University of Idaho
College of Engineering

ADVANCED INPUT SYSTEMS

P.R.E.S.S.
Proven, Repeatable, & Effective Scientific Solutions

# BUTTON CYCLER ENHANCEMENTS FOR ADVANCED INPUT SYSTEMS


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# SYSTEM BACKGROUND

## CURRENT SYSTEM CAPABILITES

- Incremental counters detect and display # of switch closures after reset
- System force can be somewhat controlled through input pressure.
- Multiple air cylinders (Bimbas) can test multiple keys on a device.

## CURRENT SYSTEM DRAWBACKS

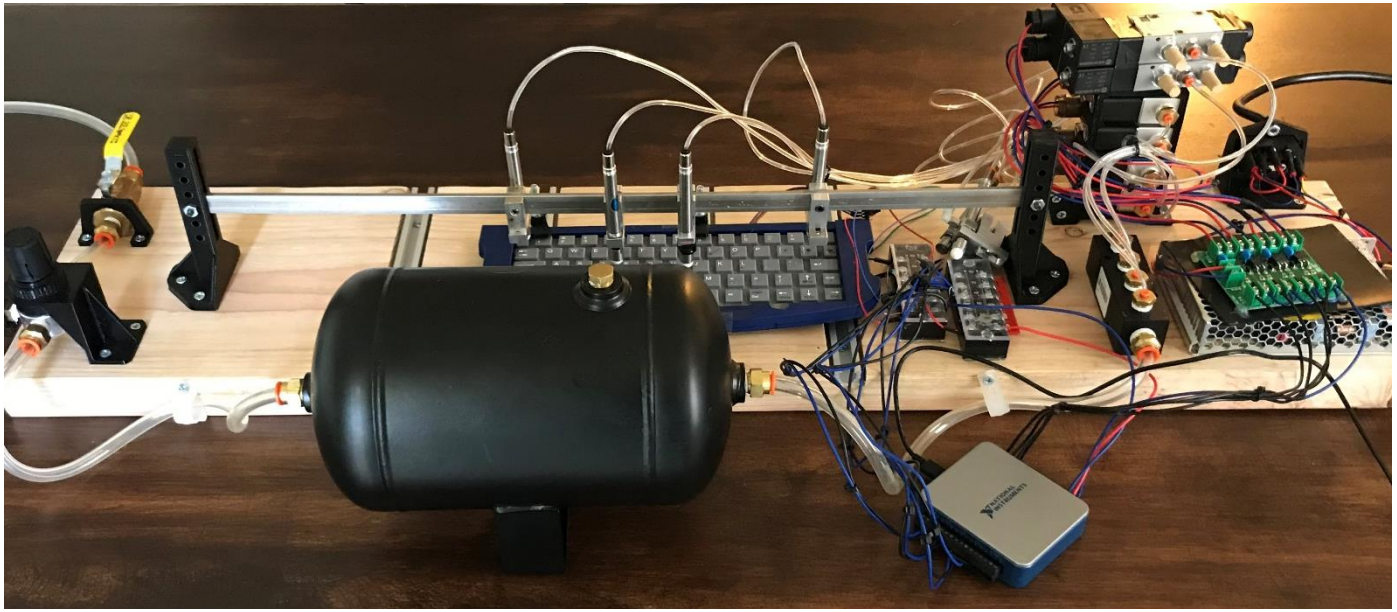
- No way to monitor or accurately adjust force applied by pneumatic Bimbas.
- No way to measure or quantify **switch health**.
- Switch closure count doesn't indicate *when* an error has occurred.

# VALUE PROPOSITION

Exhaustive testing of human machine interfaces (HMI) associated with high technology equipment is needed to assure that the HMI remain fully functional throughout the anticipated usage life.

*The **goal** of our project is to design a next-generation switch testing equipment/software package that can be easily configured to a broad range of keyboard geometries.*

The test will reduce human labor required for data acquisition/visualization and provide information about changes in switch health throughout the entire testing procedure.



