



# Final Presentation

## Team (May 15-03)

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## Client

HGST

## Advisor

Mr. Harker

# Agenda



## Problem Statement

- Background
- Use Case
- Requirements

## System Overview

- Concept Sketch
- Block Diagram

## Technical Challenges

- Motor Issues
- Calibration
- File Parsing

## Test Results

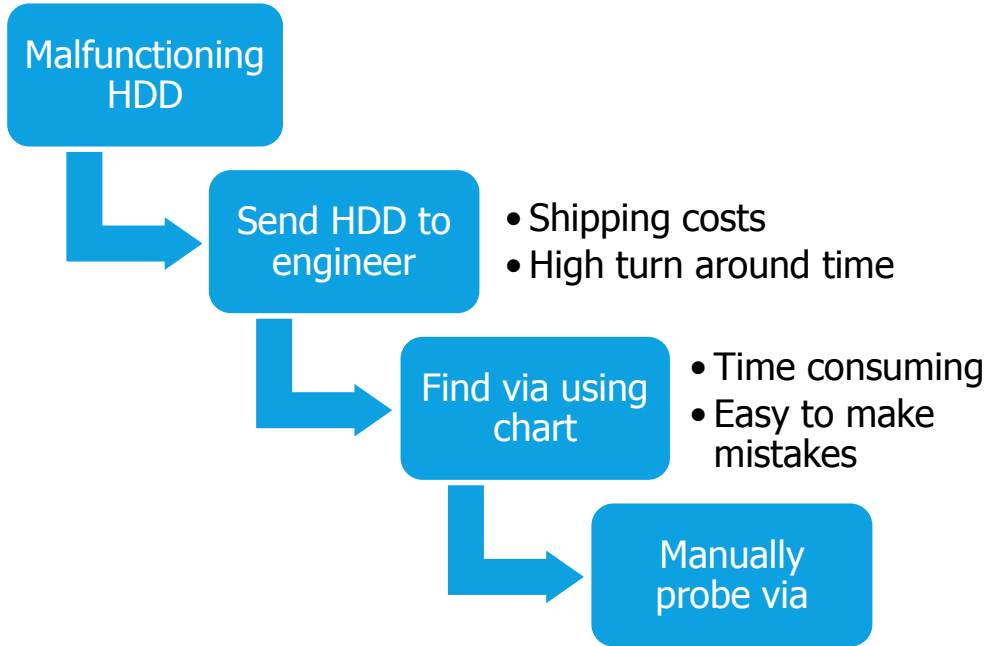
- Functional Testing
- Hypothesis

## Project Management

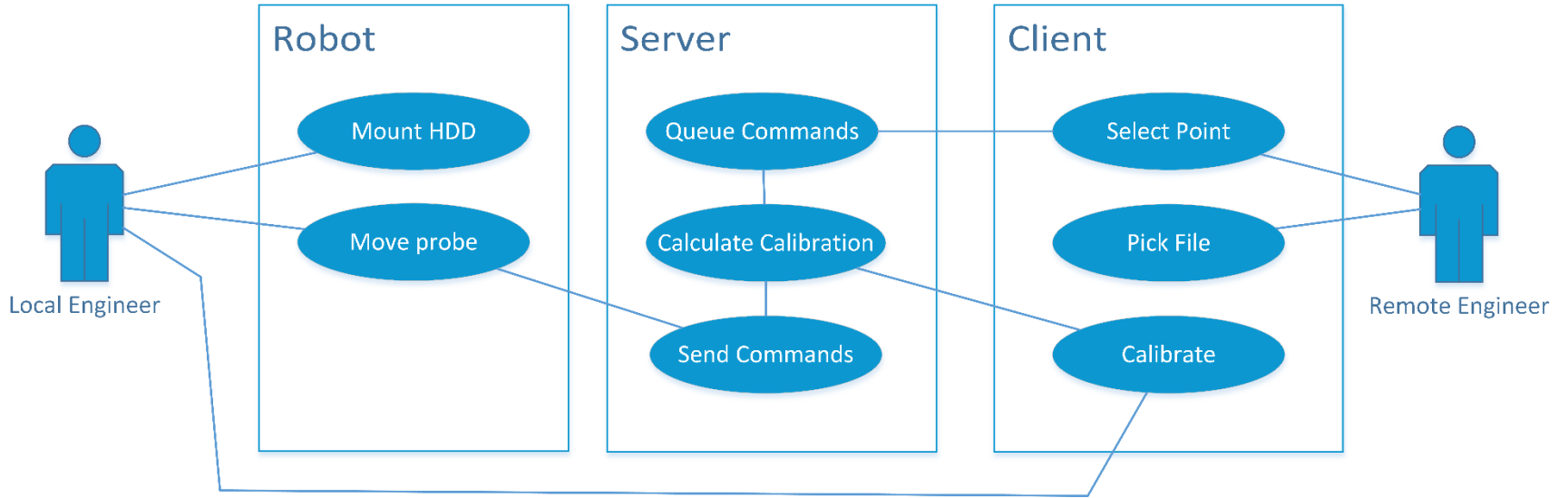
- Cost
- Summary

# PROBLEM STATEMENT

# Background



# Use Case



# Requirements

## Functional

- Hold and move LeCroy Probe
- Make a good electrical contact
- Calibration method that ensures accurate performance

