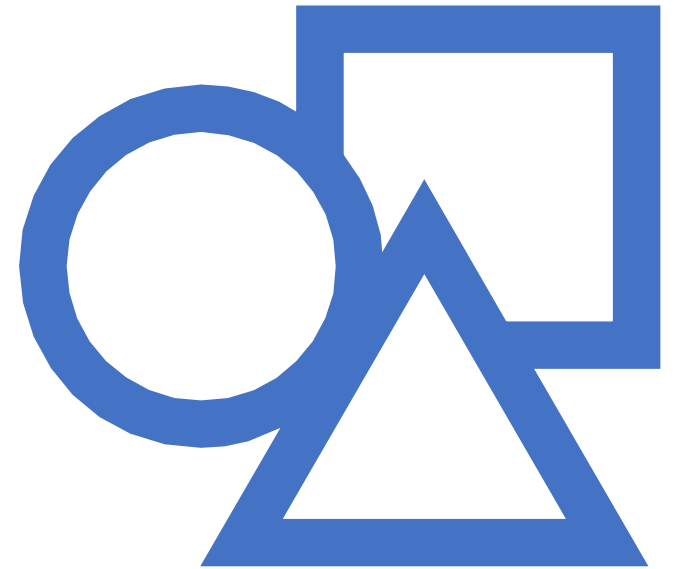


# Inventory of Product Requirements

# GUI requirements

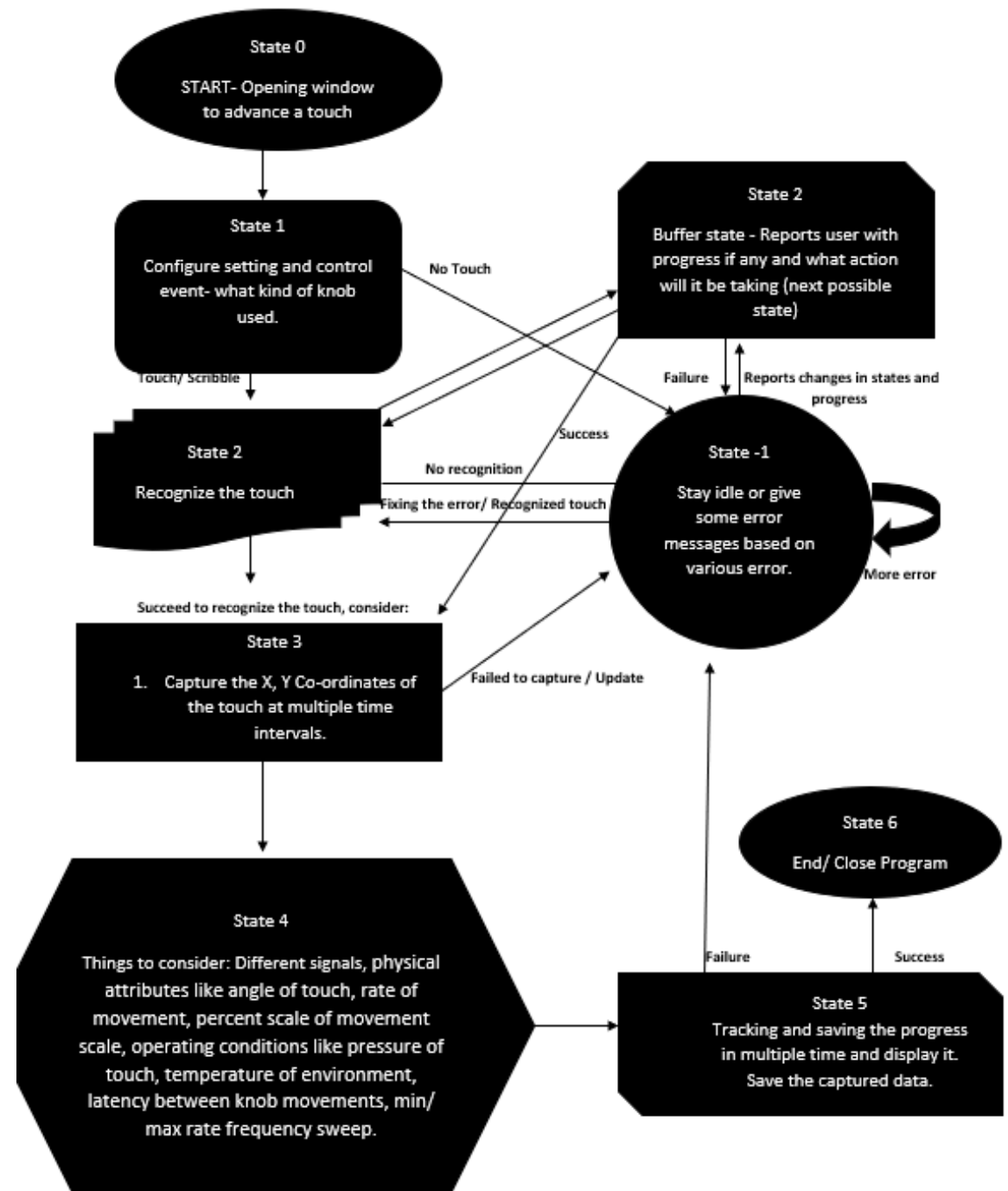
Software: Free USB analyzer and QT

- Interaction with tangible objects
  - Identify object
  - Interpret object inputs
- Process standard touch (finger)



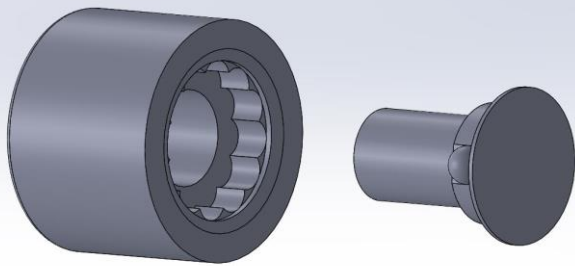
# Conceptual Development

## State Machine Design for GUI



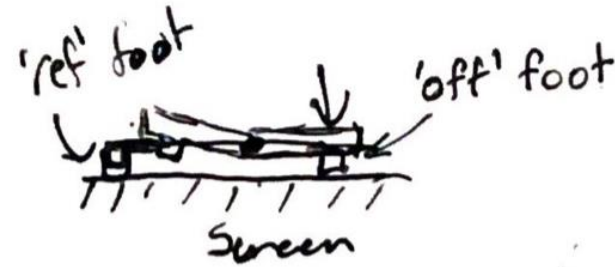
# Object Conceptual Design

- 2-touch screen
  - Puck and joystick require more touches
- Knob prototype:

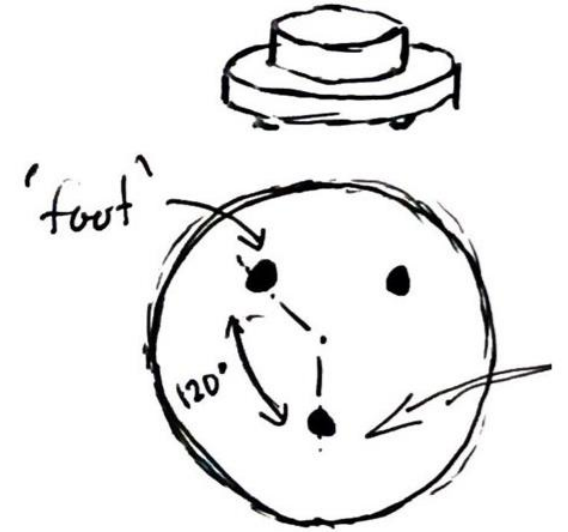


## Switch Design

- ref
- 'on'
- 'off'



