University of Idaho
College of Engineering

ADVANCED INPUT SYSTEMS

BUTTON CYCLER ENHANCEMENTS FOR ADVANCED INPUT SYSTEMS

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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 keyboard 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.

PROBLEM STATEMENT

Develop enhancements to a button cycler for use in qualification testing of electro-mechanical switches designed into Advanced Input Systems' products.

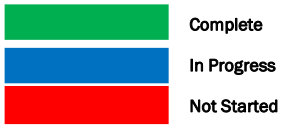
CURRENT SYSTEM CAPABILITES

- 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

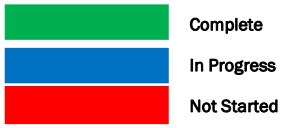
- No way to monitor or adjust force applied by pneumatic Bimbas.
- No way to measure or quantify **switch health**.
- Switch closure count doesn't indicate *when* an error has occurred.

SYSTEM REQUIREMENTS



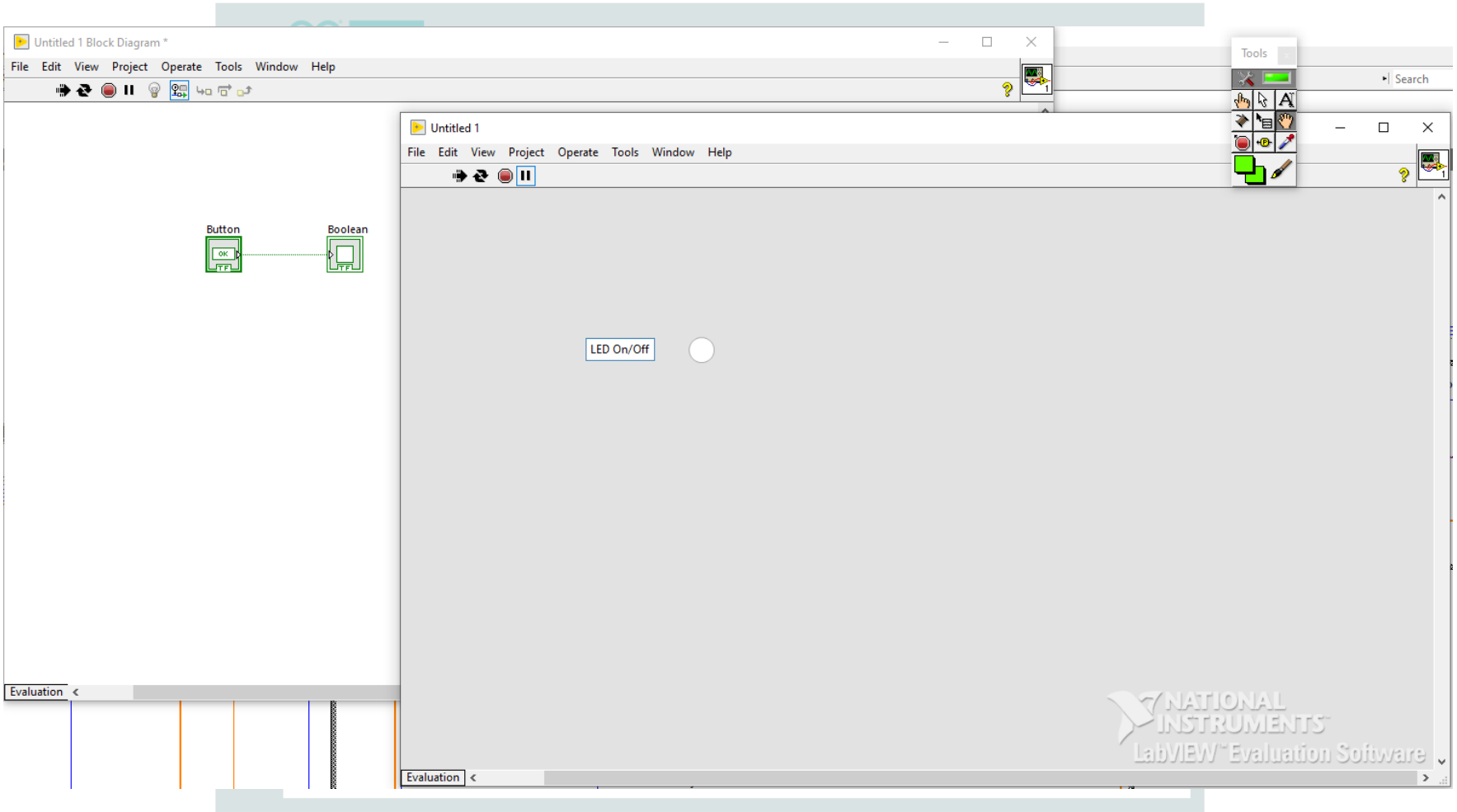
- Priority scale, structured as tiers (1-4)
  - 1 – LabVIEW program, debounce detection, and datalogging
    - Test 1 to 30 switches simultaneously at a rate from 1Hz to 5Hz,
    - Allow operator to assign cycle rate, and cycle count prior to test start.
    - Monitor switch health during cycling:
      - 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 Excel report at test end.

