NORTHERN ARIZONA UNIVERSITY

MSMA LATERAL LOADING DEVICE

PROGRESS REPORT

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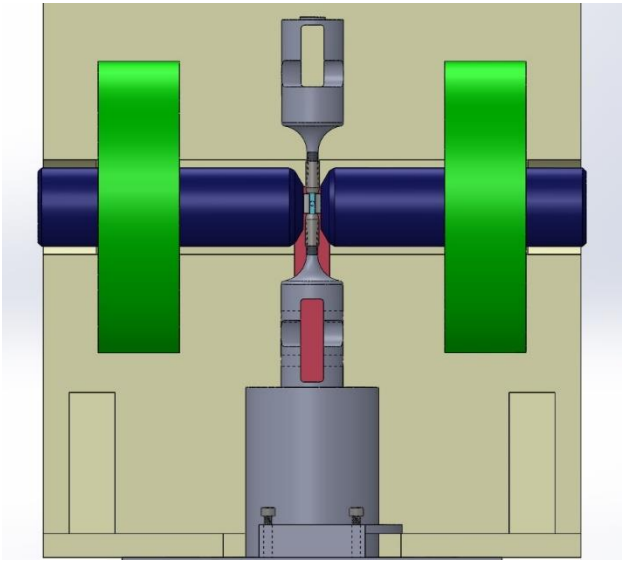
Overview

I. Problem Identification
II. Project Description
III. Design Concepts
    a. Force Sensing Device
    b. Actuation Devices
IV. Cost Comparison and Product Decision
V. Project Planning
    a. Team Member Responsibilities
    b. New Project Timeline
VI. Conclusion
VII. References

Problem Identification

- Dr. Ciocanel
  - Associate Professor at Northern Arizona University
  - Conduct research on Smart Materials, (MSMA's)
  - Wants to expand his testing process to include compressive force in the third dimension
  - Operates at room temperature in a laboratory setting

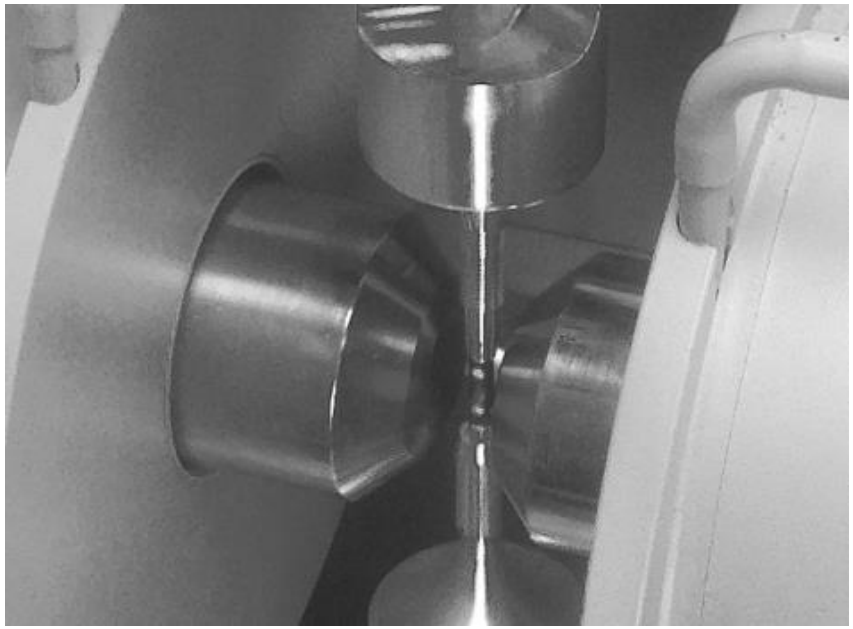
Solidworks Model of Instron Machine



Project Description

- Construction of a device capable of laterally loading up to 200 N
- Work within a $2500 budget
- Fit within 10mmx12mm area under a magnetic field
- Provide feedback control