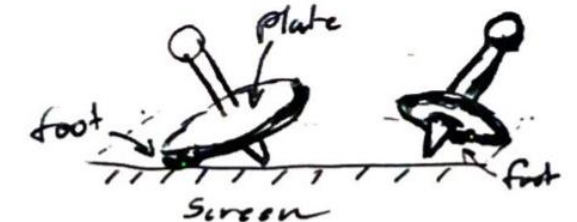
## Puck Design



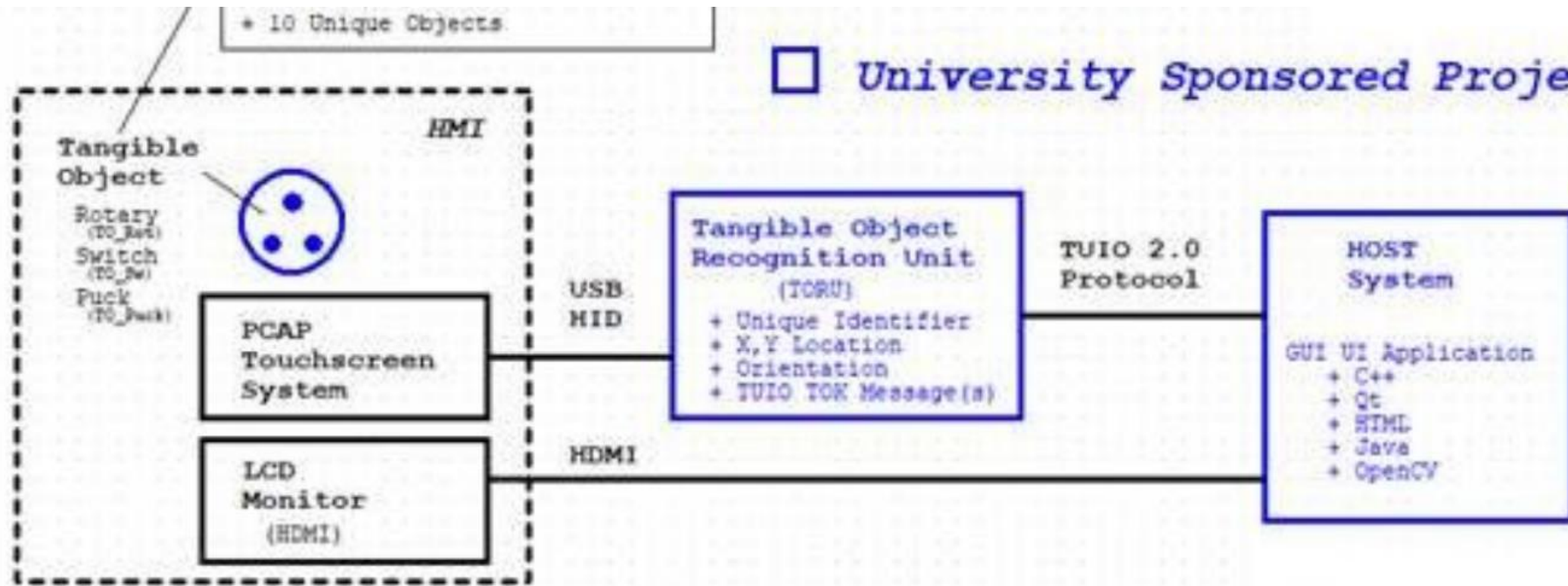
## Knob Design



## Joystick Design



## □ University Sponsored Project

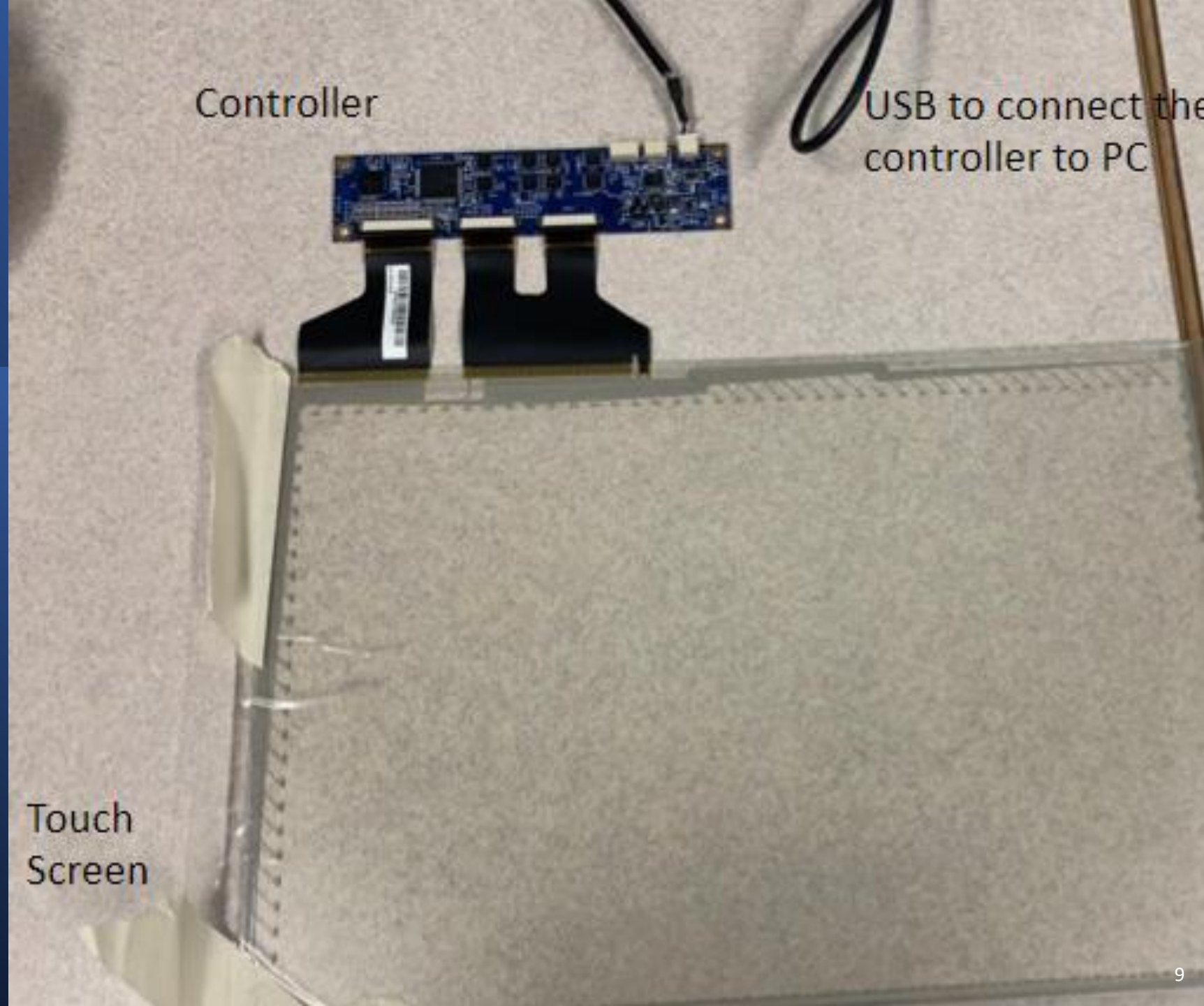


## Touchscreen Operation

- Touchscreen Data output
- TUIO/TURO protocol
- GUI Host system
- Screen output



# Touchscreen Data Analysis Setup



# Touchscreen Raw Data

**000207: Report Arrived (UP), 2020-10-08 16:18:24.1492161 +0.0069800**

**Report Name:**Touch Screen

**Report ID:**-1

Unknown[0x0..0xf]: 0x0

Tip Switch: 1

In Range: 1

Unknown: 1

X[0..2047]: 1365

Y[0..2047]: 1285

**000209: Report Arrived (UP), 2020-10-08 16:18:24.1572555 +0.0080259**

**Report Name:**Touch Screen

**Report ID:**-1

**000211: Report Arrived (UP), 2020-10-08 16:18:24.1702580 +0.0129807**

**Report Name:**Touch Screen

**Report ID:**-1

Unknown[0x0..0xf]: 0x0

Tip Switch: 1

In Range: 1

Unknown: 1

X[0..2047]: 1365

Y[0..2047]: 1282

HMI VIEW

```
00000231 2020-10-08 16:22:06.9314131 +0.0090033 UP 0x00000000 URB_FUNCTION_BULK_OR_INTERRUPT_TRANSFER
00000233 2020-10-08 16:22:06.9364071 -0.0049628 UP 0x00000000 URB_FUNCTION_BULK_OR_INTERRUPT_TRANSFER
00000235 2020-10-08 16:22:06.9424250 -0.0060070 UP 0x00000000 URB_FUNCTION_BULK_OR_INTERRUPT_TRANSFER
00000237 2020-10-08 16:22:06.9524387 -0.0100014 UP 0x00000000 URB_FUNCTION_BULK_OR_INTERRUPT_TRANSFER
00000239 2020-10-08 16:22:06.9574163 -0.0049662 UP 0x00000000 URB_FUNCTION_BULK_OR_INTERRUPT_TRANSFER
00000241 2020-10-08 16:22:06.9634379 -0.0060093 UP 0x00000000 URB_FUNCTION_BULK_OR_INTERRUPT_TRANSFER