TENTATIVE SYSTEM REQUIREMENTS



- 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~~

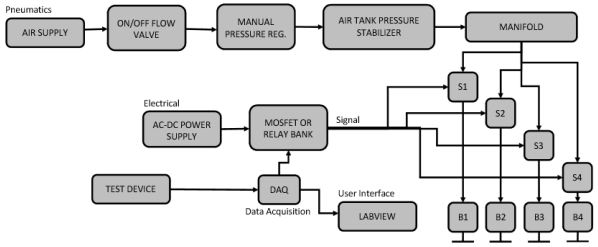
WHAT IS LABVIEW?

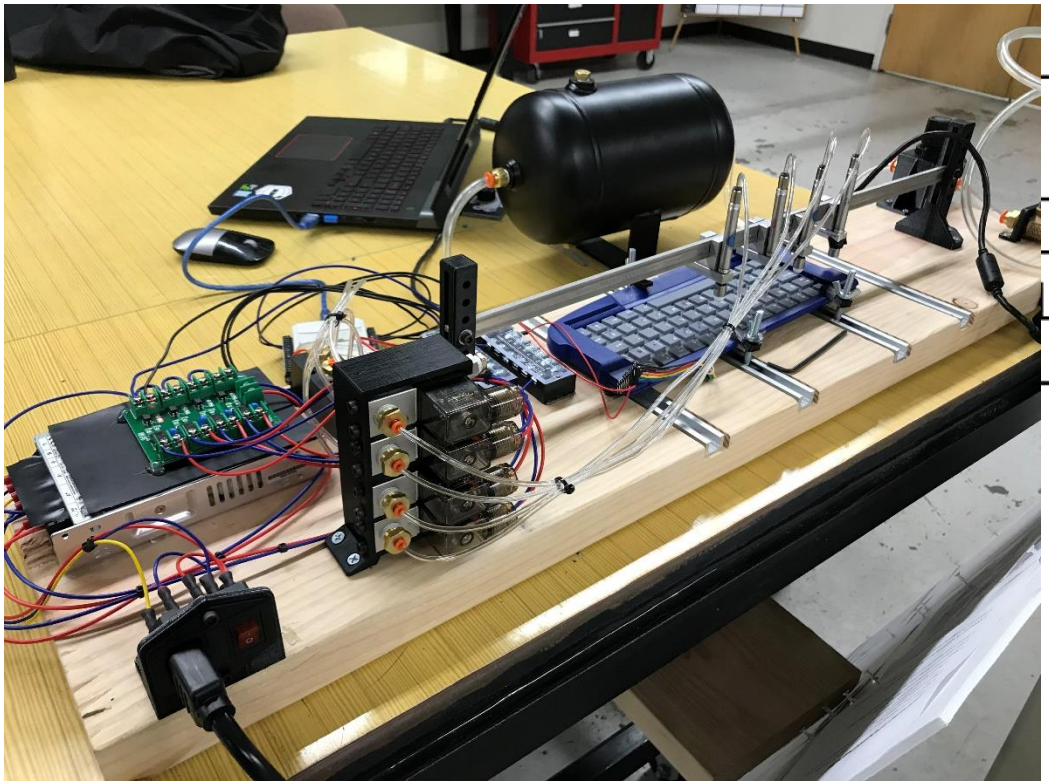


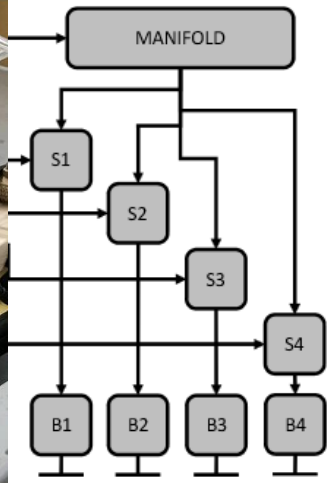
SYSTEM HARDWARE

AIS Button Cycler Enhancements

Priority 1 System Diagram







Key:
Solenoid – S
Bimba – B

Key:
Solenoid – S
Bimba – B

SYSTEM SOFTWARE - FUNCTIONALITY

- 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~~

