Hold Down & Release Mechanism

Preliminary Design Review

Sponsored by General Atomics – Electromagnetic Systems

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Basis of Design

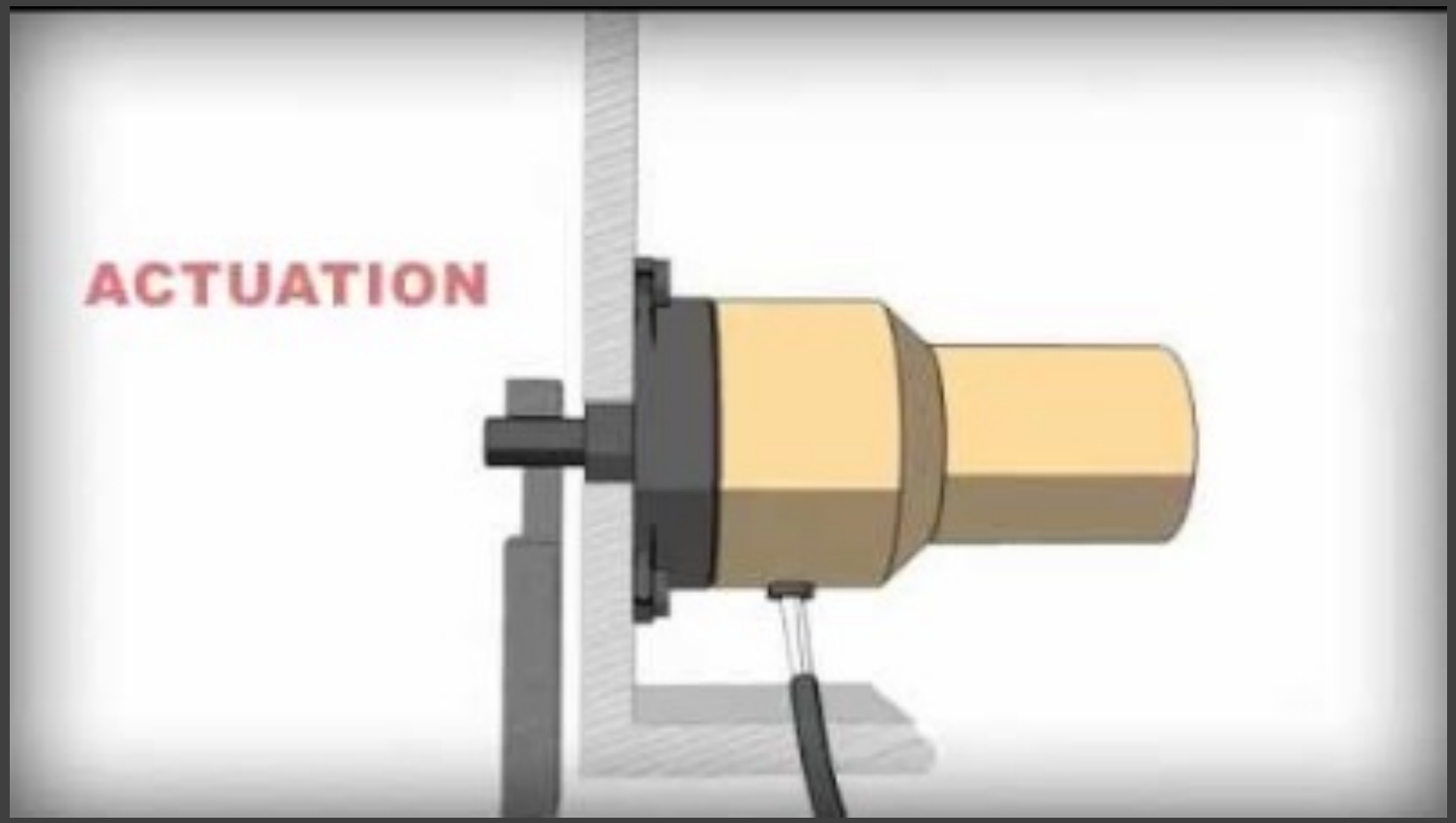

Figure 1: TiNi Aerospace Pinpuller Concept Demo video

Background

- What does an HDRM do?

Figure 2: GIF Demo of Satellite unfolding

- Why design a new one?