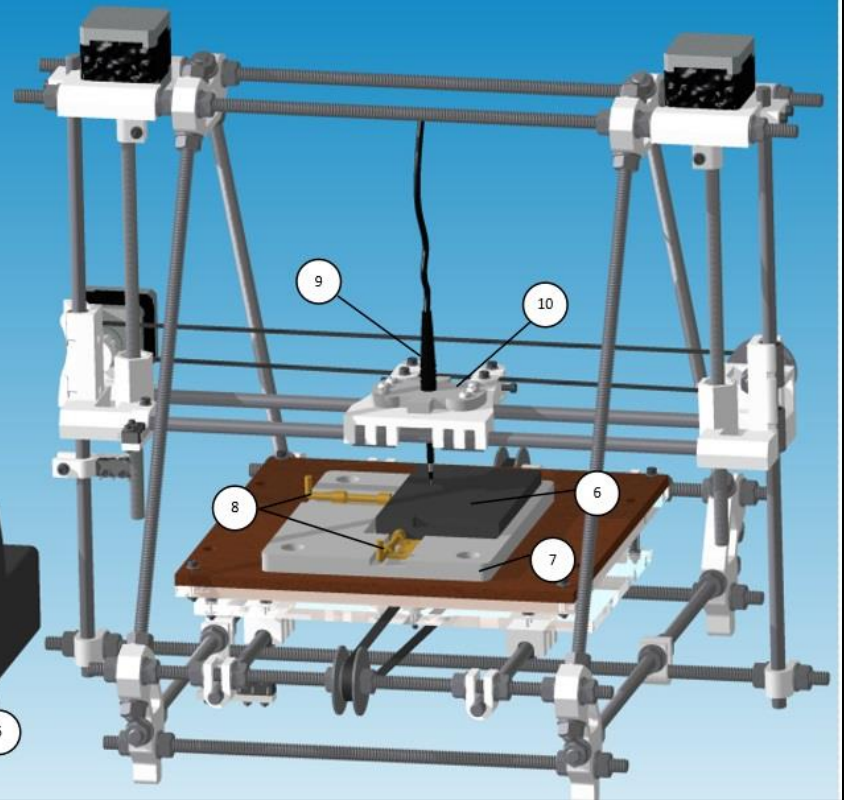
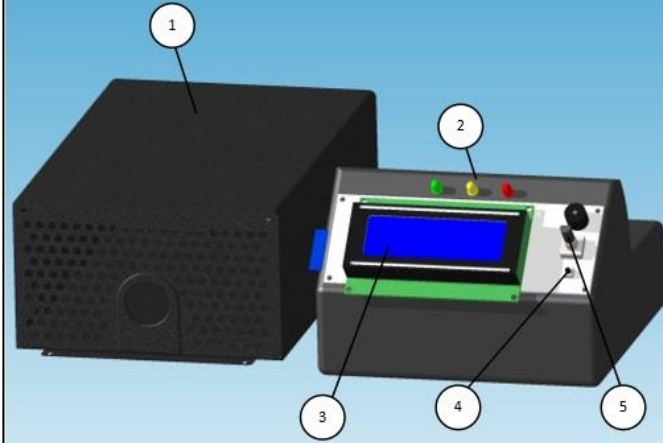
## Non-Functional

- Move to any point within 60 seconds
- LEDs and LCD that indicate state
- Take up less than 4ft<sup>3</sup>
- Support a manual operation mode

# SYSTEM OVERVIEW

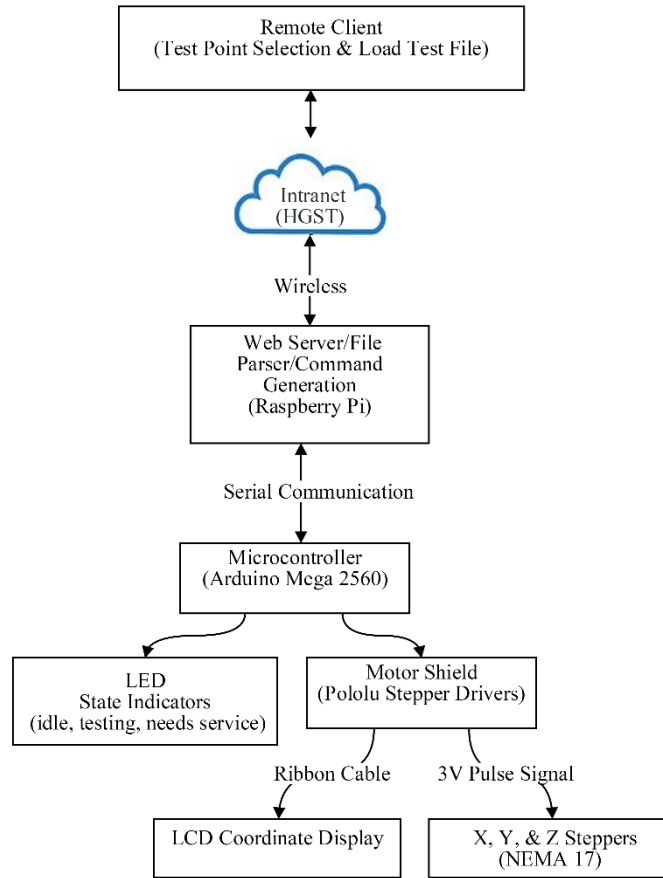
# Concept Sketch

1	Power Supply
2	Indicator LEDs
3	LCD Screen
4	Push Button
5	Twist Knob
6	HDD
7	HDD Jig
8	Spring Loaded Latch
9	Oscilloscope Probe
10	Probe Holder