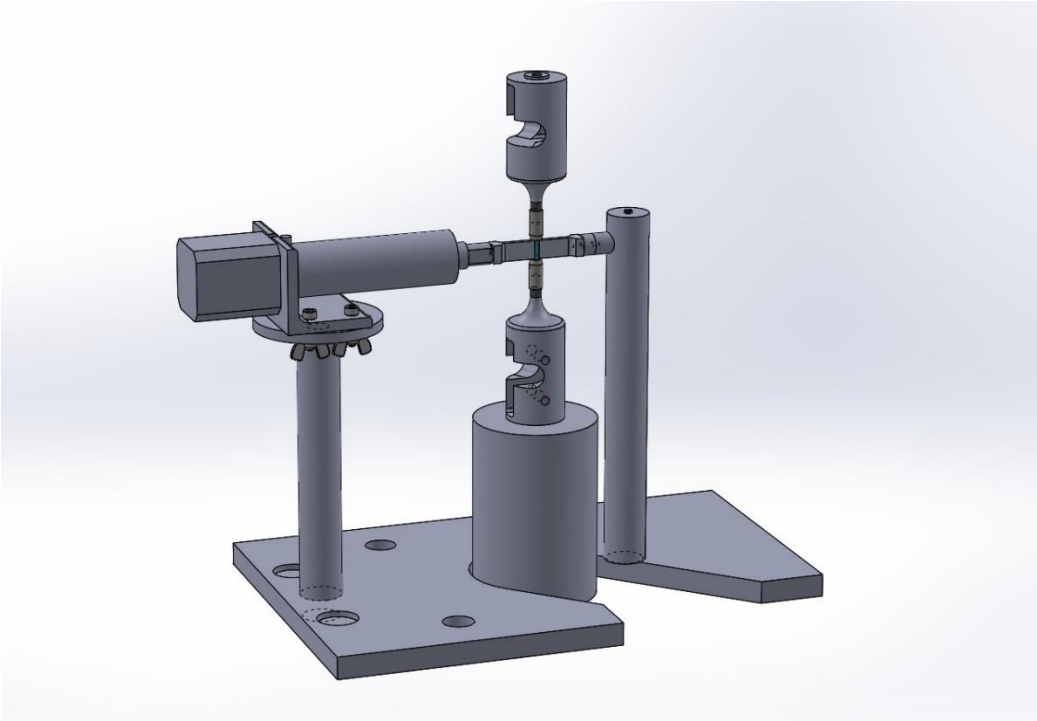
Experimental Setup for MSMA Testing



Design Concepts

- Space limitations require design to be outside 10mmX12mm area
- Similar setup so focus shifts to
  - Actuation
  - Force Sensing

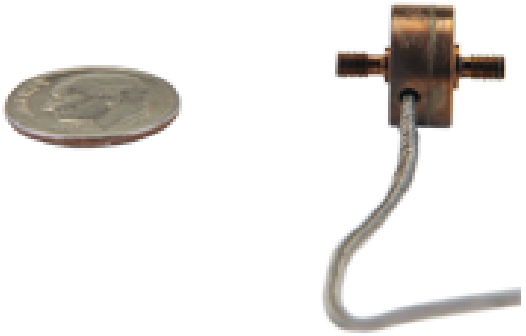
Basic System Apparatus [2][3]



Strain Gauge Force Sensor

- Measures strain through voltage via deflection of wires attached to material.
- For this application the strain gauge will need to be high precision while also not being high cost.
- Due to this, the selected strain gauge is the Honeywell Model 11.