Figure 3: GA-EMS 12U CubeSat unfolded

CAD Model

- Designed for 3d printing
- Designed for simple assembly
- Main Purpose: test SMA actuator

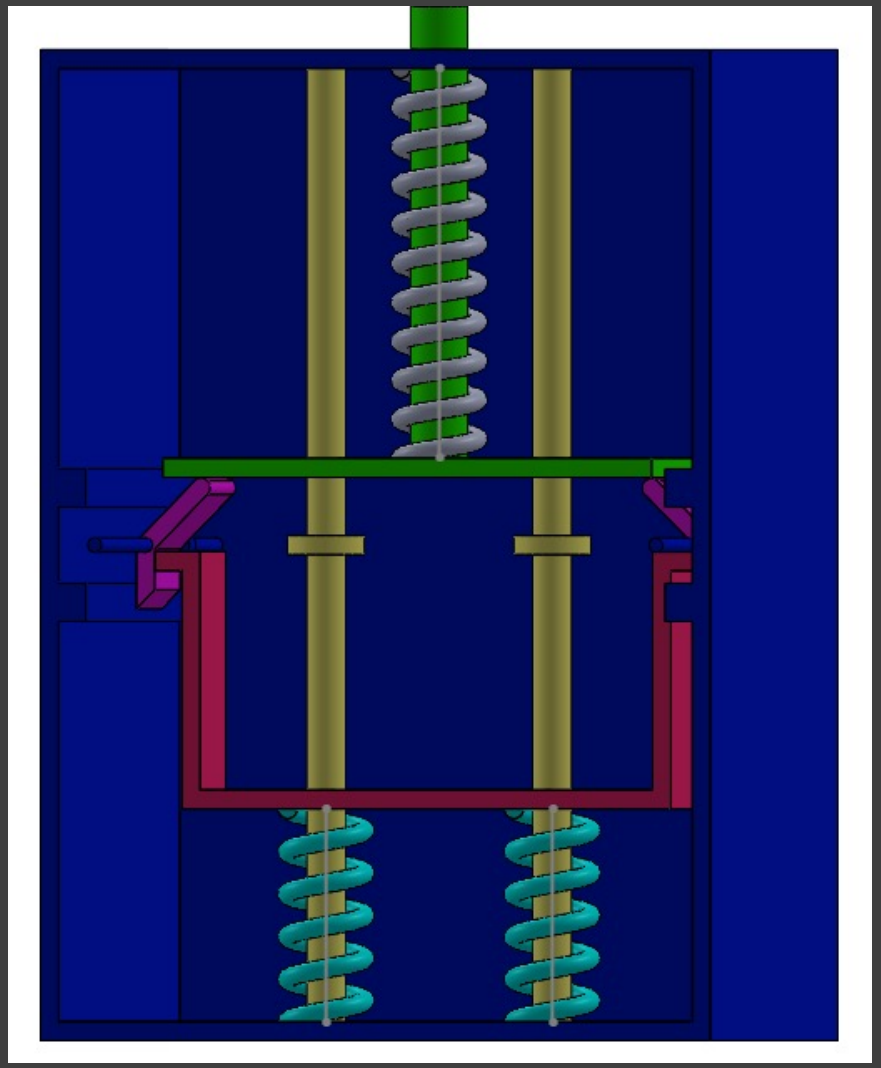

Figure 4: CAD of Current Design

CAD Model Subsystems

- Pin
  - Hold Down
- Lock Mechanism
  - Hold Down
  - Release
- SMA Actuator
  - Release
  - Reset

