NORTHERN ARIZONA UNIVERSITY

MSMA LATERAL LOADING DEVICE

CONCEPT GENERATION AND SELECTION

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Overview

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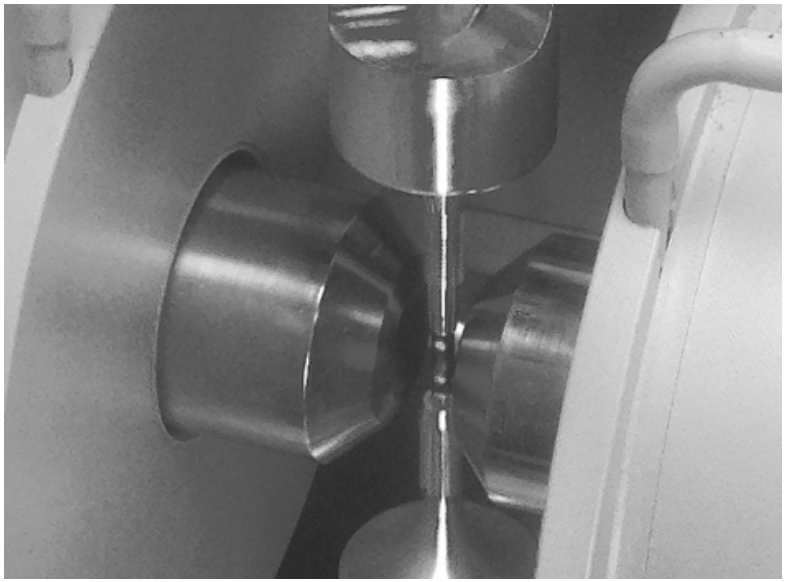
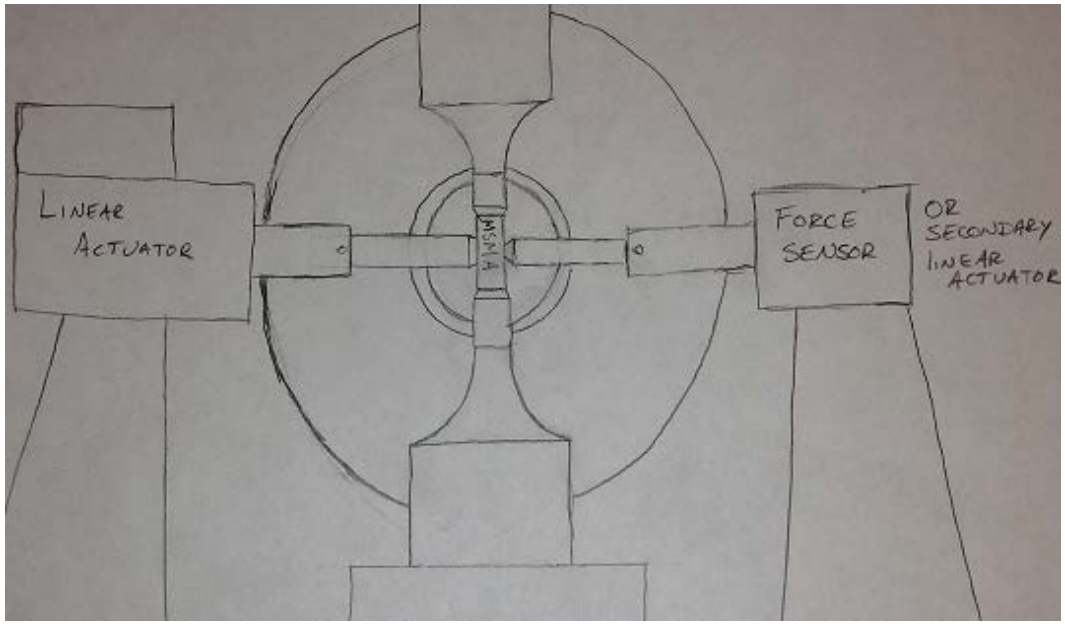
- Project Description
  - Dr. Ciocanel
    - Conducts research on Magnetic Shape Memory Alloy (MSMA)
    - Construction of a device capable of laterally loading under $2500
    - Fit within 10mmx12mm area under a magnetic field

