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Design Review

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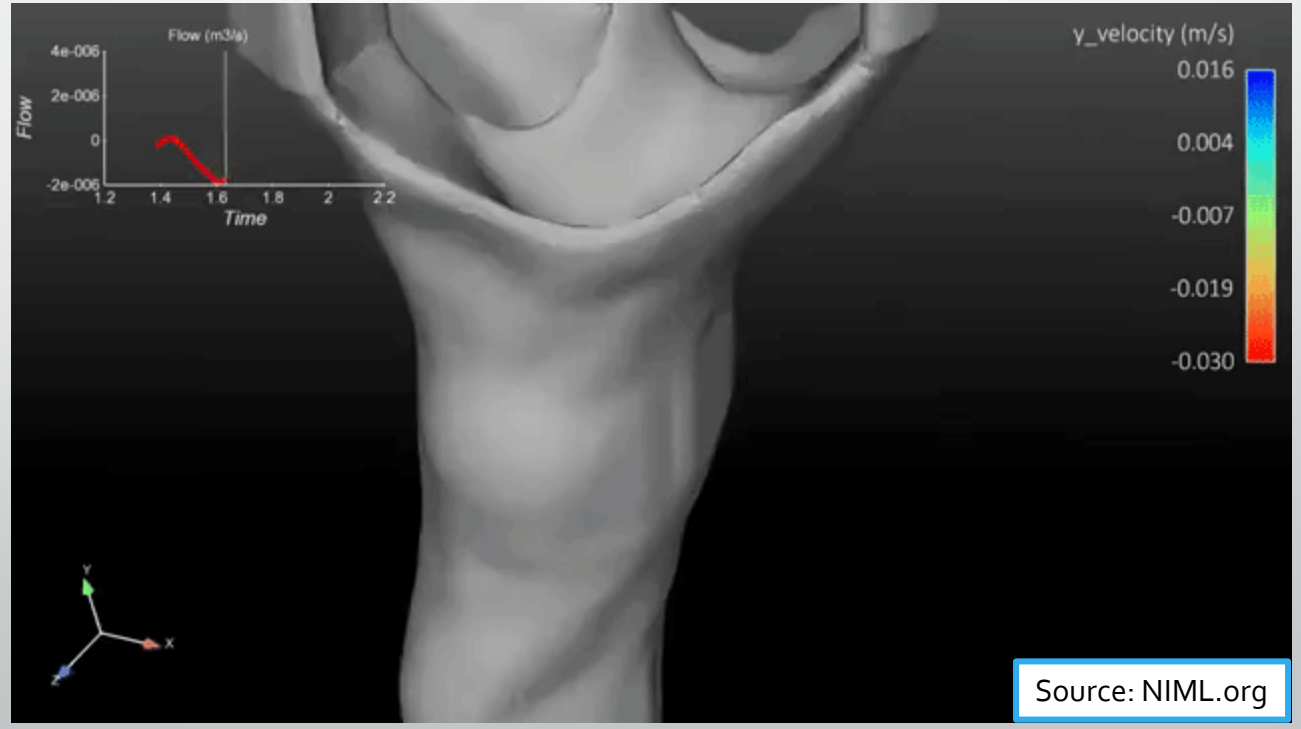
Outline

- Design Specifications
- Project Learning Summarization
- Concept Review
- Cost Outline
- Schedule Outline
- Potential Problems and Risks

Background

- Mission Statement:

To design, test, and refine a compact, low-cost, oscillatory-flow pump that will reproduce realistic Cerebral Spinal Fluid (CSF) flow conditions within a given range of mammal cerebral spinal models. Flow rates mimic cardiac and respiratory frequencies simultaneously and have an adjustable frequency and flow volume.