00000243 2020-10-08 16:22:06.9734422 -0.0099879 UP 0x00000000 URB_FUNCTION_BULK_OR_INTERRUPT_TRANSFER
00000245 2020-10-08 16:22:06.9794528 -0.0059939 UP 0x00000000 URB_FUNCTION_BULK_OR_INTERRUPT_TRANSFER
00000247 2020-10-08 16:22:06.9844402 -0.0049719 UP 0x00000000 URB_FUNCTION_BULK_OR_INTERRUPT_TRANSFER
00000249 2020-10-08 16:22:06.9944373 -0.0099859 UP 0x00000000 URB_FUNCTION_BULK_OR_INTERRUPT_TRANSFER
00000251 2020-10-08 16:22:06.9994408 -0.0049916 UP 0x00000000 URB_FUNCTION_BULK_OR_INTERRUPT_TRANSFER
00000253 2020-10-08 16:22:06.0234499 -0.0239981 UP 0x00000000 URB_FUNCTION_BULK_OR_INTERRUPT_TRANSFER
00000255 2020-10-08 16:22:06.0324141 -0.0089439 UP 0x00000000 URB_FUNCTION_BULK_OR_INTERRUPT_TRANSFER
00000257 2020-10-08 16:22:06.0424632 -0.0100372 UP 0x00000000 URB_FUNCTION_BULK_OR_INTERRUPT_TRANSFER
00000259 2020-10-08 16:22:06.0514653 -0.0089952 UP 0x00000000 URB_FUNCTION_BULK_OR_INTERRUPT_TRANSFER
00000261 2020-10-08 16:22:06.0604281 -0.0089462 UP 0x00000000 URB_FUNCTION_BULK_OR_INTERRUPT_TRANSFER
```

Complete  
**000253: Bulk or Interrupt Transfer (UP), 2020-10-08 16:22:06.0234499 +0.0239981. (1. Device: PH1401) Status: 0x00C**  
Pipe Handle: 0xc0be63b8 (Endpoint Address: 0x81)  
Get 0x5 bytes from the device

PACKET VIEW

# Data Interpretation

## Physical Touch on TS

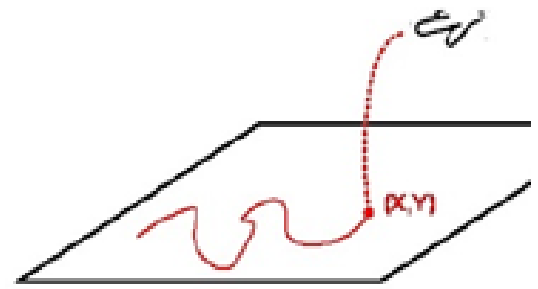


Event 1

**Touch Report - Endpoint 1**

1				
9	Xmsb	Xlsb	Ymsb	Ylsb
0	0x00	0x00	0x00	0x00
0	0x00	0x00	0x00	0x00
0	0x00	0x00	0x00	0x00
0	0x00	0x00	0x00	0x00
0	0x00	0x00	0x00	0x00
0	0x00	0x00	0x00	0x00
0	0x00	0x00	0x00	0x00
0	0x00	0x00	0x00	0x00
0	0x00	0x00	0x00	0x00
1				