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

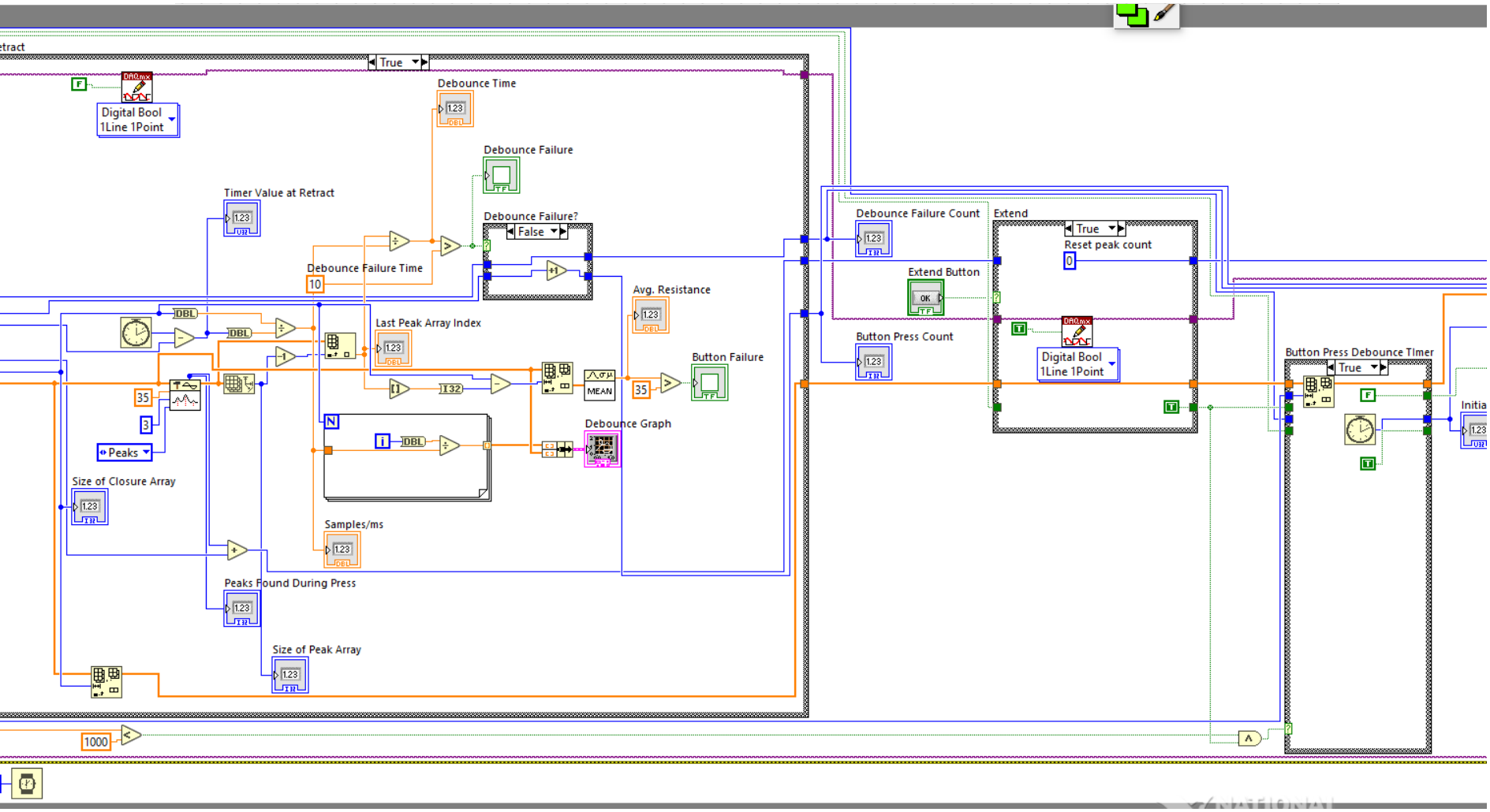
RECALL

2) Choose cylinders/buttons to test

CLEAR ALL

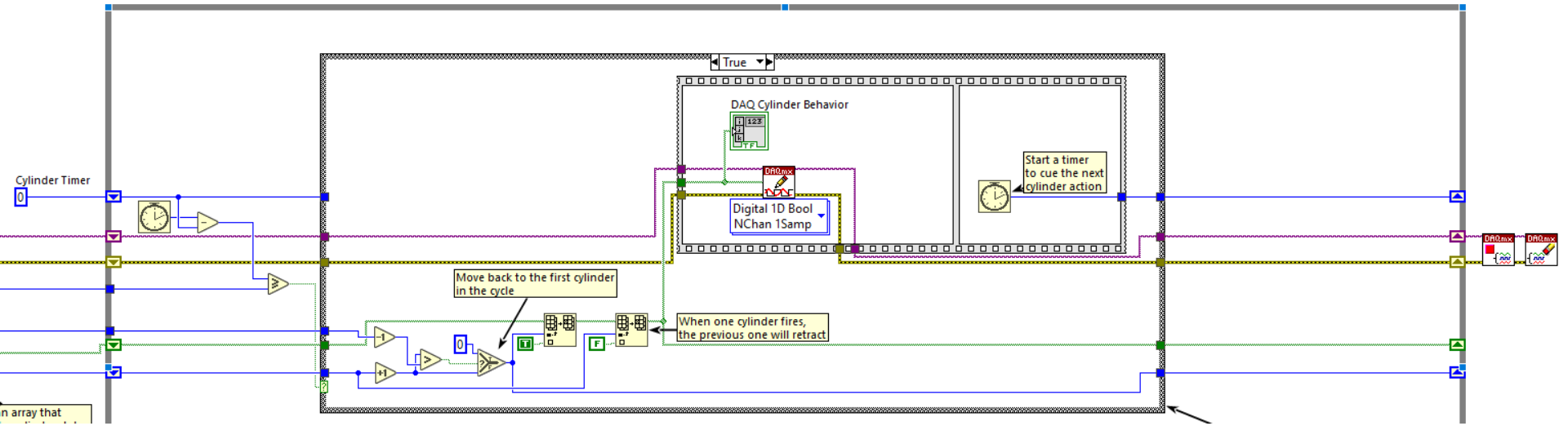
Cylinder ID	Switch ID	Cylinder Output Channel	Total Failures	Avg. Closed Resistance (Ohms)	Avg. Closure Debounce (ms)	Avg. Open Resistance (Ohms)	Avg. Release Debounce (ms)
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