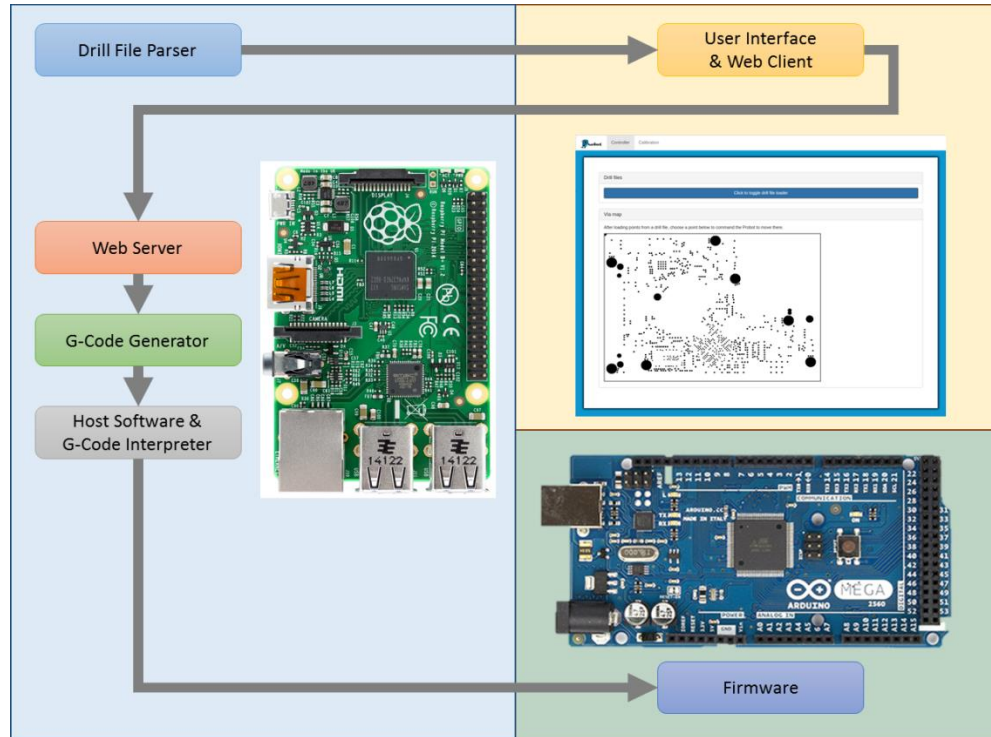




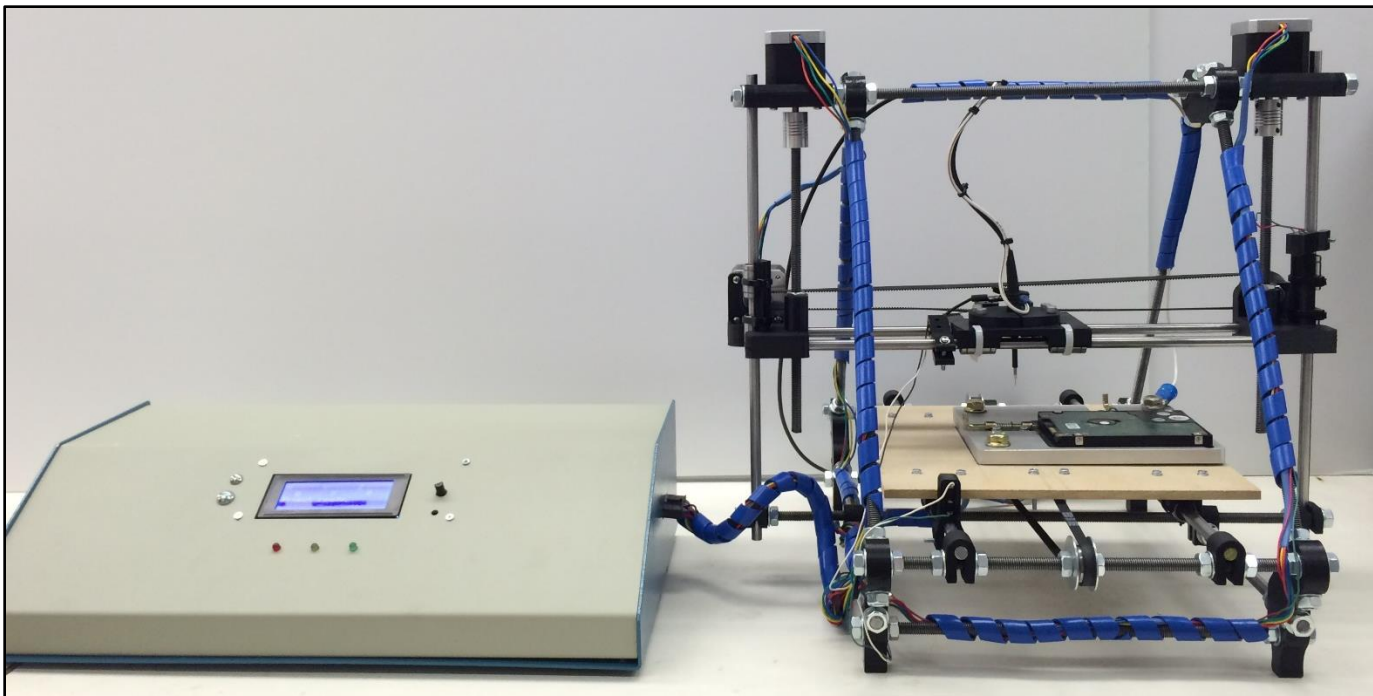
# Block Diagram



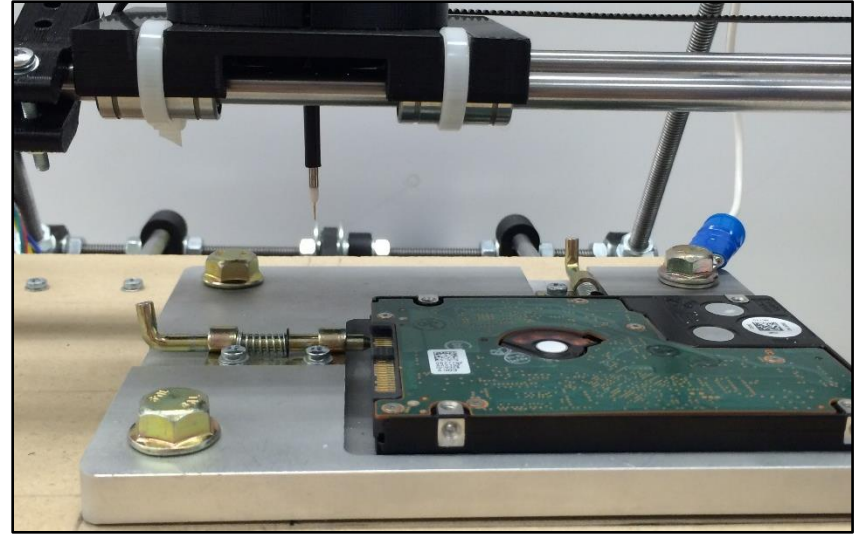
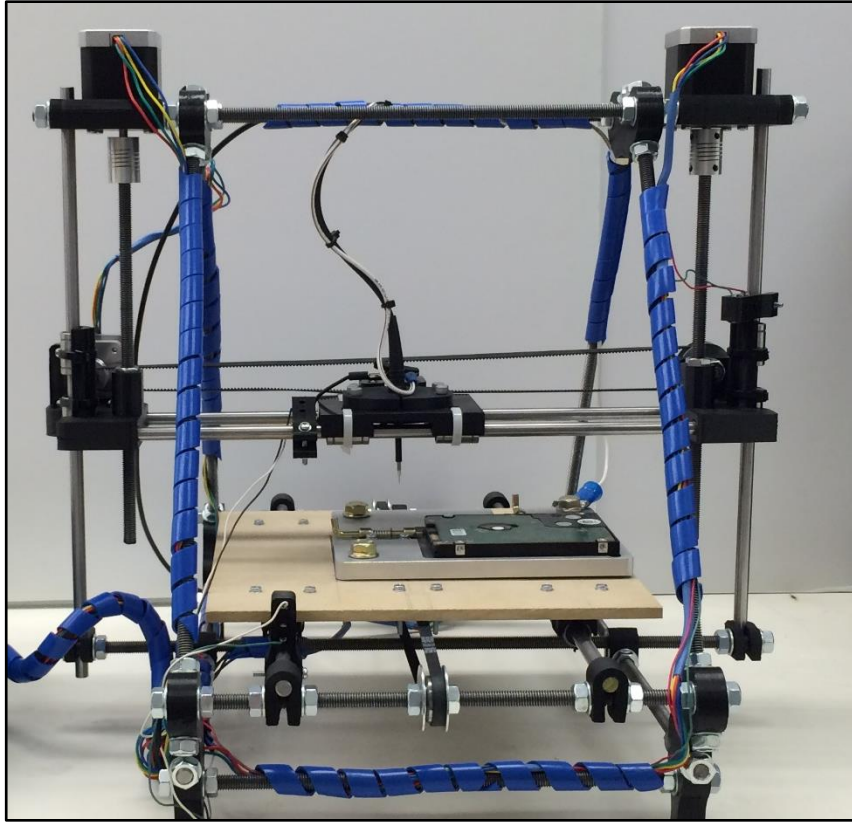
# Software Overview