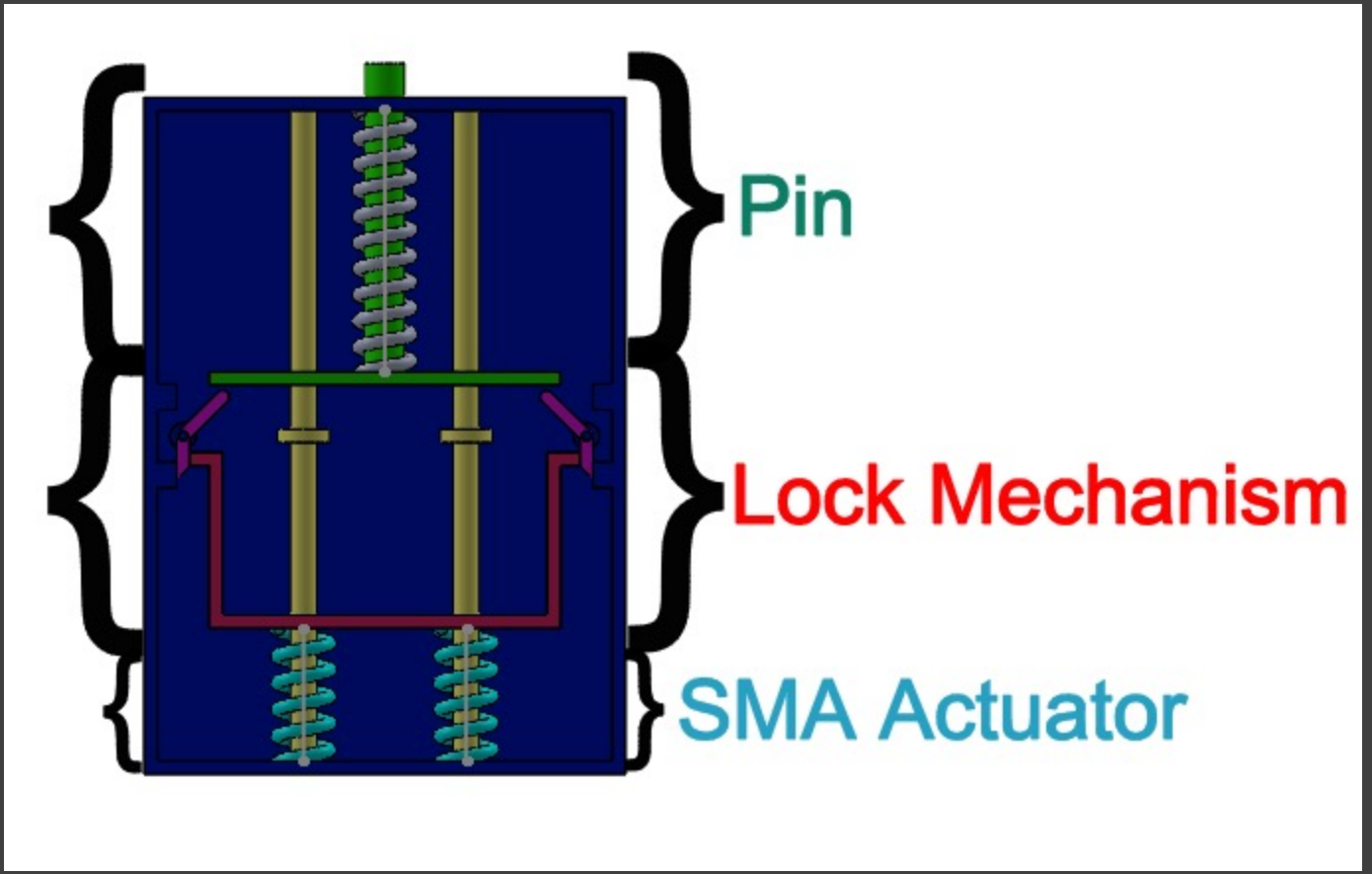

Figure 5: CAD Subsystems

Animation Demonstration

- Blue to Red SMA transition represents heating
- SMA springs will be 2-way

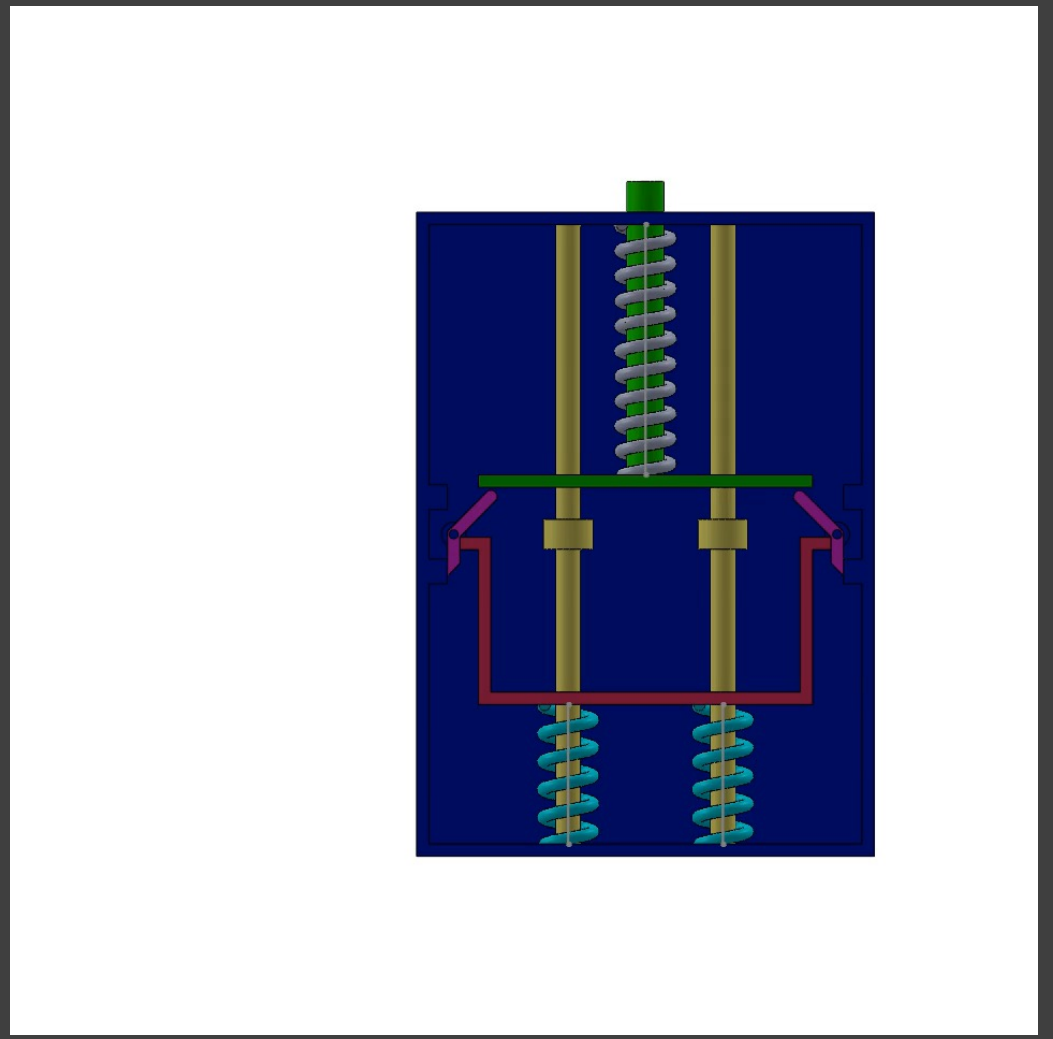

Figure 6: CAD Animation

Customer Requirements

- No space debris
- Cannot protrude >1cm from CubeSat surface.
- Easy reset
- Retaine “held” configuration until deployment

Engineering Requirements

- No combustion
- Zero breakaway parts
- Reliability (99%)
- Minimize reset time (<60s)
- Less importance on:
  - Lightweight
  - Minimize Volume

Final Concept Justification

- Requirements met:
  - No Debris
  - Cannot protrude >1cm from Satellite
  - Fully resettable
- Requirements likely met:
  - Easy reset (<60s)
  - Retain held position until deployment
- Requirements not met:
  - Volume requirements
  - Weight requirements
  - Reliability (>99%)

Design Validation – FMEA

Hold Type – SMA

- Possible Failures
  - Permanent deformation of SMA
  - Fatigue life
  - Electrical connection
- Solutions
  - SMA testing
  - Connection types

Release Type – Pin Pull

- Possible Failures
  - Incomplete retraction
  - Shear loading on pin
- Solutions
  - Analysis on internal forces
  - Static Analysis on Pin – increase SF

Design Validation – FMEA (cont'd)

Reset Mechanism

- Potential Failures
  - Repeatability
  - Full reset
  - Overloading the mechanism
- Solutions
  - Fatigue test reset procedure; optimize design
  - Design/implement physical limits to motion