Event 1 - Finger touches the surface (in red) with the corresponding touch report with Tip Switch set (1)



Event 2

**Touch Report - Endpoint 1**

0x01				
0x08	Xmsb	Xlsb	Ymsb	Ylsb
0x00	0x00	0x00	0x00	0x00
0x00	0x00	0x00	0x00	0x00
0x00	0x00	0x00	0x00	0x00
0x00	0x00	0x00	0x00	0x00
0x00	0x00	0x00	0x00	0x00
0x00	0x00	0x00	0x00	0x00
0x00	0x00	0x00	0x00	0x00
0x00	0x00	0x00	0x00	0x00
0x00	0x00	0x00	0x00	0x00
0x01				

Event 2 - Finger is lifted, no touches are detected. The controller copies the previous touch report (before before lift) and sets the Tip Switch to 0.

# Data Interpretation

	Usage	Values
Report ID	USB Communication with API	01h always
Tip Switch	Indicates lift-off of a finger	1 during touch 0 after releasing finger
Rsvd	reserved	0 always
Touch ID	Finger ID for finger trajectory formation	00h for invalid touch 01h..0Ah for valid touch
Touch X Coordinate	Touch X coordinates for operating system user event input control	0000h..7FFFh 0000h addresses the most left pixel column of the operating system desktop environment 7FFFh addresses the most right pixel column of the operating system desktop environment
Touch Y Coordinate	Touch Y coordinates for operating system user event input control	0000h..7FFFh 0000h: top most pixel row of the operating system desktop environment 7FFFh:bottom most pixel row of the operating system desktop environment
Time stamp	Scan Time High-Resolution time-stamp that is saved at the end of the multi-touch algorithm. Rollover from +65535 to 0. The scan time is in the physical unit of 0.1ms.	0000h..FFFFh
Touch Count	Number of reported touches in the report	00h...0Ah