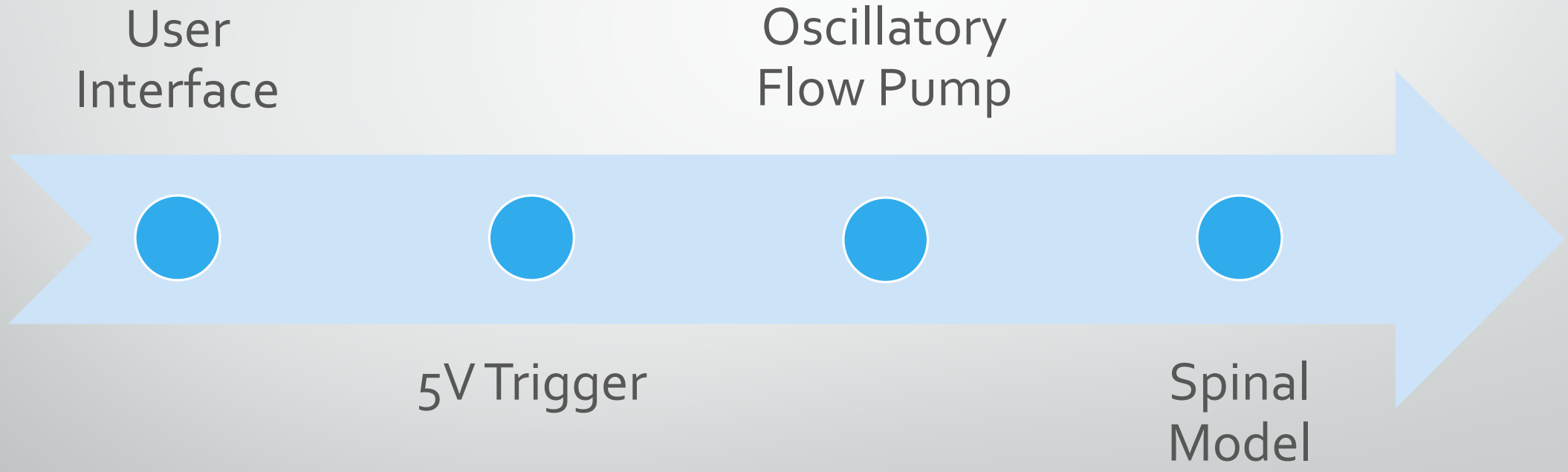


Source: NIML.org

Prototype 1

- Single Frequency ~ 1 Hz
- Constant Volume - 1 cc
- Large System
- Non Compact/User Friendly

System Layout



Design Specifications

Priority	Need	Metric	Value
Must	Compact (subjective)	Fit in your pocket	Yes
Must	Easy to use (subjective)	Can be operated by person of any profession	Yes
Must	Consistent	Pump performs reliably and tested throughout time	Reliability +-5%
Must	Adjustable Frequency	Can model animals from human size to small mammal	30 - 230 BPM
Must	Adjustable Volume	Can operate with varying stroke flow volumes	.01-2 mL
Must	5V trigger	square waveform signal sent at peak of each cardiac or respiratory cycle	5V
Should	System piping	Piping should connect to spine model and have minimal head loss	<6" tubing to model
Should	Bleed system for piping	System will be sealed	No air in piping
Should	Simple Interface	mechanical or programmed switches to alter motor output	>5 frequency values
Should	MRI-compatable	Non-ferrous, non-electrical	Yes
Should	Low cost	simple design to reduce parts list and cost	Final BOM < $500
Should	Noise Isolation (subjective)	Noise should not interfere with other devices or testing abilities	< 40 dB