# PROGRESS



May15-03



May15-03

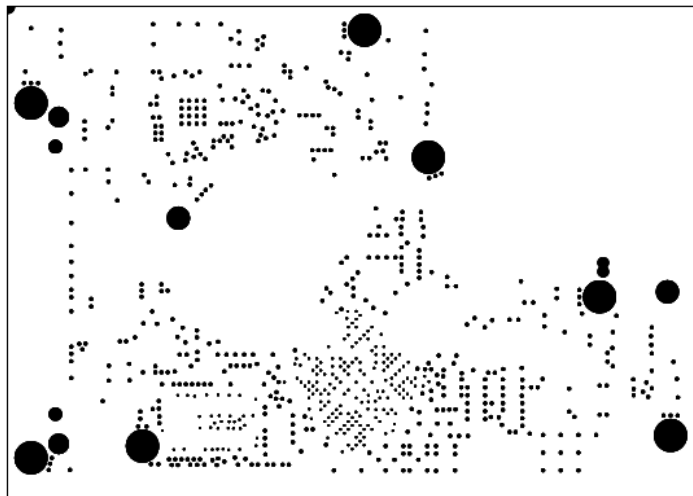


## Drill files

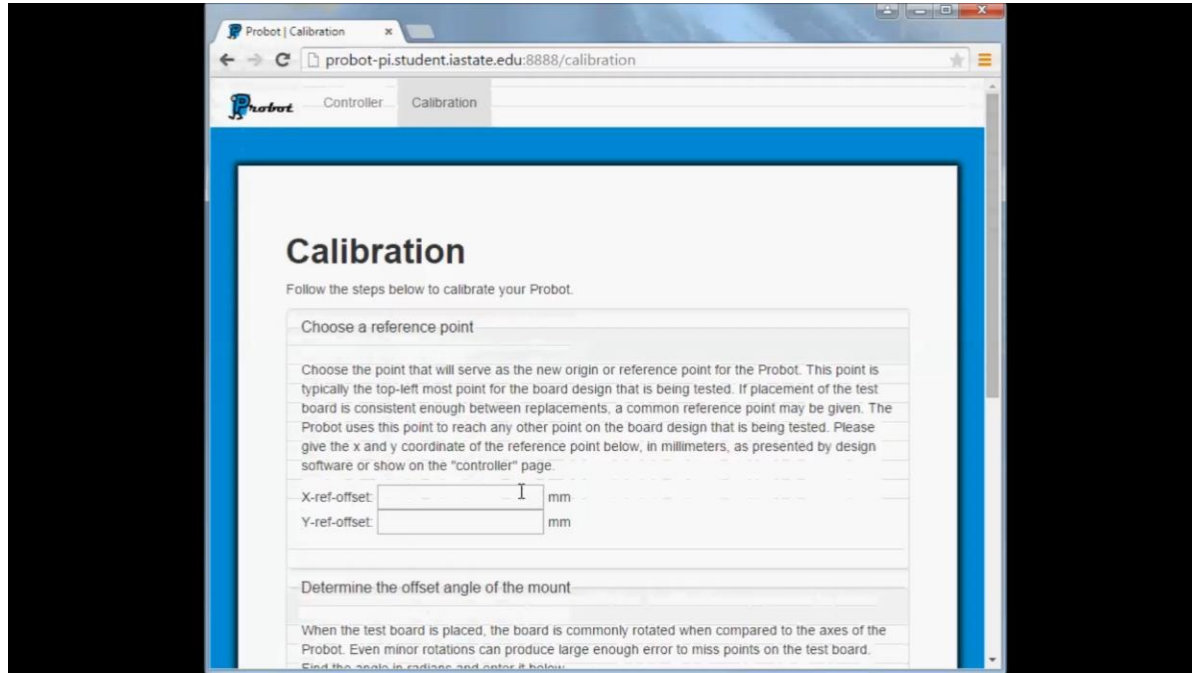
[Click to toggle drill file loader](#)

## Via map

After loading points from a drill file, choose a point below to command the Probot to move there.



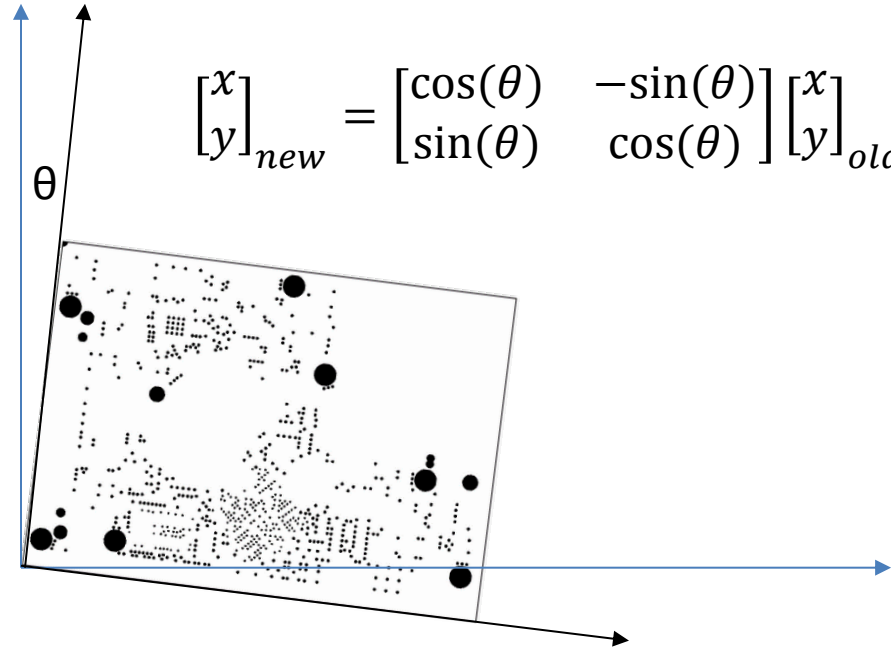
# Video





# TECHNICAL CHALLENGES

Probe/HDD Coordinate System



$$\begin{bmatrix} x \\ y \end{bmatrix}_{new} = \begin{bmatrix} \cos(\theta) & -\sin(\theta) \\ \sin(\theta) & \cos(\theta) \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}_{old}$$

# Calibration: Coordinate Translation

# Z-Axis Motors

~30 hours to debug

Continuity?

Transients?

Signals?

High Load?

Bad Motor?