# SYSTEM REQUIREMENTS


- Priority scale, structured as tiers (1-4)
  - 1 – LabVIEW program, debounce detection, and datalogging
    - Test 1 to 30 switches simultaneously at a rate from 1Hz to 5Hz – outputs are functional, measurements still need work
    - Allow operator to assign cycle rate, and cycle count prior to test start.
    - Monitor switch health during cycling:
      - Open/Closed resistance waveform
      - Show present values of data logging during test.
      - Switch bounce that lasts >10ms
    - Allow operator to pause/resume/restart tests and save test setups.
    - Format report at test end.

# SYSTEM REQUIREMENTS

Complete

In Progress

Next Steps

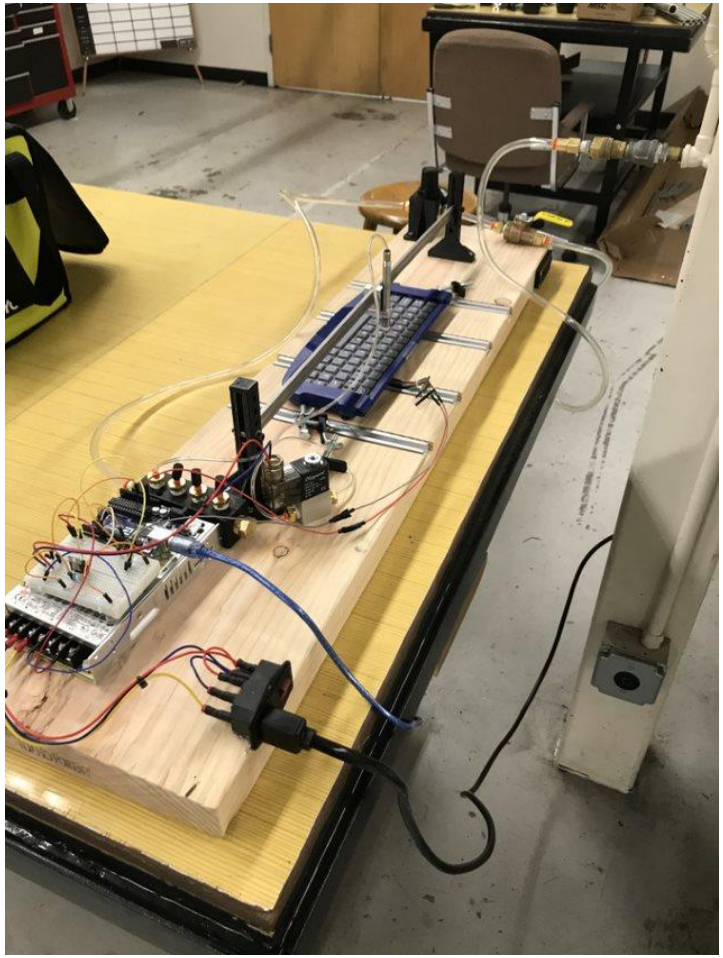
- Priority scale (1-4), structured as tiers (lowest number is highest priority)
  - 2 – Force input and detection
    - Allow operator to assign cycle force prior to test start.
    - Monitor maximum applied button force during cycling
  - ~~3 – Switch characterization~~
    - ~~Characterize switch's F/D/R behavior at pre-programmed test intervals~~
    - ~~Output hysteresis curve of results~~
  - ~~4 – Additional hardware redesign~~
    - ~~Modernize hardware setup for button cycler system with new test apparatus~~

# DEVELOPMENT PROCESS

**Snapshot 1** – Arduino Test Apparatus
https://vandalsuidaho-my.sharepoint.com/:v:/r/personal/over5500_vandals_uidaho_edu/Documents/PRESS/Media/Arduino%20Test%20Bench.MOV?csf=1&web=1&e=2n9FII