# Testing the touch

Single and Multiple Touch



# Testing the touch

## Example Paint application in Qt

```
bool ScribbleArea::event(QEvent *event)
{
    switch (event->type()) {
    case QEvent::TouchBegin:
    case QEvent::TouchUpdate:
    case QEvent::TouchEnd:
    {
        const QTouchEvent *touch = static_cast<QTouchEvent *>(event);
        const QList<QTouchEvent::TouchPoint> touchPoints = static_cast<QTouchEvent *>(event)->touchPoints();
        for (const QTouchEvent::TouchPoint &touchPoint : touchPoints) {
            switch (touchPoint.state()) {
            case Qt::TouchPointStationary:
            case Qt::TouchPointReleased:
                // don't do anything if this touch point hasn't moved or has been released
                continue;
            default:
                {
                    QSizeF diams = touchPoint.ellipseDiameters();
                    if (diams.isEmpty()) {
                        qreal diameter = MaximumDiameter;
                        if (touch->device()->capabilities() & QTouchEvent::Pressure)
                            diameter = MinimumDiameter + (MaximumDiameter - MinimumDiameter) * touchPoint.pressure();
                        diams = QSizeF(diameter, diameter);
                    }

                    QPainter painter(&image);
                    painter.setPen(Qt::NoPen);
                    painter.setBrush(myPenColors.at(touchPoint.id() % myPenColors.count()));
                    painter.drawEllipse(touchPoint.pos(), diams.width() / 2, diams.height() / 2);
                    painter.end();

                    modified = true;
                    const int rad = 2;
                    QRectF rect(QPointF(), diams);
                    rect.moveCenter(touchPoint.pos());
                    update(rect.toRect().adjusted(-rad,-rad, +rad, +rad));
                }
            }
            break;
        }
    }
    break;
}
default:
    return QWidget::event(event);
}
return true;
```