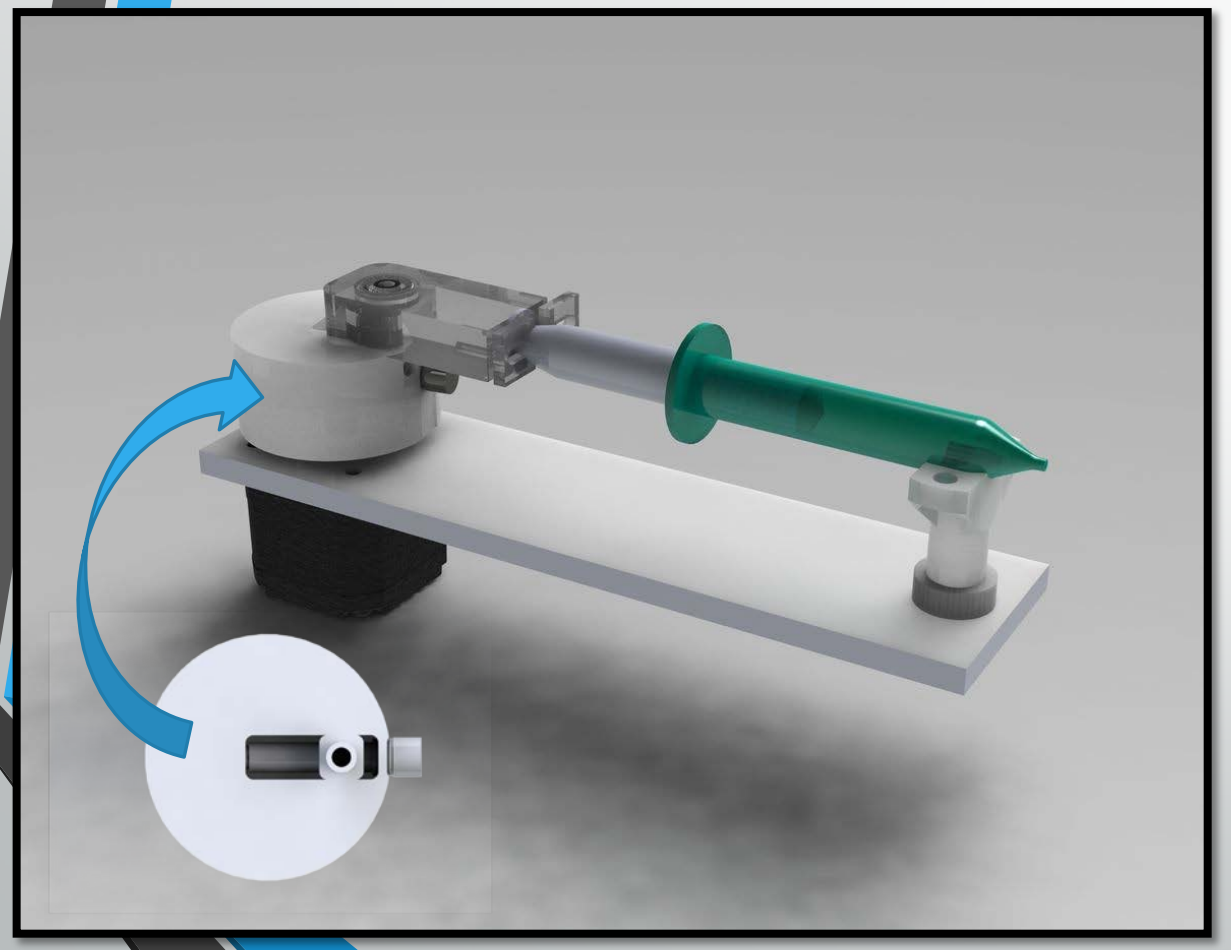
Deliverables

- Pump must produce an oscillating flow within spinal cord models ranging from the size of a human to a small vertebrate.
- Flow must be adjustable in volume and frequency.
- Pump should be low-cost and easy to operate.
- Design must also include a 5V, square-wave-form trigger.