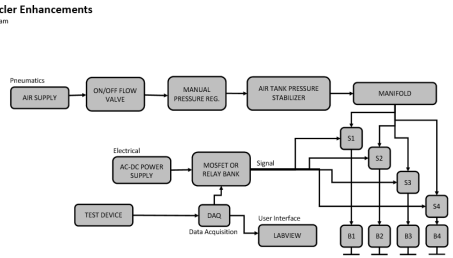
**Snapshot 2** – Single Cylinder LabVIEW Apparatus
https://vandalsuidaho-my.sharepoint.com/:v:/r/personal/over5500_vandals_uidaho_edu/Documents/PRESS/Media/LabVIEW%20V0-03.MOV?csf=1&web=1&e=EUJZLp

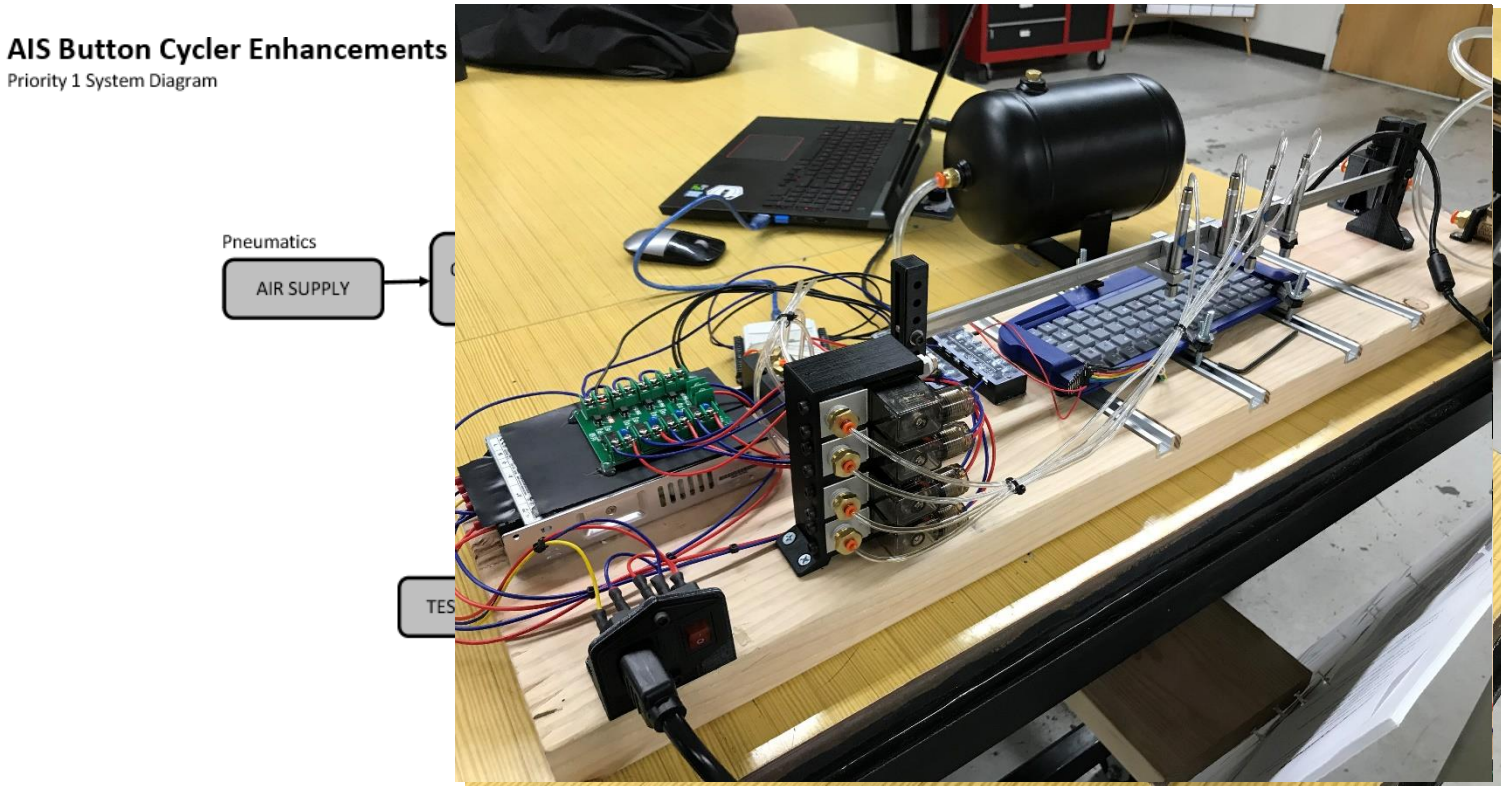
**Snapshot 3** – Multiple Cylinder LabVIEW Apparatus
https://vandalsuidaho-my.sharepoint.com/:v:/r/personal/over5500_vandals_uidaho_edu/Documents/PRESS/Media/LabVIEW%20V0-10.MOV?csf=1&web=1&e=Y83RAW