Experimental Setup for MSMA Testing



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

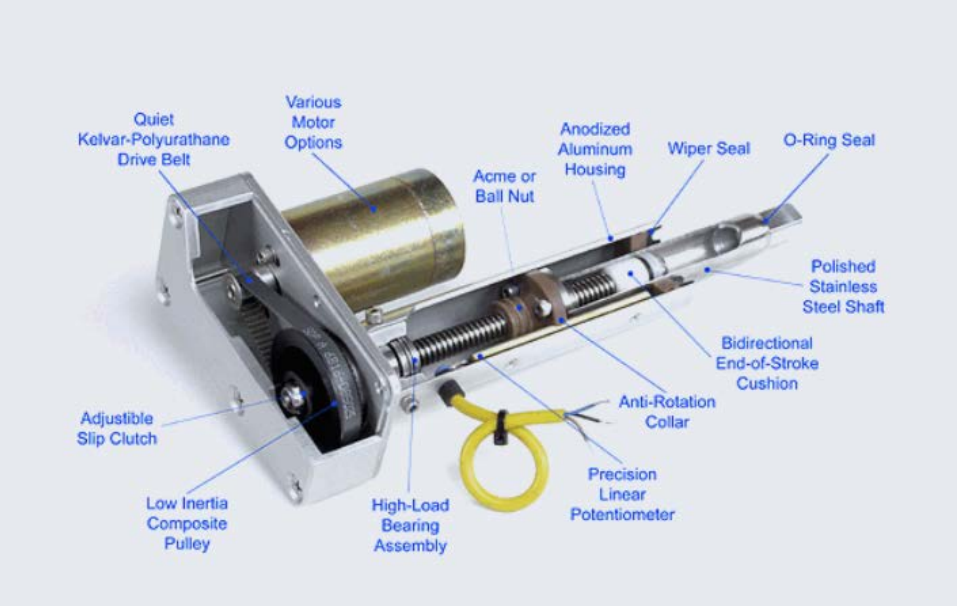
Basic System Apparatus



Electromechanical Actuation

- Motor driven screw
- Pros
  - High precision
  - Available force feedback
- Cons
  - Large in size
  - Large operating range

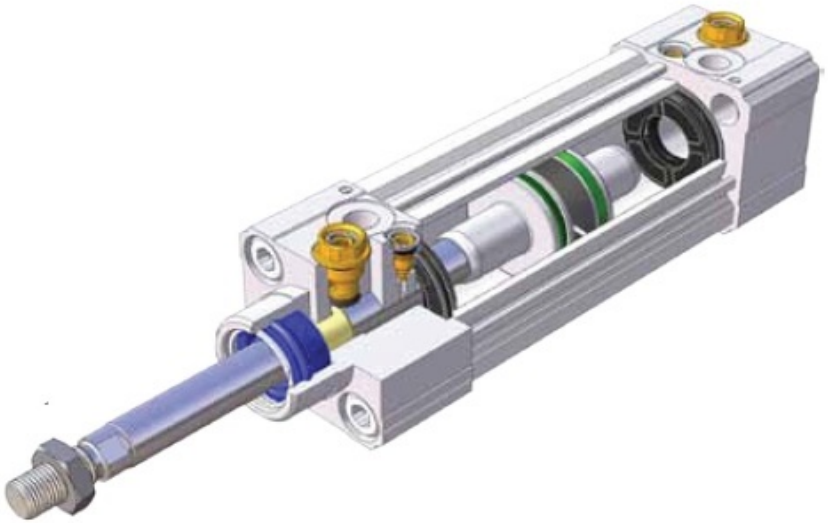
Electromechanical Actuator Design [4]



Pneumatic Actuation

- Piston cylinder or hose powered by air
- Pros
  - Fits within allowable space
  - Lower in cost
- Cons
  - Lacks precision

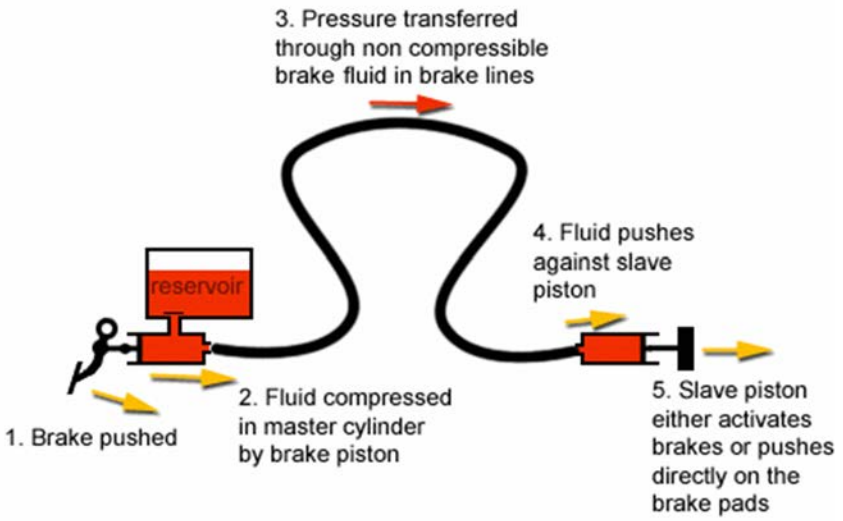
Pneumatic Actuator Schematic [3]