Project Learning

- Syringes
  - Learning about different types of syringes and material to reduce drag force
  - Possible solutions:
- Rigid System
  - Experiencing problems with system having too much flexibility
  - Possible Solutions: More fixtures in system, Simplify system
- Linear Actuator
  - Team has little to no experience with linear actuators
  - Possible Solutions: Gain user knowledge, Access Online Code Libraries

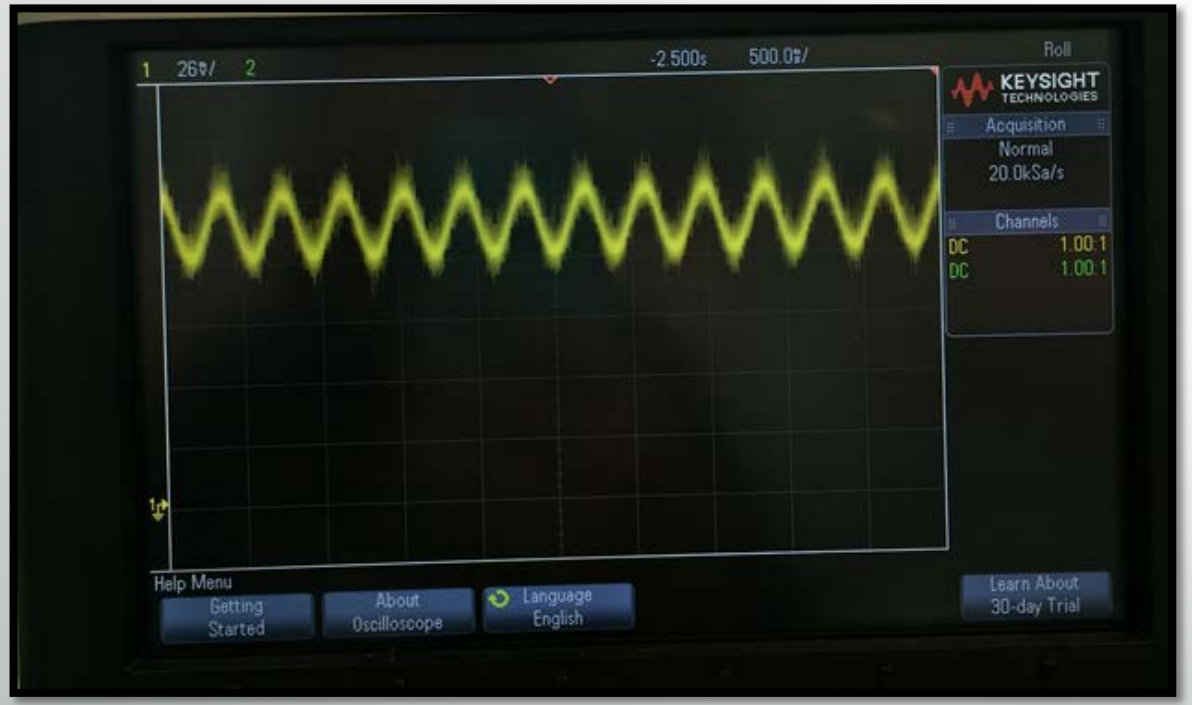
Flywheel Concept



- Pros:
  - Easily adjustable
  - Mechanical
  - Can achieve desired specifications
- Cons:
  - Largest Design
  - Current Mounting for syringe Inadequate
  - Machining Intensive(Time Intensive)