Snapshot 1 Apparatus

# FINAL DESIGN: SYSTEM HARDW/




**Key:**
Solenoid – S
Bimba – B

# FINAL DESIGN: SYSTEM SOFTWARE

- Program structure (overview) – state machine
  - Idle
    - User can graphically assign test parameters
    - Natural state of the program when nothing is happening
  - Calibrating
    - Data on the system is obtained that is needed prior to the test
  - Testing
    - Information on switch health is recorded and displayed to the user
  - Logging
    - A brief system pause is allowed to log data to the device
  - Paused
    - So the operator can make adjustments to hardware if needed during the test
  - Complete
    - The test reached its specified number of cycles and is now finished
    - Analysis can be executed

# AIS Button Cycler V0-10

CLOSE VI

Program State

Idle

Completion (%)

0

## 1) Select test settings

### Configuration

Test Config CSV File Path

C:\Users\aoverby\Desktop\AIS Capstone\AIS Button Cycler U of I Test Config.csv

### Analyzation

Data Logging Folder Path

Data Logging File Name (no extension needed)

### Test Parameters

| | |
|---|---|
| Test Duration (Cycles) | 100 |
| Cycle Rate (Hz) | 5 |
| Failure Criteria (%) | 2 |
| Data Logging Period (Cycles) | 10 |
| Closed Resistance Threshold (Ohms) | 40 |
| Closure Debounce Threshold (ms) | 10 |
| Open Resistance Threshold (Ohms) | 1000 |
| Release Debounce Threshold (ms) | 10 |