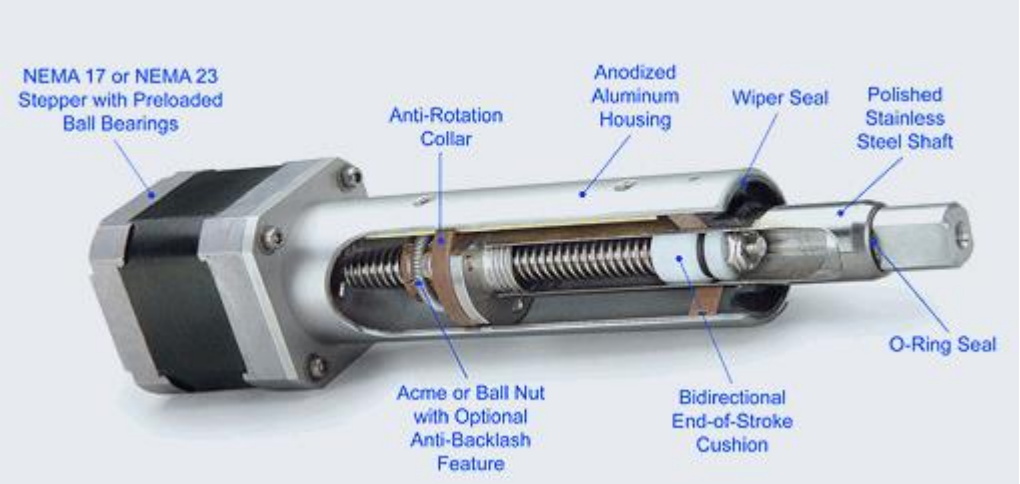
Basic Strain Gauge [4]



Electromechanical Actuation

- Ultramotion Digit NEMA 17
- Uses stepper drive for control
- Can be customized to meet project needs

Electromechanical Actuator Cutaway [2]



Piezoelectric Actuation

- Meets requirements with high resolution
- Requires power supply and piezo controller

Piezo-actuator with feedback control [5]

Option 1

- THORLABS PAZ015 series piezo-actuator
- Capable of high resolution location-based feedback
- Requires additional Strain Gauge Reader

Piezo-actuator without feedback control [5]

Option 2

- THORLABS PAS015 series piezo-actuator
- Does not include feedback

Cost Comparison

Component	EM	PE1	PE2	Cost
Digit NEMA 17 Stepper	X			$620.00
ST5-S Stepper Drive	X			$360.00
THORLABS PAS015 Piezo-Actuator			X	$1463.48
T-Cube Piezo Controller		X	X	$595.00
THORLABS PAZ015 Piezo-Actuator		X		$1933.85
T-Cube Strain Gauge Reader		X		$545.00
Power Supply		X	X	$105.00
Model 11 Load Cell*	X	X	X	$771.00
6061 Al Rod, 1” Diameter, 3’ Length	X	X	X	$19.34
6061 Al, ¼” x 6” x 3’	X	X	X	$35.46
Flathead Screw, 5 pack	X	X	X	$5.24
Wing Nuts, 25 pack	X	X	X	$7.21
Socket Head Cap Screw, 25 pack	X	X	X	$5.61
Set Screw, 25 pack	X	X	X	$3.76
Total Cost	**$1056.62**	**$3255.47**	**$2240.10**	

*Already in possession, does not contribute to cost

Product Decision:

- Force Sensing: Honeywell Model 11 Force Sensor
- New Technologies
- Actuation: Digit NEMA 17 Stepper (electromechanical) with ST5-S Stepper Drive
  - Inconsistent Force
- Actuation: THORLABS PAS105 Piezo-Actuator with T-Cube Piezo Controller, and Power Supply
  - Higher Cost