SYSTEM SOFTWARE – DEBOUNCE DETECTION

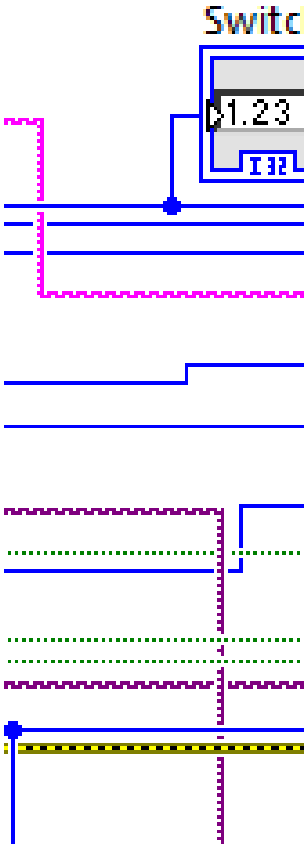


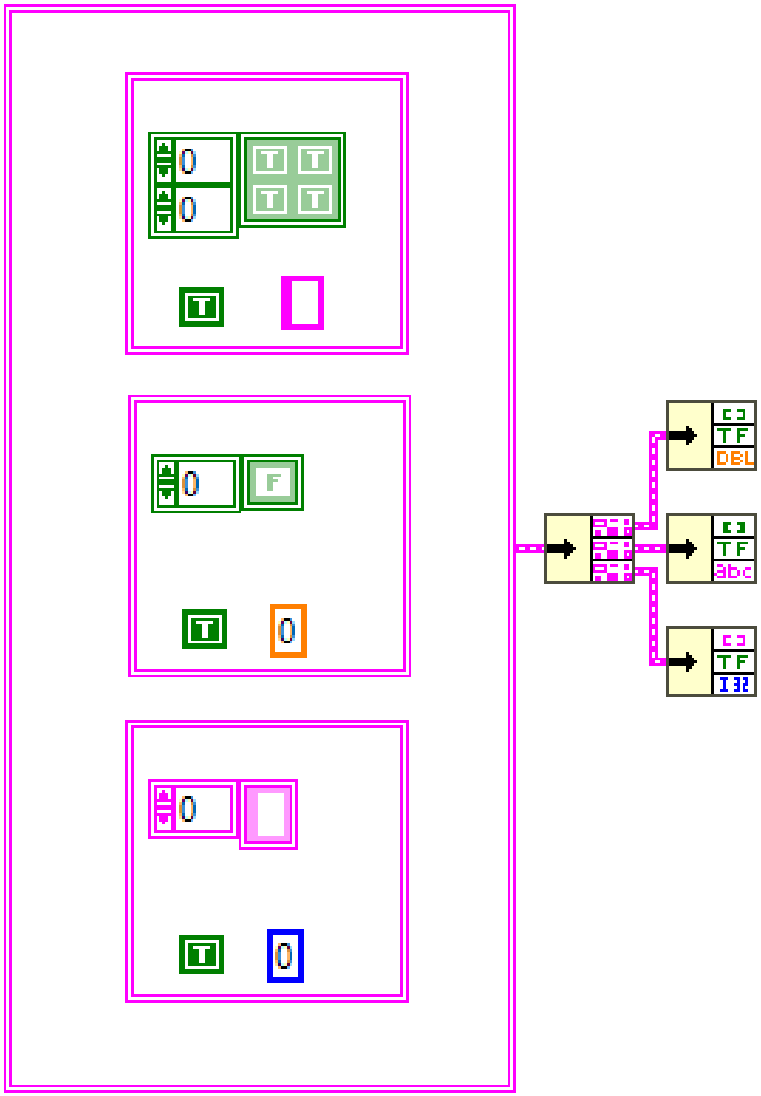
SYSTEM SOFTWARE – MULTIPLE CYLINDERS