# BUDGET

## INCOME

Total amount received from AIS => \$4k

## EXPENSES

Grad Student Support => \$1.1k

Contribution to ME Shop => \$5k

UI Overhead => \$200

Balance available for materials/travel => \$2300

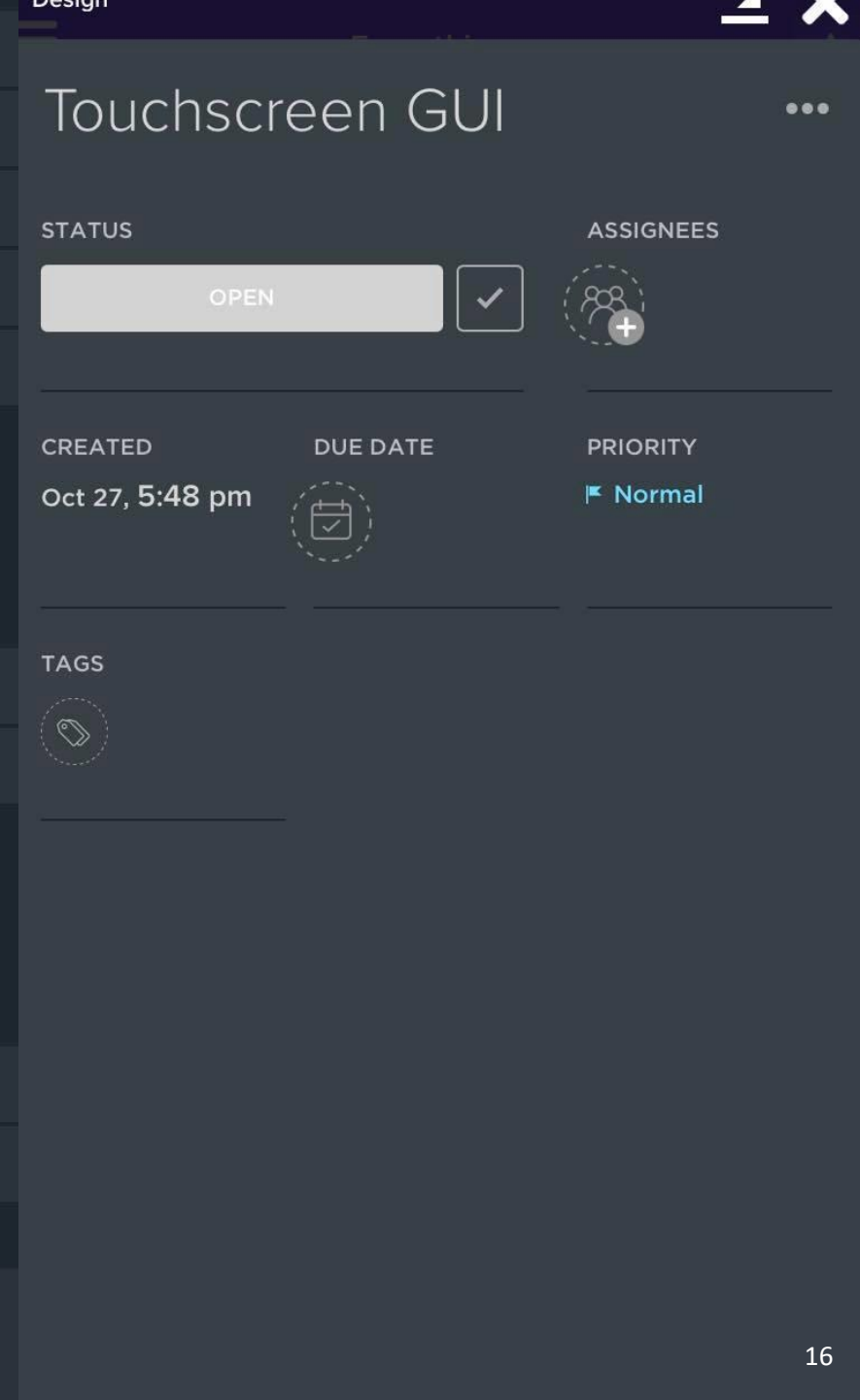
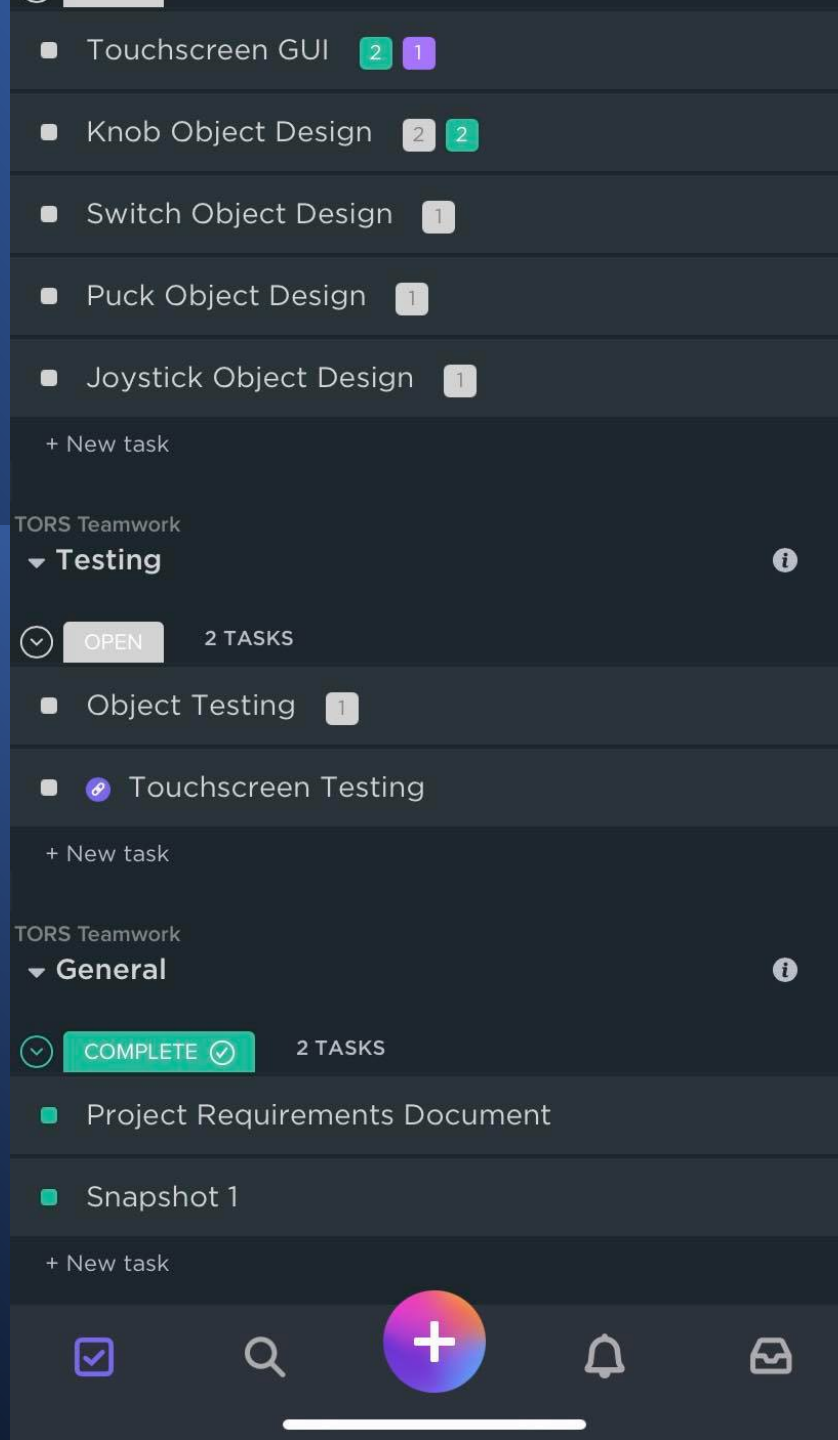
Used amount - \$0