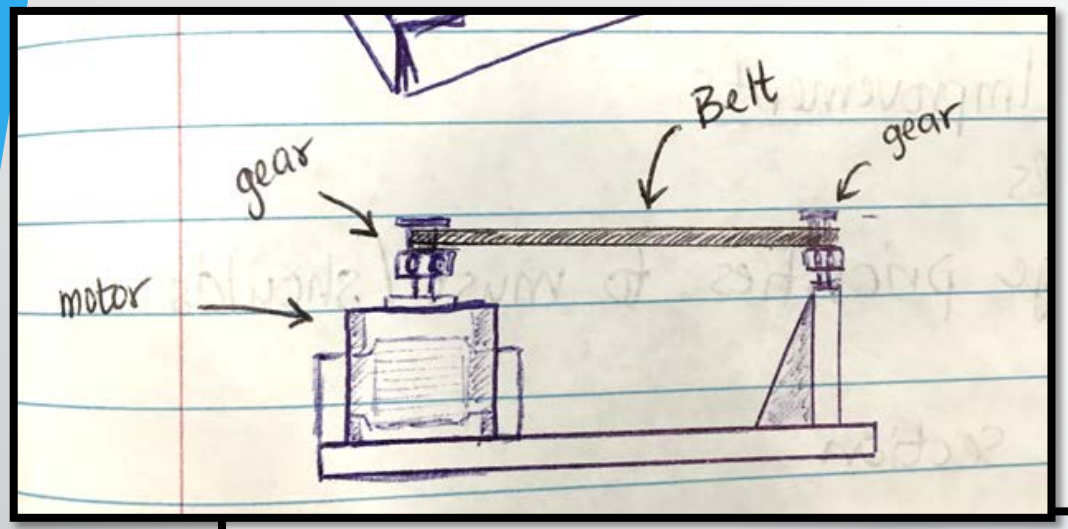
Cost Estimate: $80 + Manufacturing Time

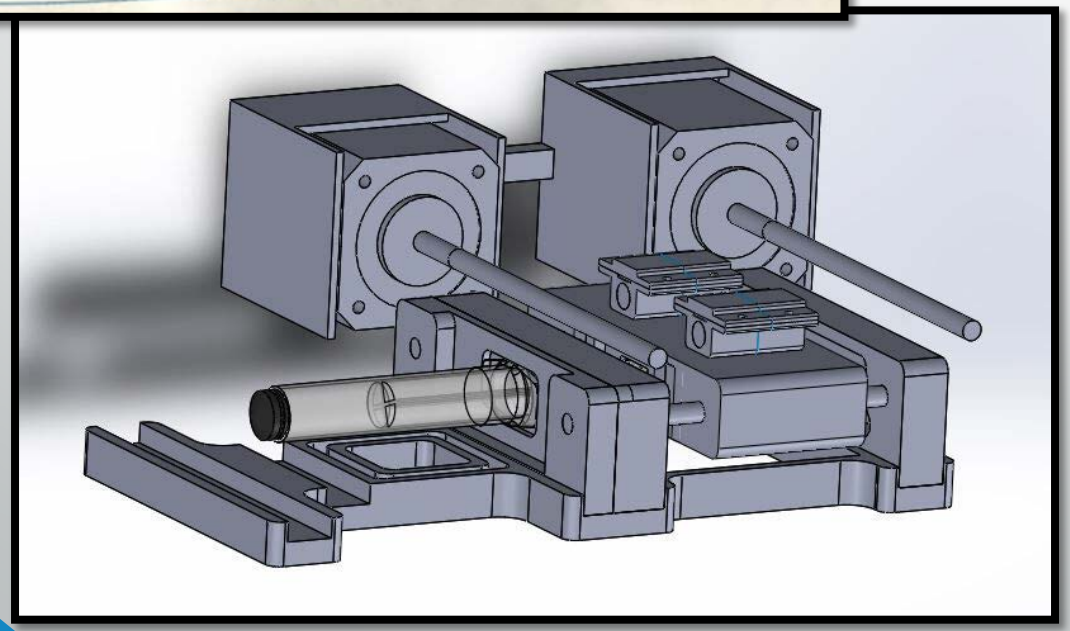
Flywheel Testing



- Achieved Sinusoidal Wave Form
- Tested Frequency: 2.5 Hz
- Other Testing: Slow down frequency to get better sin wave result

Linear Belt





- Pros:
  - Highly programmable.
  - Could be compact.
  - Pre built parts can be found online.
- Cons:
  - Code the motor to produce a sinusoidal motion.

