

# **MSMA LATERAL LOADING DEVICE**

# **ENGINEERING ANALYSIS**

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# Overview

I. Project Description and Analysis BreakdownII. Electromechanical vs. Piezoelectric DesignIII. Analysis

- a. Actuator and Sensor Towers
- b. Base
- c. Screws
- **IV. Material Selection**
- V. Project Planning a. Gantt Chart VI.Conclusion



# Project Description

- Dr. Ciocanel
  - Conducts research on Magnetic Shape Memory Alloy (MSMA) [3]
  - Construction of a device capable of laterally loading for under \$2500
  - Fit within 10mmx12mm area under a magnetic field
  - Provide feedback control

Experimental Setup for MSMA Testing







# Analysis Breakdown

- Force Sensor [1] [5]
  - Similar size
  - Similar mounting position
  - Capable of handling fatigue
- Actuator
  - Similar forces
  - Similar cyclic fatigue
- Mounting
  - Different geometries
    - Base, Towers, Screws

## Solidworks Model of Instron Machine





## Electromechanical Design Setup

Solidworks Model of Electromechanical Mounting Design [2] [4]



Cody Burbank



## Piezoelectric Stack Design Setup



Jonathan McCurdy



#### Analysis of Towers

# Finite Element Analysis of sensor, electro-mechanical actuator towers





### Analysis of Towers (cont'd)

FEA of piezo actuator, secondary electro-mechanical actuator towers



Jonathan McCurdy







By-Hand Analysis of Screws





# Material Selection

- Base/Towers: 6061 Aluminum
- Screws: 8-18 Stainless Steel
  - Cheap, common material
  - Yield strength exceeds maximum stress
  - Non-magnetic
  - Good machinability (base/towers)



## MSMA Lateral Testing Project Timeline

🛱 Gantt 🕅 Resources Chart														
キャイナダ 淡				Zoom Out	Today 🔻	Today ▼   ← Past   Future → Show critical path   Baselines								
GANTT Project			2013		Formula	Formulation and Planning Presentation			#1			Engineering Analysis Presentation Fi		
Name	Begin date	End date	/eek 39	Week 40 9/29/13	Week 41 10/6/13	Week 42 10/13/13	Week 43 10/20/13	Week 44 10/27/13	Week 45	Week 46	Week 47	Week 48	Week 49	
Define Problem	9/24/13	10/8/13												
Conduct State-Of-The-Art Research	10/9/13	10/15/13												
Generate Preliminary Designs	10/16/13	10/22/13												
<ul> <li>Conduct Analysis</li> </ul>	10/23/13	10/29/13	-											
<ul> <li>Generate Design Alternative</li> </ul>	10/30/13	11/5/13												
<ul> <li>Analyze Alternatives</li> </ul>	11/6/13	11/18/13	1											
Finalize Design	11/18/13	12/2/13									-			
Formulation and Planning Presentation	10/8/13	10/8/13	1000		•									
Concept Generation and Selection Prese	. 10/29/13	10/29/13						•						
<ul> <li>Engineering Analysis Presentation</li> </ul>	11/18/13	11/18/13									•			
Final Design Presentation	12/3/13	12/3/13											٠	



# Conclusion

- Create a device that laterally loads within a small area. We have selected basic product types and created two unique mounting setups.
- Aluminum and 8-18 Stainless Steel were selected as materials for mounting construction.
- The by-hand and finite element analyses show adequate material properties.
- Next our team will continue searching for low price products and construct a final design after consulting client.



# •References

[1] "9313AA1VP 1-Component Force Link - Kistler." *9313AA1VP 1-Component Force Link - Kistler*. Kistler, n.d. Web. 7 Nov. 2013.

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

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

[4] "M-238 Heavy-Duty DC-Mike Actuator." (2006): 1-34. *Www.pi.ws*. Physik Instrumente (PI) GmbH & Co. KG, 2006. Web. 12 Nov. 2013.

[5] "Model 11." Model 11. Honeywell International Inc, 2013. Web. 6 Nov. 2013.

[6] "N-216 NEXLINE Linear Actuator." *PIEZO NANO POSITIONING*. Physik Instrumente (PI) GmbH & Co. KG, n.d. Web. 15 Nov. 2013.