CLEAR ALL

RECALL

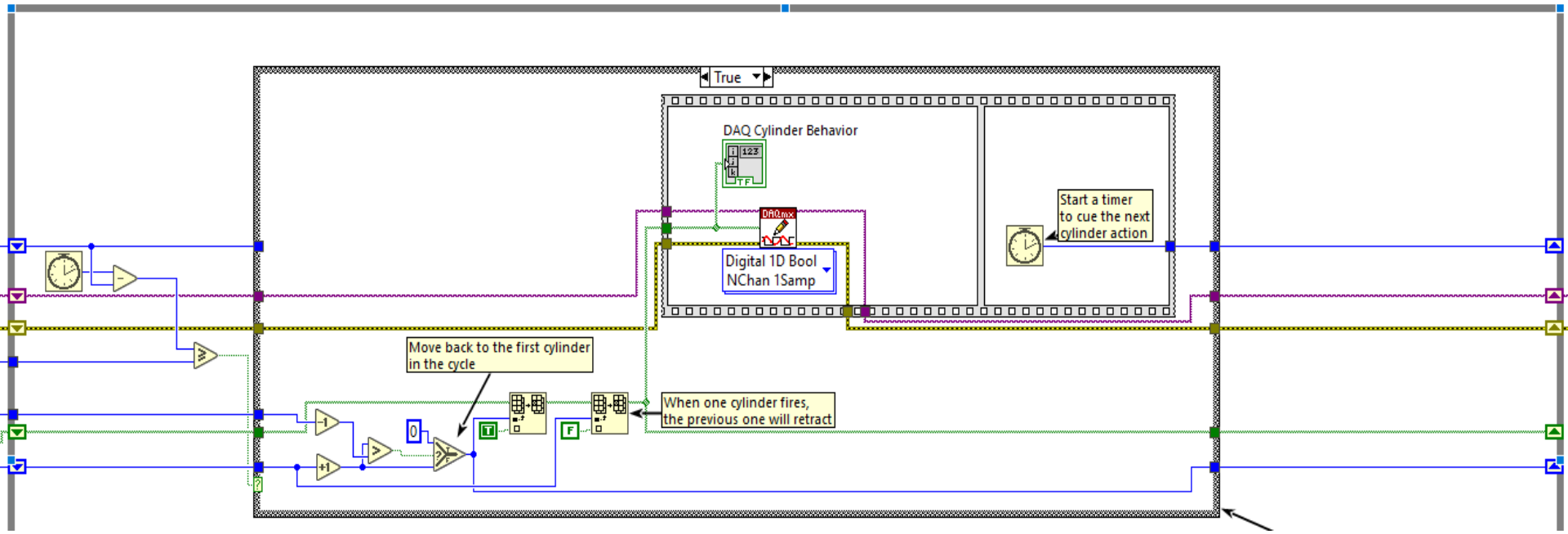
## 2) Choose cylinders/buttons to test

CLEAR ALL

| Cylinder ID | Switch ID | Cylinder Output Channel | Total Failures | Avg. Closed Resistance (Ohms) | Avg. Closure Debounce (ms) | Avg. Open Resistance (Ohms) | Avg. Release Debounce (ms) |
|---|---|---|---|---|---|---|---|
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |
| 6 | | | | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |