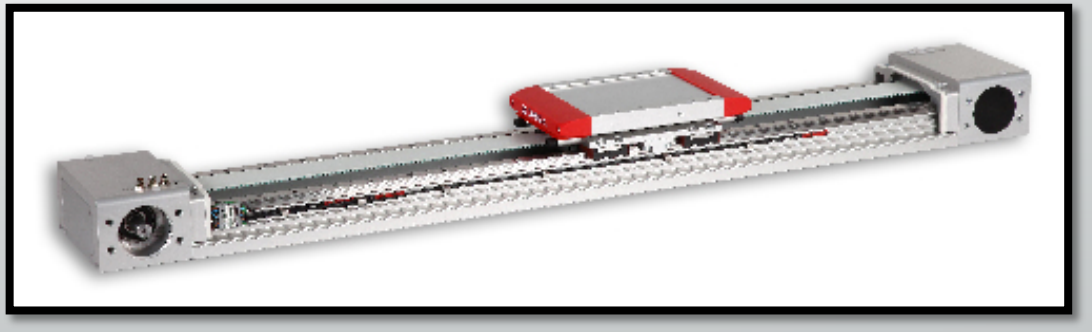
Cost Estimate: $80

CURRENT TEST RESULT

- Poor belt driving mechanism
- More triangular than sinusoidal waveform

POSSIBLE SOLUTIONS FOR DEVELOPMENT

- Buy a pre-built linear belt drive actuator
- Write a code for stepper movement for a more accurate sinusoidal back and forth movement. (CNC PROGRAMMING)

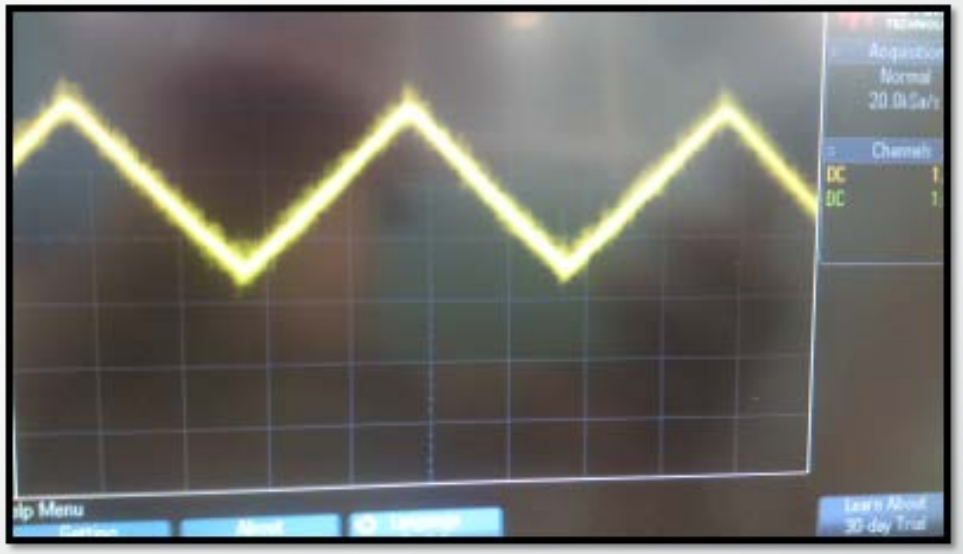


Linear Actuator

- Pros:
  - simple
  - Compact
- Cons:
  - Coding ability
  - Finding the right one that meet the specs