# File Parsing

## Binary File

- No preparation needed
- Information rich
- Proprietary parser
- Windows only

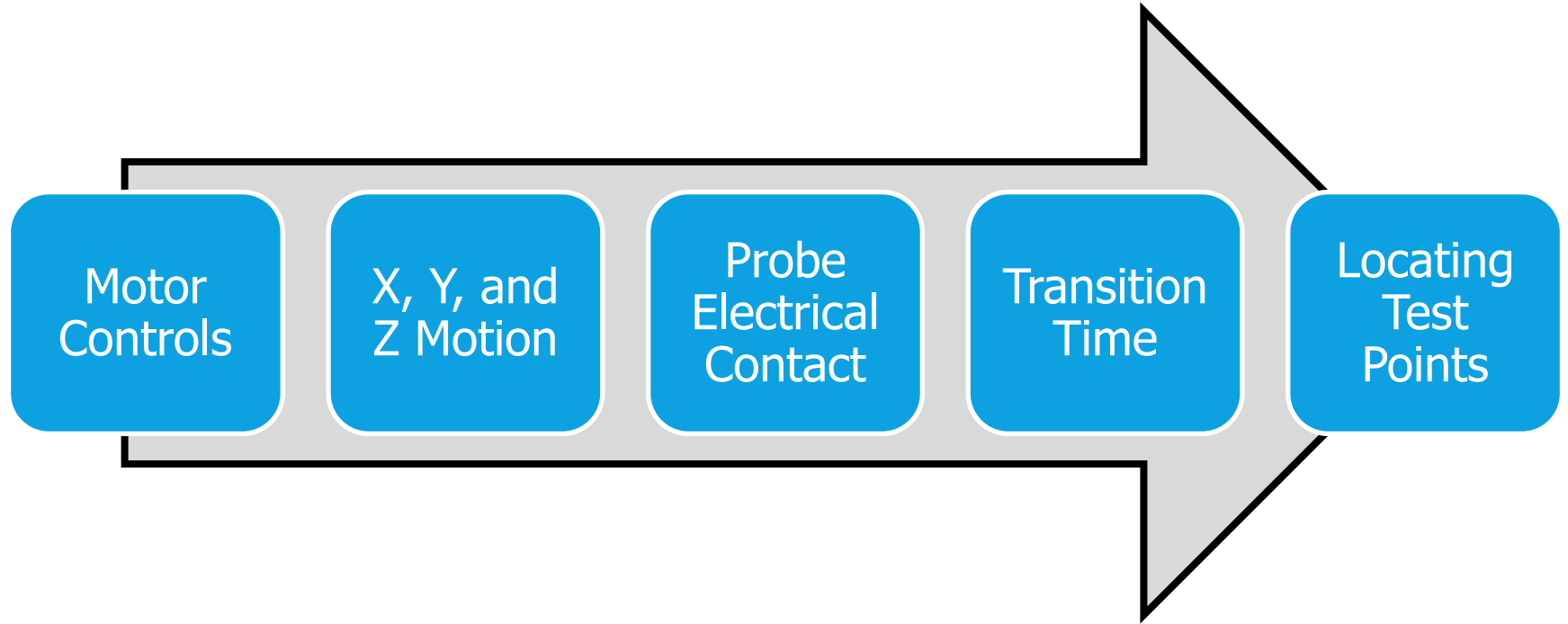


## Plain text

- Preparation needed
- Only contains via coordinates
- Easy to parse
- Platform independent

# PRODUCT VERIFICATION

# Hardware Testing



# Hardware Test

## Plan

- Test 80 randomly generated vias
- 3 Trials

## Results

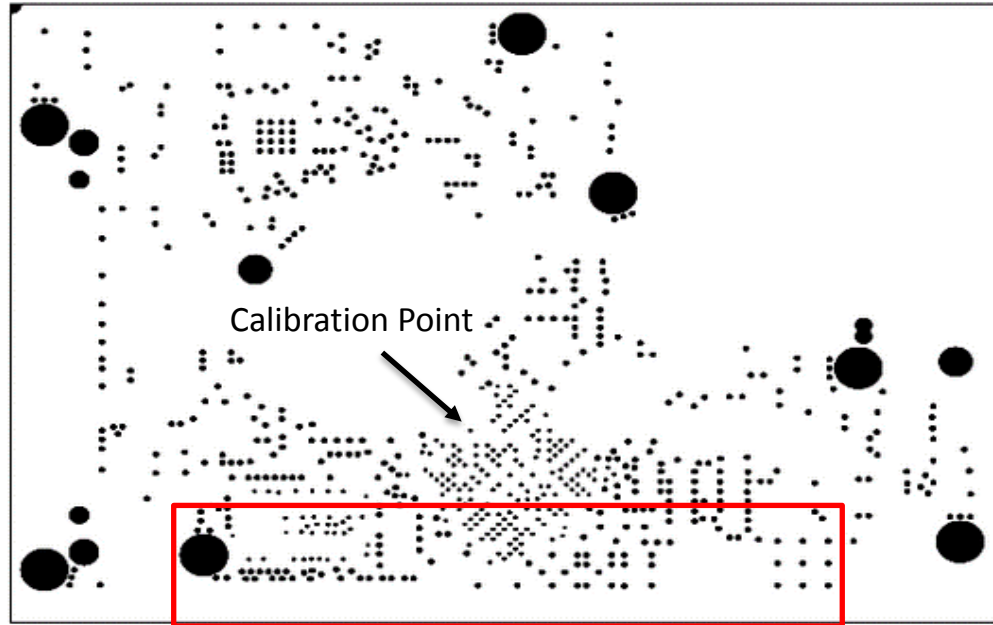
- Time: 21 min 20 seconds (16 seconds between points)
- Accuracy: 69/80 vias made electrical contact (86% accuracy)