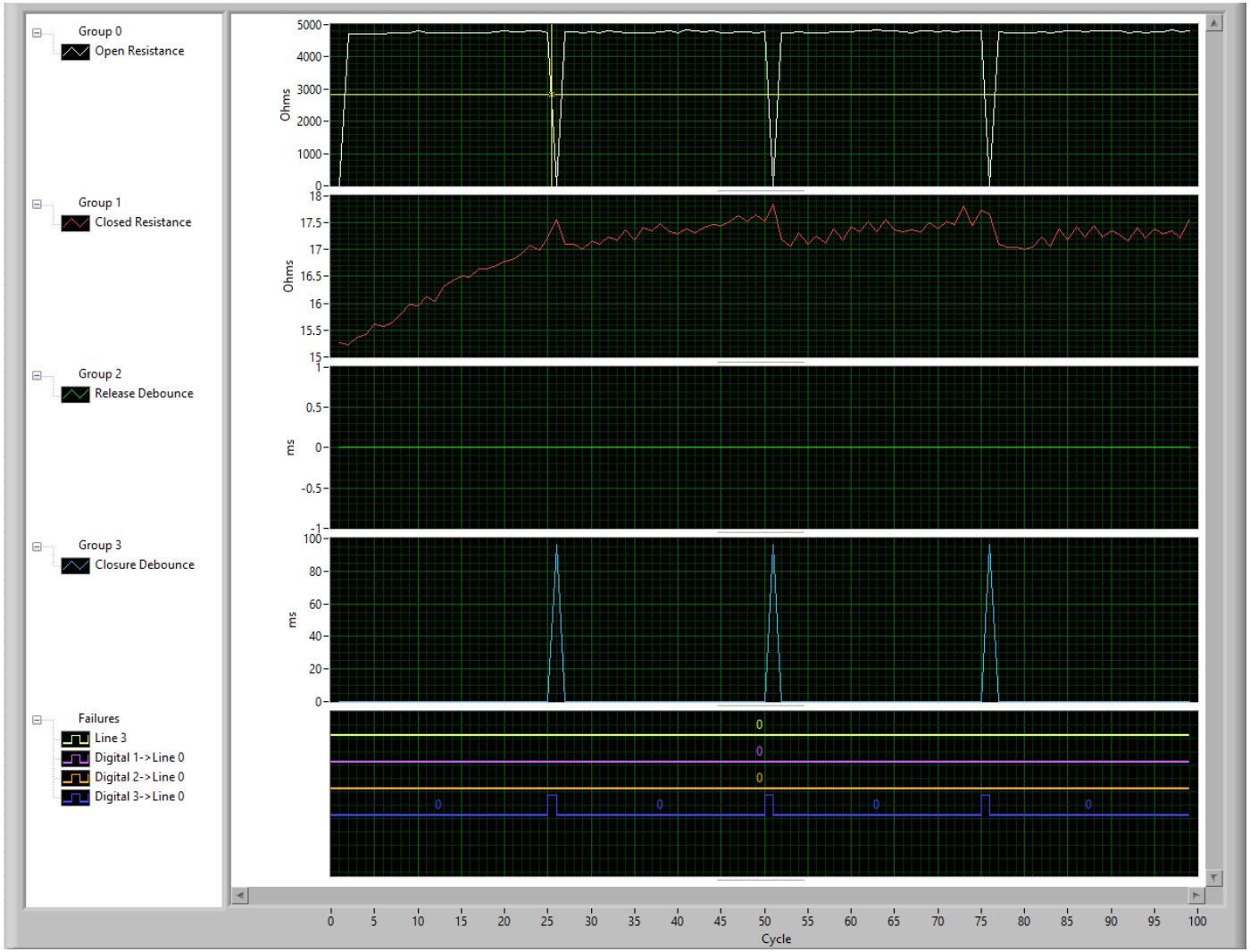
# SYSTEM SOFTWARE – MULTIPLE CYLINDERS

- State control through a Boolean array
- Indexer to keep track of what cylinder will fire
- Timer to tell the cylinder when it needs to extend or retract