Cost Estimate: $100

Actuator Testing



- PWM coding
- Analog Signal

Potential Problems and Risks

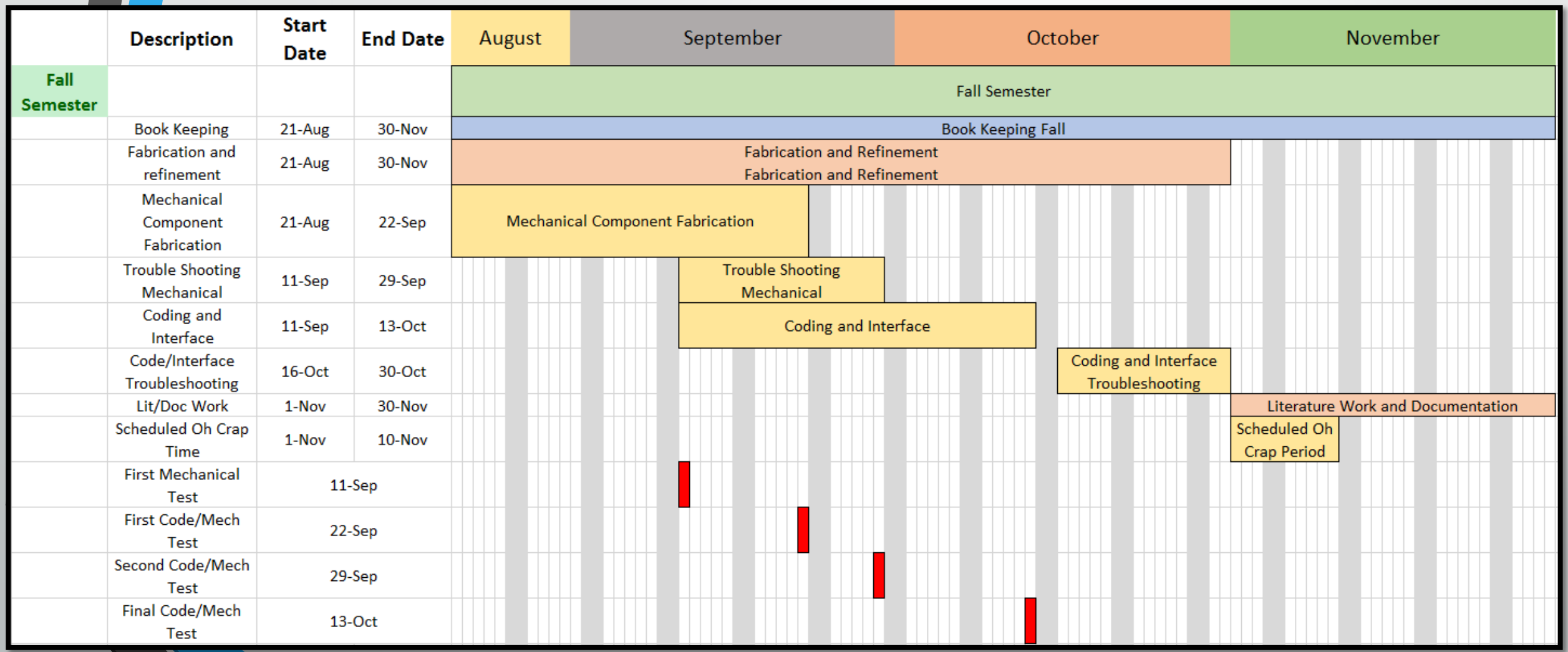
- Parts manufacturing
- Finding parts that meet the given specification
- Produce a product that is compact enough
- Develop code for motor movement

Conclusion

- Preferred Design: Linear Actuator
  - Simple
  - Compact
  - Most potential to achieve desired sinusoidal wave form
- Focusing on the Future
  - Further developing the linear actuator design
  - Create user friendly interface
  - MRI compatibility

Fall Schedule

	Description	Start Date	End Date
Fall Semester			
	Book Keeping	21-Aug	30-Nov
	Fabrication and refinement	21-Aug	30-Nov
	Mechanical Component Fabrication	21-Aug	22-Sep
	Trouble Shooting Mechanical	11-Sep	29-Sep
	Coding and Interface	11-Sep	13-Oct
	Code/Interface Troubleshooting	16-Oct	30-Oct
	Lit/Doc Work	1-Nov	30-Nov
	Scheduled Oh Crap Time	1-Nov	10-Nov
	First Mechanical Test	11-Sep	
	First Code/Mech Test	22-Sep	
	Second Code/Mech Test	29-Sep	
	Final Code/Mech Test	13-Oct	



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Questions?

- Comments/Questions on design concepts?
- What is your idea of the perfect Interface?
- What type of shield material could be applied to the actuator design?
- Could the maximum sound [dB] be a tradeoff in design?