- 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



SYSTEM





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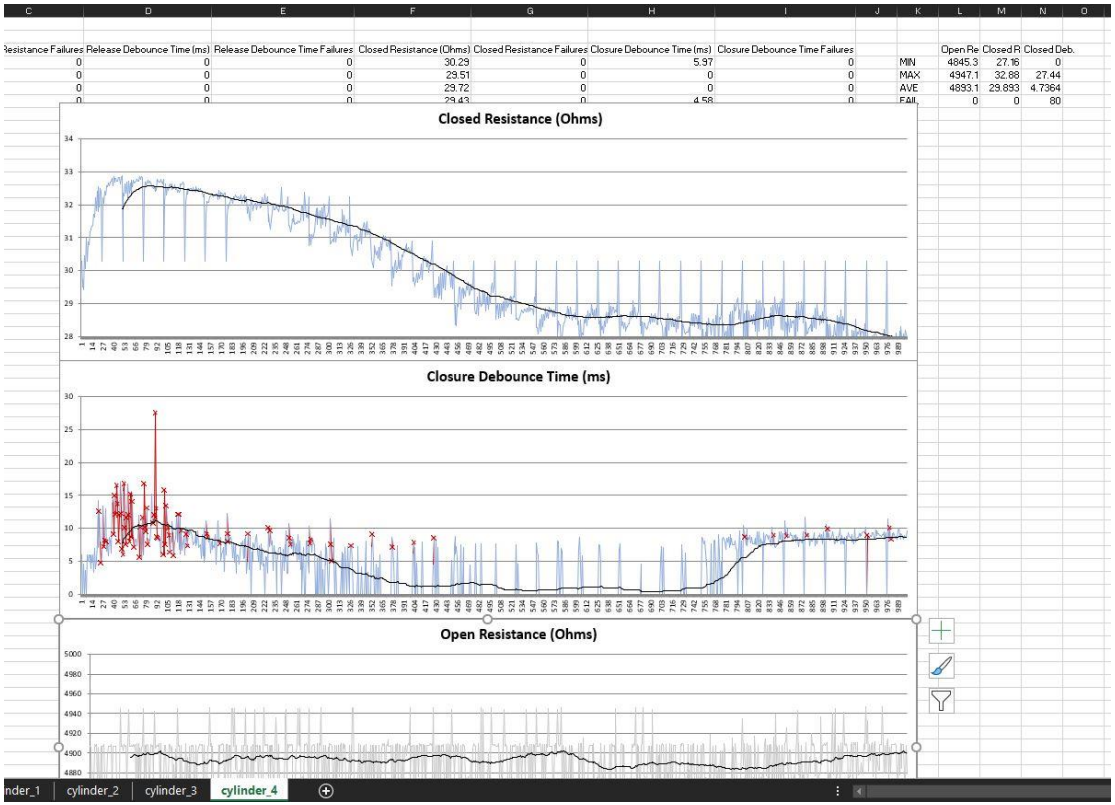
TEST ANALYZATION