Hydraulic Actuation

- Computerized piston and hose or cylinder design
- A hose attached to actuators on either side of the specimen
- Pros
  - Flexible, fits in allowed space
  - Incompressible flow; finer control
- Cons
  - Less precise than electromechanical

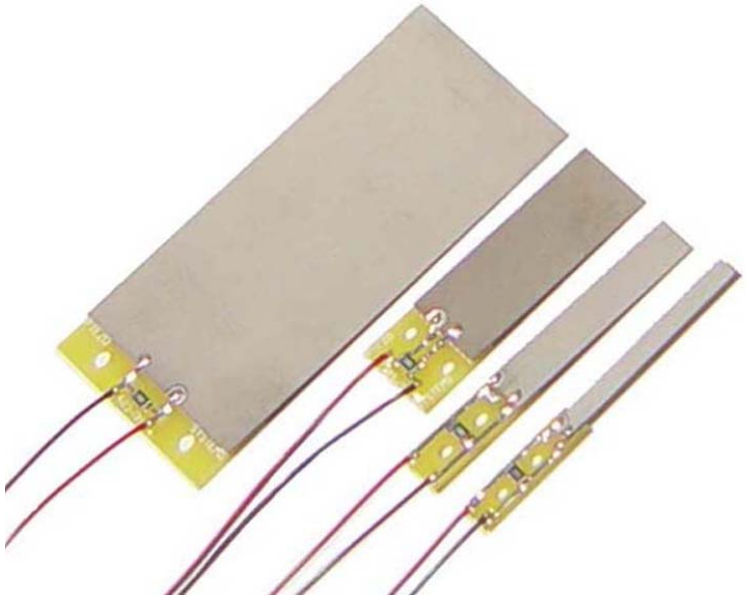
Hydraulic Actuation Process [2]



Piezoelectric Force Sensor

- Deflection generates an output voltage
- Voltage can be transferred to actuator
- Pros
  - Excellent sensitivity
  - Small size
- Cons
  - Fragile
  - Expensive

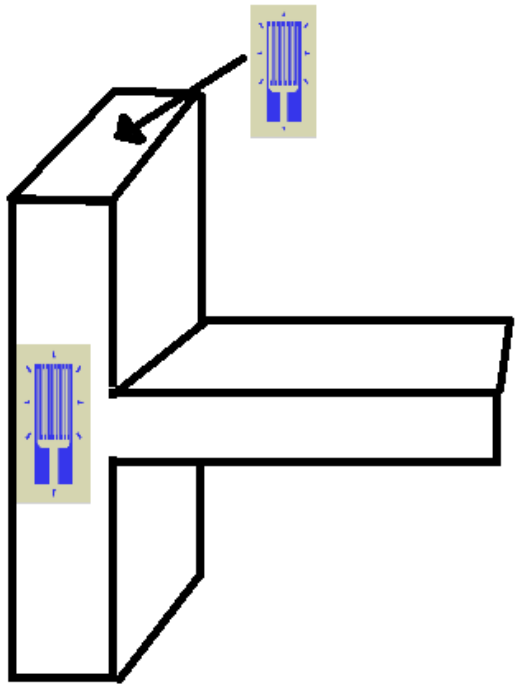
PZT sensor in various sizes [9]



Strain Gauge Force Sensor

- Applying strain gauges to a piston style actuator
- Measure strain in the piston and set up a Virtual Instrument (VI)
- Pros
  - Low cost
  - High sensitivity
- Cons
  - Size could be an issue

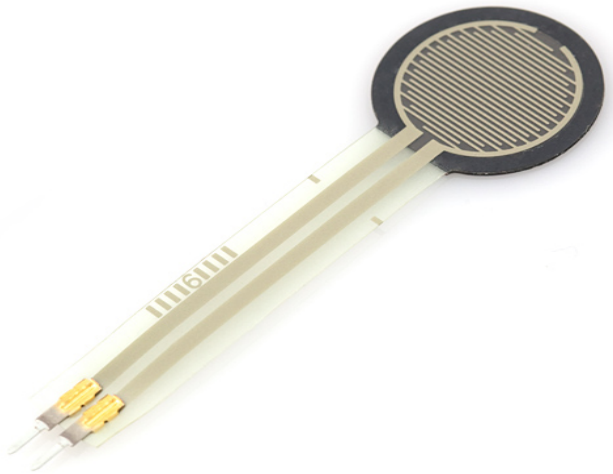
Basic Strain Gauge Design [5]