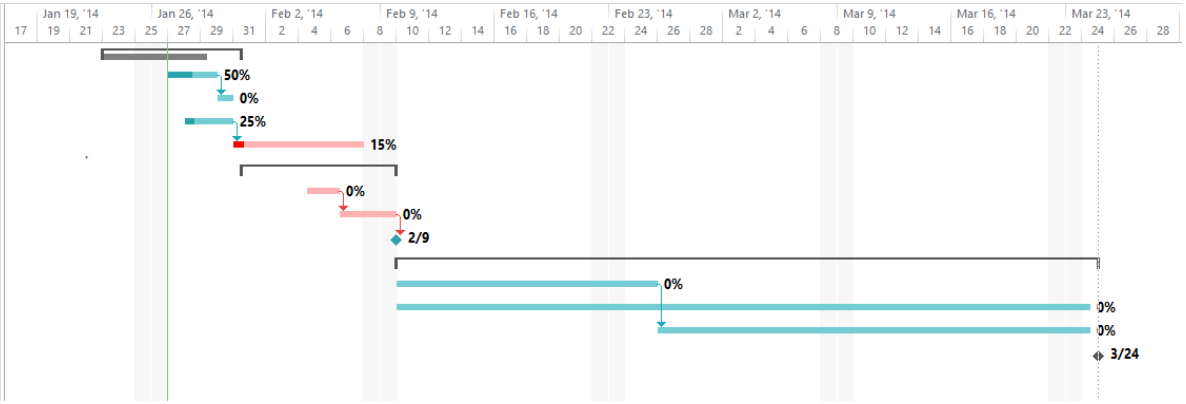
Team Member Responsibilities

- Assigned a Main and Secondary Lead
  - User Manual & UGRADS- Joy, Thaddeus
  - Redesign Mounting System (per client request)- Thaddeus, Joy
  - Order and Acquisition of Products- Matthew, Cody
  - LabView Programming- Cody, Jonathan
  - Manufacturing Prototype- Jonathan, Matthew
- Testing & Redesign
  - Full Team

MSMA Lateral Testing

New Project Timeline

	% Complete	Task Name	Duration	Start	Finish	Resource Names
1	**24%**	**Finishing Design And Order Parts**	**6.5 days**	**Thu 1/23/14**	**Fri 1/31/14**	
2	50%	Choose Actuator	3 days	Mon 1/27/14	Wed 1/29/14	Full Team
3	0%	Order Actuator	1 day	Thu 1/30/14	Thu 1/30/14	Matt,Cody
4	25%	Complete Support Design	3 days	Tue 1/28/14	Thu 1/30/14	Thad,Joy
5	15%	Order and Obtain Materials	6 days	Fri 1/31/14	Fri 2/7/14	Matt,Cody
6	**0%**	**Assemble Setup**	**6.5 days**	**Fri 1/31/14**	**Sun 2/9/14**	
7	0%	Machine Aluminum	2 days	Tue 2/4/14	Thu 2/6/14	Jon,Matt
8	0%	Build Setup	2.5 days	Thu 2/6/14	Sun 2/9/14	Jon,Matt
9	0%	Hardware Review 1	0 days	Sun 2/9/14	Sun 2/9/14	
10	**0%**	**Build, Programming, and Testing**	**31 days**	**Mon 2/10/14**	**Mon 3/24/14**	
11	0%	Finishing Build	12 days	Mon 2/10/14	Tue 2/25/14	Thad,Matt
12	0%	Program Labview	30.5 days	Mon 2/10/14	Mon 3/24/14	Cody,Jon
13	0%	Test and Redesign	18.5 days	Wed 2/26/14	Mon 3/24/14	Full Team
14	0%	Hardware Review 2	0 days	Mon 3/24/14	Mon 3/24/14	



Conclusion

- Must create a feedback controlled device that laterally loads a MSMA up to 200 N within a small area for under $2500.
- Continued research for electromechanical and Piezo options, in terms of cost analysis, per client request.
- The final products will be selected on Wednesday (1/29)
- The team delegated tasks, and reconstructed project timeline.

•References

•[1] Leo, Donald J. Engineering Analysis of Smart Material Systems. Hoboken, NJ: John Wiley & Sons, 2007.

•[2] "The Digit." *http://www.ultramotion.com/products/digit.php*. Ultra Motion. Web. 1 Dec. 2013.

•[3] Garcia, Matt, Randy Jackson, Jeremy Mountain, Qian Tong, and Hui Yao. *Material Testing Fixture*. *Material Testing Fixture*. Dr. Ciocanel, 2012. Web. 15 Nov. 2013.<http://www.cefns.nau.edu/capstone/projects/ME/2013/DFMTM/index.html>.

•[4] "Model 11." *Model 11*. Honeywell International Inc, 2013. Web. 6 Nov. 2013.

•[5] "Piezo Driver Bandwidth Tutorial." *Replaceable Tip Piezo Actuators*. Thorlabs, n.d. Web. 3 Jan. 2014.

QUESTIONS?