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



TEST ANALYZATION-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	Cylinder ID	2	Cylinder ID	3	Cylinder ID	4
Switch ID	A	Switch ID	E	Switch ID	B	Switch ID	;
Cycle #	Fail Type	Cycle #	Fail Type	Cycle #	Fail Type	Cycle #	Fail Type
21	CL_DB	21	CL_DB	21	CL_DB	21	CL_DB
26	CL_DB	26	CL_DB	26	CL_DB	26	CL_DB
27	CL_DB	27	CL_DB	27	CL_DB	27	CL_DB
30	CL_DB	30	CL_DB	30	CL_DB	30	CL_DB
38	CL_DB	38	CL_DB	38	CL_DB	38	CL_DB
39	CL_DB	39	CL_DB	39	CL_DB	39	CL_DB
41	CL_DB	41	CL_DB	41	CL_DB	41	CL_DB
42	CL_DB	42	CL_DB	42	CL_DB	42	CL_DB
43	CL_DB	43	CL_DB	43	CL_DB	43	CL_DB
44	CL_DB	44	CL_DB	44	CL_DB	44	CL_DB
45	CL_DB	45	CL_DB	45	CL_DB	45	CL_DB
47	CL_DB	47	CL_DB	47	CL_DB	47	CL_DB
48	CL_DB	48	CL_DB	48	CL_DB	48	CL_DB
49	CL_DB	49	CL_DB	49	CL_DB	49	CL_DB
51	CL_DB	51	CL_DB	51	CL_DB	51	CL_DB
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53	CL_DB	53	CL_DB	53	CL_DB	53	CL_DB
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56	CL_DB	56	CL_DB	56	CL_DB	56	CL_DB
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58	CL_DB	58	CL_DB	58	CL_DB	58	CL_DB
60	CL_DB	60	CL_DB	60	CL_DB	60	CL_DB
61	CL_DB	61	CL_DB	61	CL_DB	61	CL_DB
63	CL_DB	63	CL_DB	63	CL_DB	63	CL_DB
70	CL_DB	70	CL_DB	70	CL_DB	70	CL_DB
71	CL_DB	71	CL_DB	71	CL_DB	71	CL_DB
73	CL_DB	73	CL_DB	73	CL_DB	73	CL_DB
75	CL_DB	75	CL_DB	75	CL_DB	75	CL_DB
76	CL_DB	76	CL_DB	76	CL_DB	76	CL_DB