# Test Results Analysis

	<b>Goal</b>	<b>Actual</b>
Transition time	60 sec	16 sec
Accuracy	80%	86%

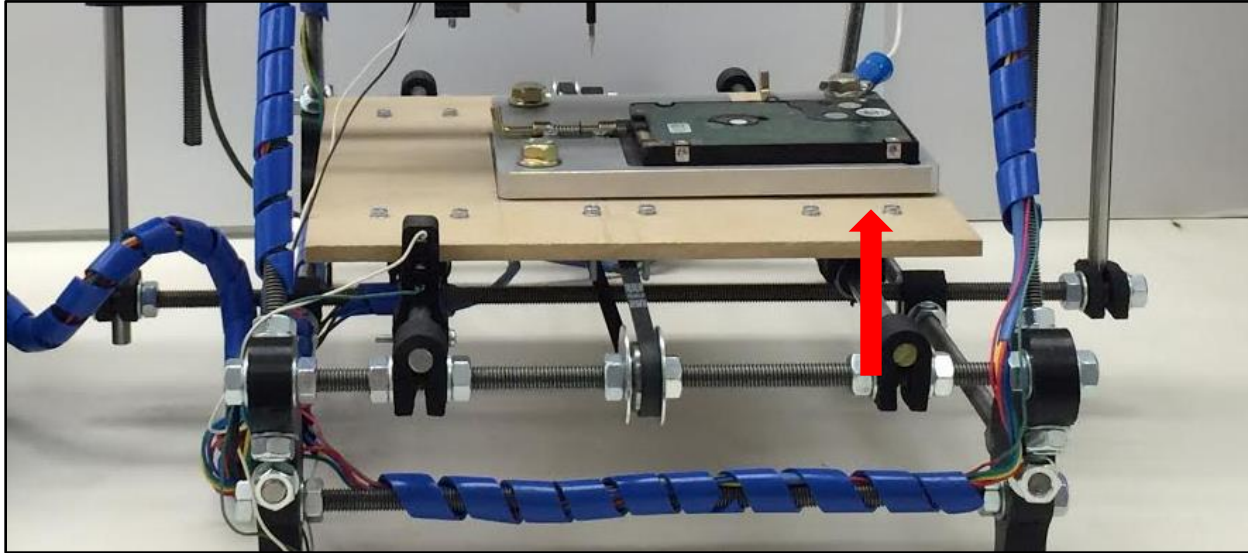


# Missed Points



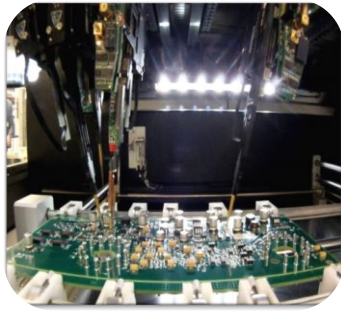
*Note: Missed vias by  $\sim 5\mu\text{m}$*

# Possible Issue

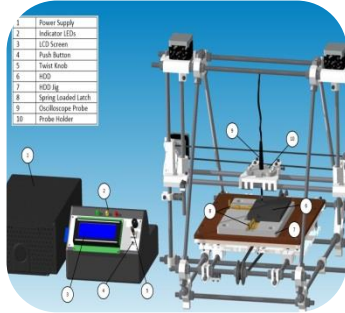


Cost	Description
\$619.37	RepRap Prusa i2 3D Printer Kit
\$50.00	Raspberry Pi B+ w/ 8GB NOOBS microSD card
\$162.14	Enclosure + Switches + Hardware + Connectors
\$32.00	SainSmart LCD Control Panel
\$5.05	Locked Spring Loaded Metal Security Barrel Bolt Latch 5.5cm
\$15.00	Probe Holder (3D Printed) at \$5/in <sup>3</sup>
\$0.00	HDD Jig
~\$883 / \$1500	Total / Budget

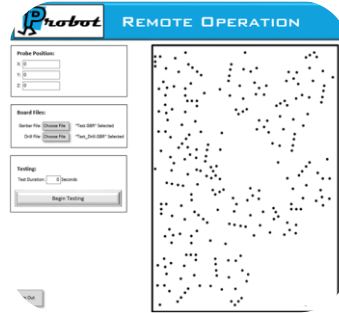
# Summary



Problem  
Remote HDD Testing



Hardware Solution  
Modified 3D Printer



Software Solution  
Web + Python + Printer

Cost	Description
\$619.37	RepRap Prusa i2 3D Printer Kit
\$40.00	Raspberry Pi B+ w/ 8GB NOOBS microSD card
\$5.99	AC to DC 5V 2A international to microUSB
\$32.00	SainSmart LCD Control Panel
\$5.05	Locked Spring Loaded Metal Security Barrel Bolt Latch 5.5cm
~\$60.00	Probe Holder (3D Printed) at \$5/m <sup>3</sup>
\$100.00	HDD Jig

Cost  
~\$883 / \$1500



Delivery  
May 2015

# QUESTIONS?

# Software Testing

## Operational Tests of GUI

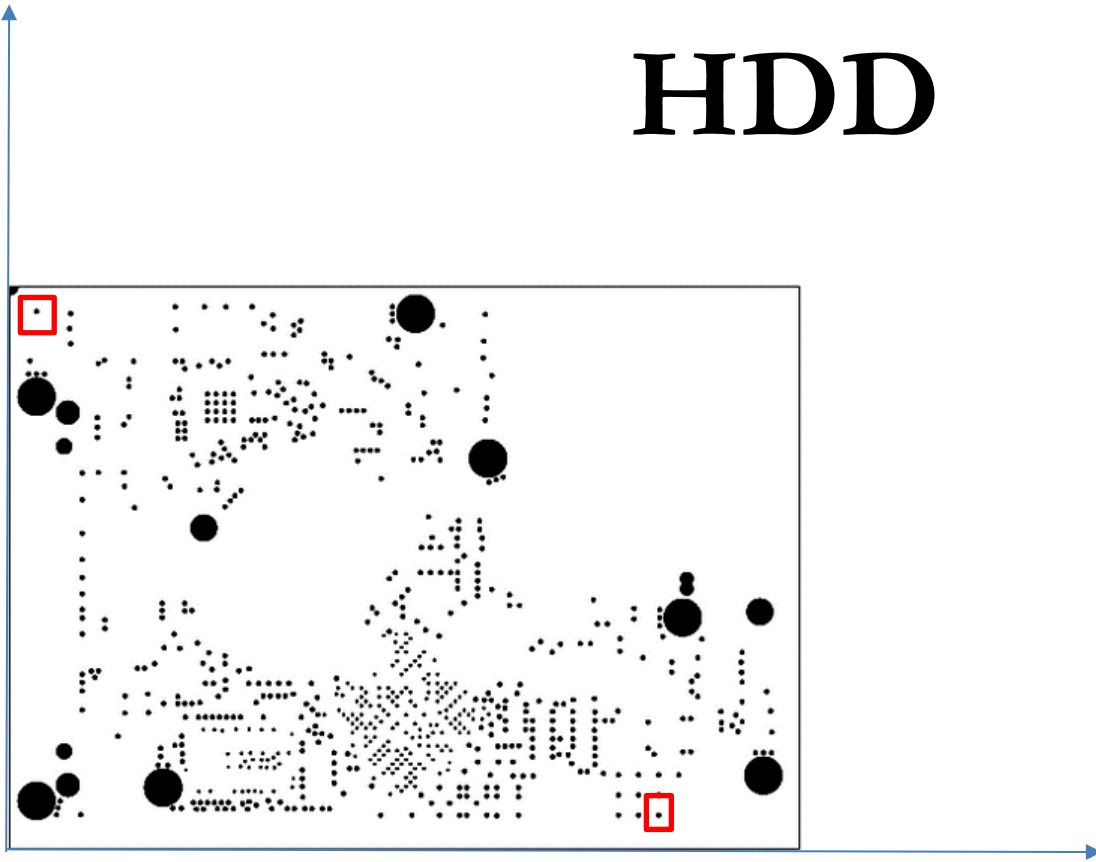
- Navigation to Points
- File Management