Received free touch screen from AIS

Free version of QT



# Task Allocation Using - Clickup

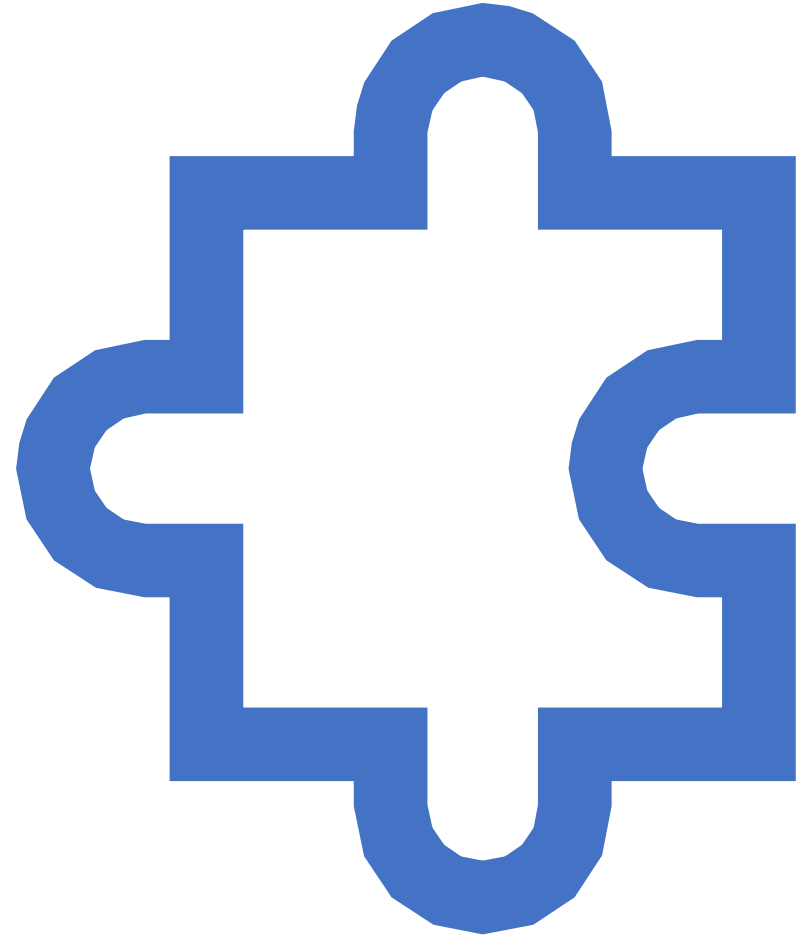




## Next Milestone

GUI- Constantly collecting the touch data in file format and analyzing it - parsing it

Object conductive material acquisition



# Design Validation Plan



Conceptual Research



Product Design and  
Process Development



Testing - Design  
verification and  
validation



Installation and  
Optimization

Thank you! Any  
question?