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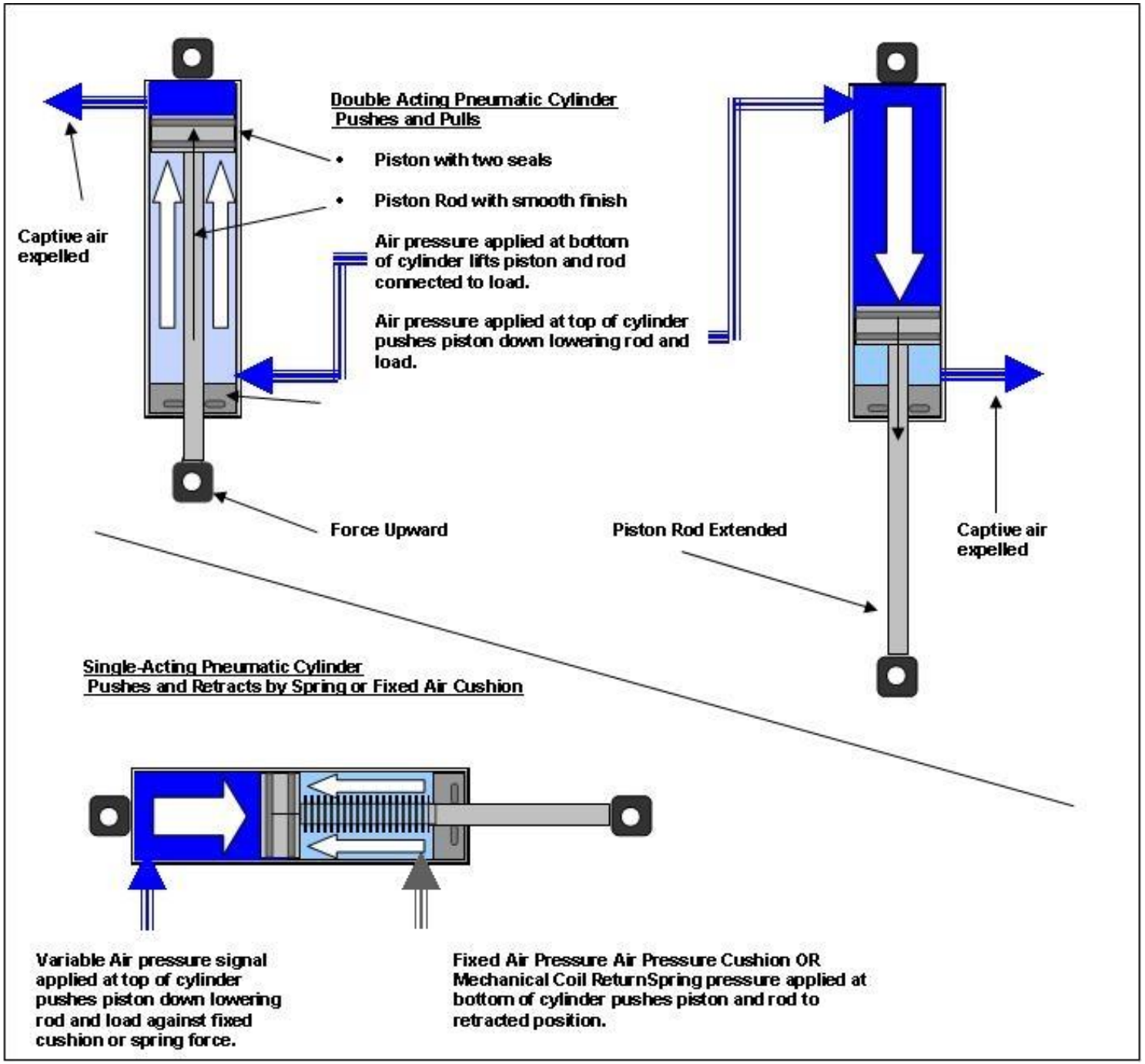

Double Acting Pneumatic Cylinder
Pushes and Pulls
Piston with two seals
Piston Rod with smooth finish
Air pressure applied at bottom of cylinder lifts piston and rod connected to load.
Air pressure applied at top of cylinder pushes piston down lowering rod and load.
Captive air expelled
Force Upward
Piston Rod Extended
Captive air expelled
Single-Acting Pneumatic Cylinder
Pushes and Retracts by Spring or Fixed Air Cushion
Variable Air pressure signal applied at top of cylinder pushes piston down lowering rod and load against fixed cushion or spring force.
Fixed Air Pressure Air Pressure Cushion OR Mechanical Coil ReturnSpring pressure applied at bottom of cylinder pushes piston and rod to retracted position.

BUDGET OVERVIEW

Expense Items	Year								Item Total
	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	
Equipment/Tools:									
									$ -
Travel:									
Travel to Cour d'a Alene	$ 100		$ 100					$ 100	$ 300
									$ -
Supplies / Parts / Services:									
McMaster-Carr		$ 205							$ 205
Moscow Building supply		$ 17							$ 17
Amazon		$ 70							$ 70
McMaster-Carr			$ 170						$ 170
Amazon			$ 104						$ 104
National Instruments				$ 387					$ 387
									$ -
									$ -
									$ -
Shop Usage (est. Hrs):									Hours
		15							15
									0
									0
									0
									0
									0

Graduate Student Support	$ 1,000
Shop Overhead	$ 400
University Overhead	$ 133
Totals	**$ 2,785**

DESIGN VALIDATION PLAN

Senior Capstone Design

Project: AIS Button Cycler Enhancements **Primary Author:** Chris Crozier

Team: P.R.E.S.S. **Date:** 12/2/2019

Design Validation Plan & Results (DVP&R)