## Unit Tests

- Via Selection Module
- File Selector Module
- Embedded Communication Module

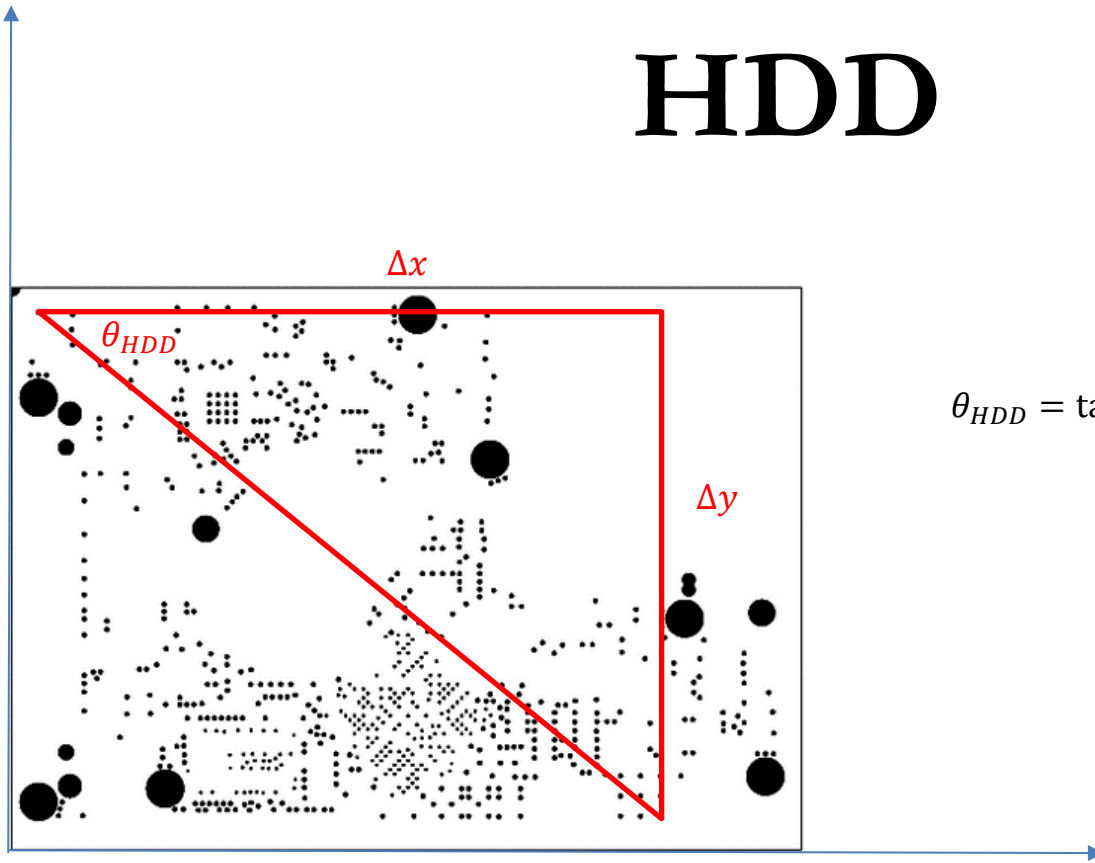
# Calibration Procedure

# HDD





# HDD

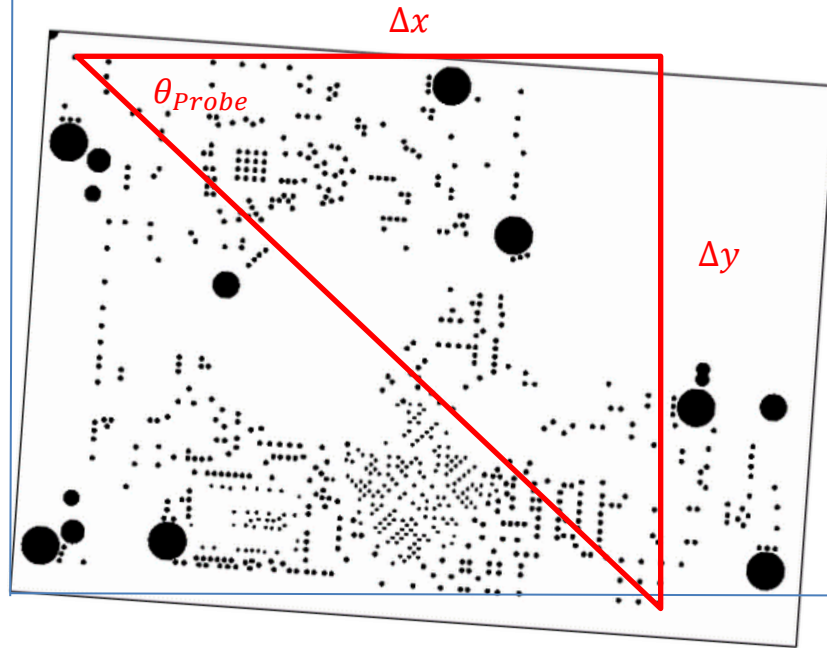


$$\theta_{HDD} = \tan^{-1} \left( \frac{\Delta y}{\Delta x} \right)$$

# Probe



# Probe



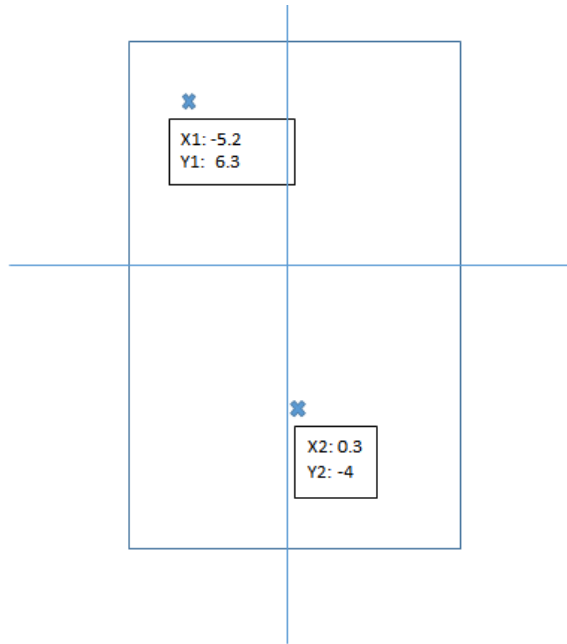
$$\theta_{probe} = \tan^{-1} \left( \frac{\Delta y}{\Delta x} \right)$$

# Rotation Angle

- $\theta_{rotation} = \theta_{HDD} - \theta_{probe}$

- $$\begin{bmatrix} x \\ y \end{bmatrix}_{new} = \begin{bmatrix} \cos(\theta) & -\sin(\theta) \\ \sin(\theta) & \cos(\theta) \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}_{old}$$