Force Sensing Resistor

- Compression changes electrical resistance
- Can be setup to measure a voltage drop
- Pros
  - Inexpensive
  - High durability
- Cons
  - Low sensitivity
  - Size could be an issue

Basic Force Sensing Resistor [8]



Weighting Criteria and Decision Matrix for Actuation

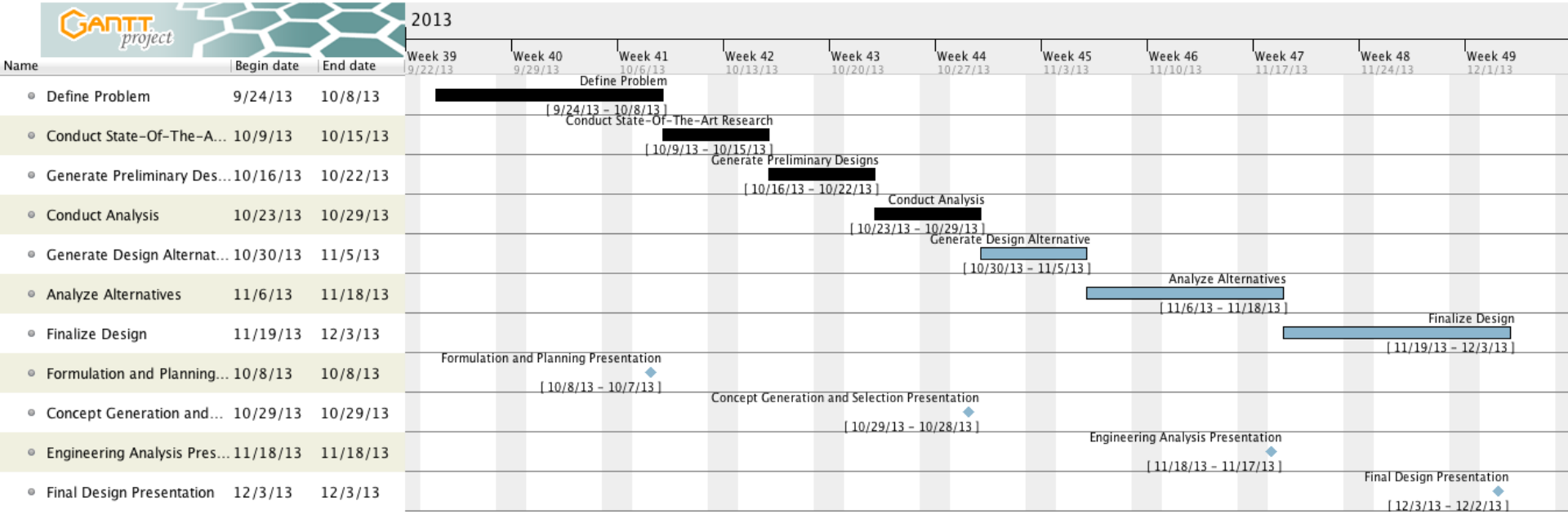
Criteria	**Weight**	Electromechanical	Hydraulic	Pneumatic
Controllability	5	9	7	4
Cost	1	3	5	3
Precision	5	6	7	3
Amount of applied force	2	5	8	8
Size	3	4	8	6
Total	n/a	100	115	72

Weighting Criteria and Decision Matrix for Force Sensing

Criteria	**Weight**	Piezoelectric	Strain Gage	Force Sensing Resistor
Sensitivity	4	8	7	4
Cost	1	4	7	9
Size	3	9	5	5
Effectiveness in a magnetic field	5	6	7	7
Durability	3	4	6	7
Total	n/a	105	103	96

MSMA Lateral Testing

Project Timeline



Conclusion

- Create a device that laterally loads within a small area. We developed a basic design and focused on two main areas for design analysis: actuation and force sensing
- Hydraulic actuation was chosen as the most feasible option. Analysis for force sensing will be conducted for piezoelectric and strain gauge designs.
- Next our team will conduct further analysis on the chosen designs and begin the finalization of the proposed project.

•References

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QUESTIONS?