Requirement	Test	Test Subject	Target Date	Result	Recommendation
Force set and calibrated prior to test start	Use load cell to measure accuracy of Bimba force at variable input settings as well as degree of error over many cycles	Individual Bimbas and full system			
System must function off existing pneumatic supply (100 psi)	Full battery short test	Full system, regulator tanks	10/22/19	Confirmed	
Characterize switch F/D/R at preset intervals	TBD				
Monitor switch resistance	Produce waveform of switch resistance over time	LabView VI	10/23/2019	Confirmed	
Flag switch bounces > 10 ms	Manual test	LabView VI	12/4/2019	Partially complete	

SCHEDULE

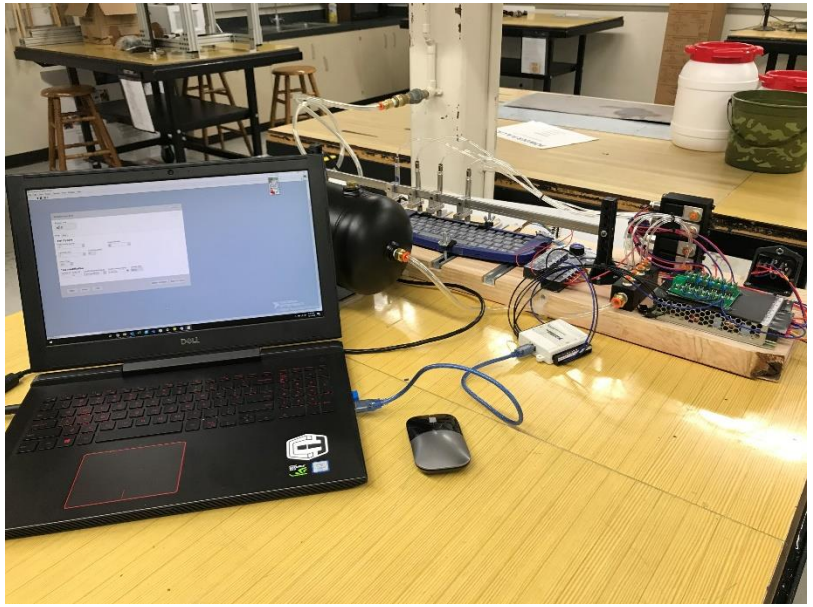
Capstone Project Schedule - Fall 2019-Spring 2020

Project:
Last Updated:

		Year	2019										
		Month	Dec	Jan				Feb					
Task Description	Duration	Assigned	12/30	1/6	1/13	1/20	1/27	2/3	2/10	2/17	2/24	3/2	3/9
~~Team Contract~~		ALL											
~~Draft Budget~~		CK											
~~Client Interview~~		ALL											
~~Product Requirements~~		AO, CK											
~~Project Schedule~~		CC											
~~Snapshot Presentation~~		ALL											
~~Snapshot Day 1~~		ALL											
~~Design Validation Plan~~		ALL											
~~Project Value Proposition~~		ALL											
~~Draft Wikipage~~		CC											
Concept Design Review		ALL											
~~Snapshot Presentation~~		ALL											
~~Snapshot Day 2~~		ALL											
~~Project Portfolio~~		ALL											
~~Register for Design Expo~~		CC											
Engineering Release Review		ALL									X		
DFMEA Document													
Portfolio Update		CK											
Wikipage Update		CC											
Snapshot Presentation													
Snapshot Day 3													X
Project Poster													
Design Expo													
Project Report													
Portfolio Final													
Wikipage Final		CC											
SYSTEM BENCHMARKS													
~~Actuate 1 Bimba with Solenoid~~													
~~Install DAQ unit~~													
~~Build LabView VI~~													
~~Read Open/Closed Resistance (Ohms) of Switch~~													
~~Establish Initial Logging Scheme in LabView~~													
~~Fine Tune Calibration Cycle~~													
Expand System to 4 Bimbas													
Update Logging Scheme													
~~Evaluate Data Stream~~													
~~Develop and Integrate Excel Reporting~~													
Expand System to 30 Bimbas													
Update and Confirm Data Logging													

NEXT STEPS

1. Multiple Bimba system
2. Complete Priority 1 project requirements
3. Begin Priority 2 project requirements (tentative)
4. Document program and provide usage instructions to AIS



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QUESTIONS?