# 2-Probe Math



$$x' = x \cos(\theta) - y \sin(\theta) \quad (1)$$

$$y' = x \sin(\theta) + y \cos(\theta) \quad (2)$$

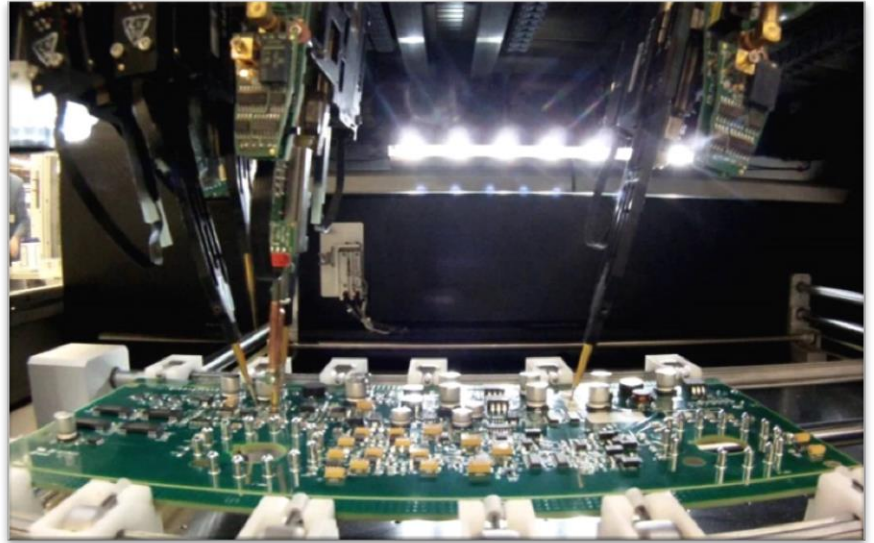
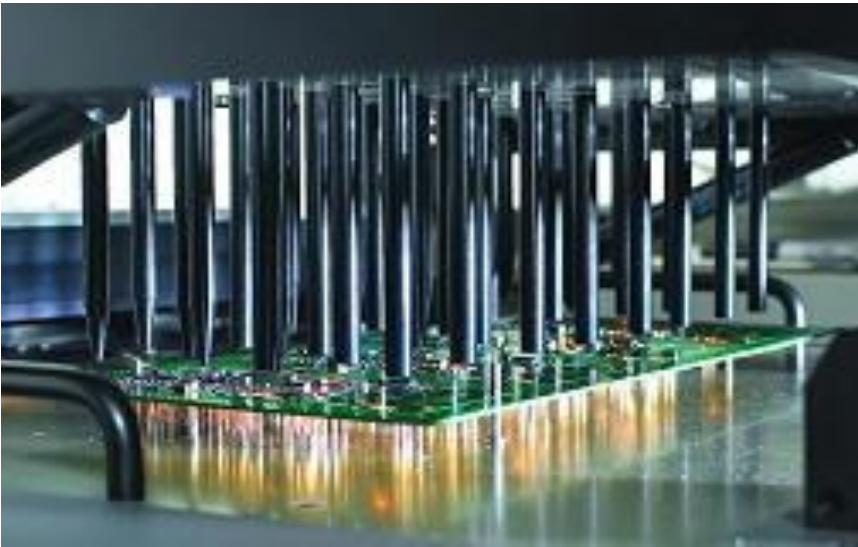
Set  $x_1$  and  $x_2$  equal to each other in equation 1 and solve for theta yields the following relationship

$$\theta = \tan^{-1} \left( \frac{x_2 - x_1}{y_2 - y_1} \right) = \tan^{-1} \left( \frac{0.3 - (-5.2)}{-4 - 6.3} \right) = 5.7927 \text{ rad (only take positive rotation)}$$

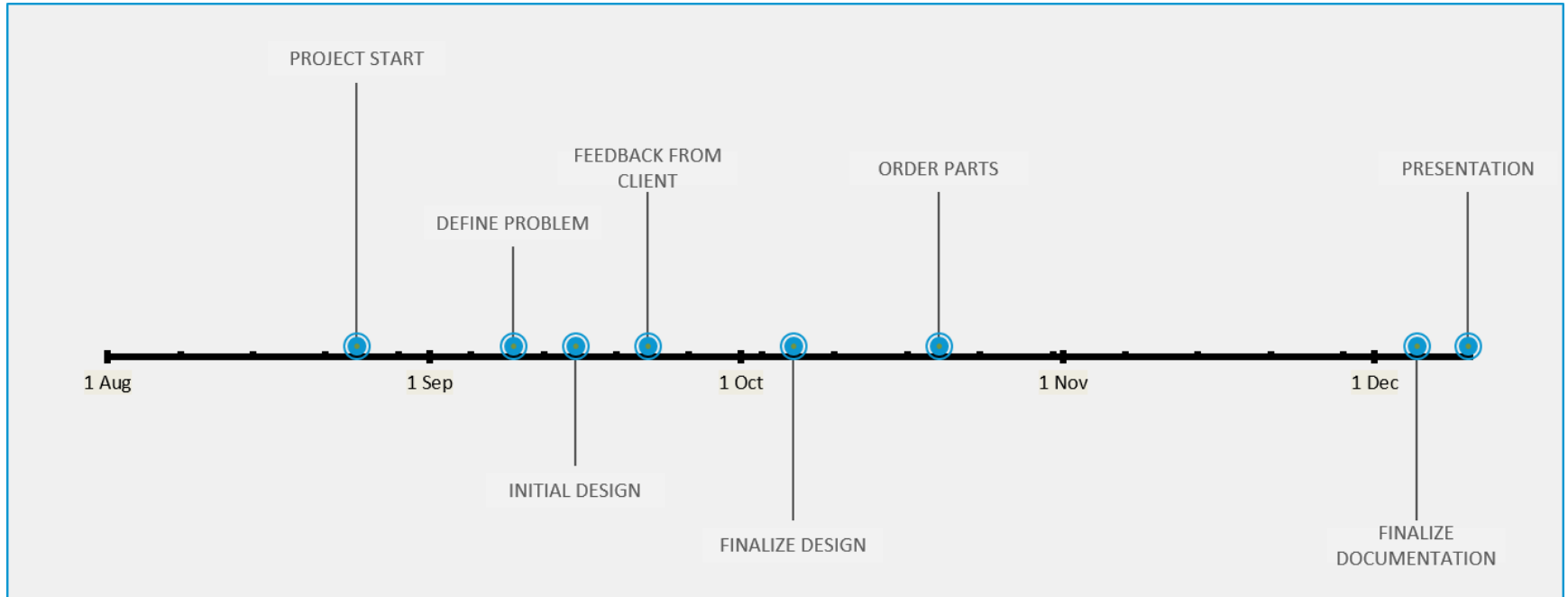
# Market Survey

Bed of Nails

Flying Probe



# Schedule – Fall



# Schedule – Spring