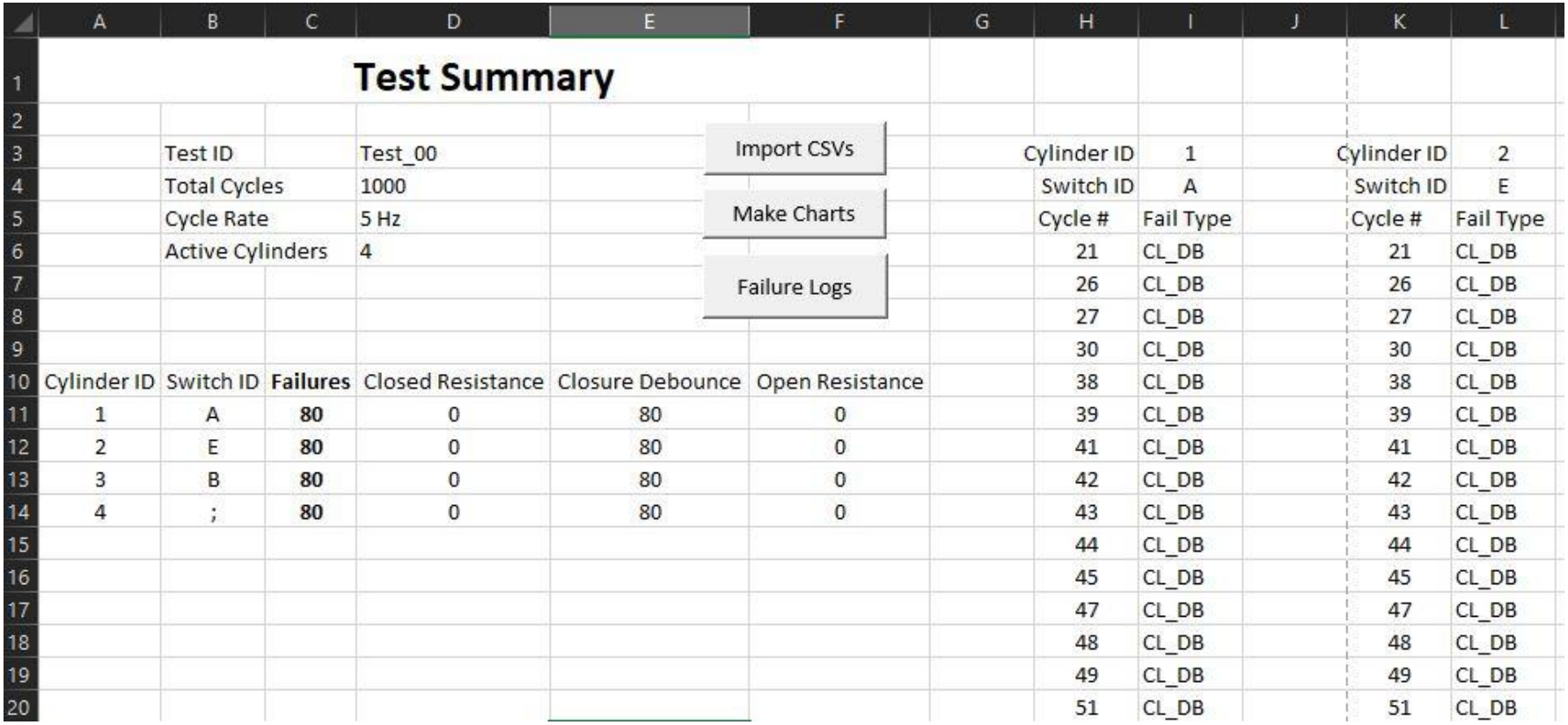


# TEST ANALYSIS

- Capabilities
  - Provide a general oversight of the data captured by the LabVIEW Program
  - Provide an easy to analyze Data Presentation Format



# TEST ANALYSIS - SUMMARY PAGE



## Test Summary

| | |
|---|---|
| Test ID | Test_00 |
| Total Cycles | 1000 |
| Cycle Rate | 5 Hz |
| Active Cylinders | 4 |

Import CSVs

Make Charts

Failure Logs

| Cylinder ID | Switch ID | Failures | Closed Resistance | Closure Debounce | Open Resistance |
|---|---|---|---|---|---|
| 1 | A | 80 | 0 | 80 | 0 |
| 2 | E | 80 | 0 | 80 | 0 |
| 3 | B | 80 | 0 | 80 | 0 |
| 4 | ; | 80 | 0 | 80 | 0 |

| Cylinder ID | 1 |
|---|---|
| Switch ID | A |
| Cycle # | Fail Type |
| 21 | CL_DB |
| 26 | CL_DB |
| 27 | CL_DB |
| 30 | CL_DB |
| 38 | CL_DB |
| 39 | CL_DB |
| 41 | CL_DB |
| 42 | CL_DB |
| 43 | CL_DB |
| 44 | CL_DB |
| 45 | CL_DB |
| 47 | CL_DB |
| 48 | CL_DB |
| 49 | CL_DB |
| 51 | CL_DB |

| Cylinder ID | 2 |
|---|---|
| Switch ID | E |
| Cycle # | Fail Type |
| 21 | CL_DB |
| 26 | CL_DB |
| 27 | CL_DB |
| 30 | CL_DB |
| 38 | CL_DB |
| 39 | CL_DB |
| 41 | CL_DB |
| 42 | CL_DB |
| 43 | CL_DB |
| 44 | CL_DB |
| 45 | CL_DB |
| 47 | CL_DB |
| 48 | CL_DB |
| 49 | CL_DB |
| 51 | CL_DB |

# LESSONS LEARNED

## ARRAY INDICES

Handling the immense amount of data is difficult, and we ran in to problems with our auto-indexing algorithm that still need to be debugged

## DATA CLUSTERS

A great way to handle data – we would have started here if we knew about them during the start of the project

## MULTIPLE BIMBA SYSTEM

Projects don’t always scale as easily as expected.

## DATA EXPORTING AND ANALYSIS

Understand what is needed as a basis early on.

# NEXT STEPS

- **Priority scale (1-4), structured as tiers (lowest number is highest priority)**
  - 1 – Achieve proper measurement inputs and datalogging capabilities for a multiple switch system
  - 2 – Force input and detection
    - Allow operator to assign cycle force prior to test start.
    - Monitor maximum applied button force during cycling
  - 3 – Switch characterization
    - Characterize switch's F/D/R behavior at pre-programmed test intervals
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# QUESTIONS?

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**Chris** is seeking a position in software development or data processing to gain experience for running his own business.

**Andrew** is working in the 3D printing & composites industry specifically geared towards automated manufacturing processes for aerospace

**Cody** is working in the infrastructure division utilizing his background in construction and engineering.