Locking Mechanism

- Potential Failures
  - Device locks in wrong configuration
  - Lock fails/slips
- Solutions
  - Re-Design Lock mechanism
  - Iterating design
  - Static analysis on lock

Design Validation – Testing

- Device must retain stowed configuration prior to deployment
  - Launch environment considerations
    - Vibration, shock, acceleration
- Deployment Reliability
  - Reset reliability / Fatigue life
- Structural Strength
  - Shear force on pin

Schedule

Semester 1

- Updated schedule

- PDR completed by week 10/16

- On schedule combined with GA-EMS and 476C

- Next step: furthering CAD model(s) and Analytics Memo

- Week 16 goal: final design/CAD with animation

- Semester 2: 16-week plan:

- prototyping, testing, manu-facturing final design with demonstration

Legend	Current Week	Next Week		
Week	Week Start	Agenda / Due	Date Due	Description
1	10-Jan			concept generation
2	17-Jan			
3	24-Jan			
4	31-Jan	Presentation 1	3-Feb	
5	7-Feb			
6	14-Feb			
7	21-Feb	Presentation 2	22-Feb	Concept gen/ starting selection
8	28-Feb			Concept selection / PDR
9	7-Mar	Website Check	11-Mar	
—	14-Mar	PDR Memo	20-Mar	
10	21-Mar			
11	28-Mar	Presentation 3	31-Mar	Presenting PDR
12	4-Apr			CDR/CAD/Prototype
13	11-Apr	CDR Memo	15-Apr	
14	18-Apr	Analytical memo	22-Apr	
15	25-Apr	Prototype demo CAD Final BOM FINAL	26-Apr	CDR / Cad w/ animations/ possibly prototype
16	2-May	Website check 2	6-May	Finalize website for sem

Figure 7: Schedule for Spring 2022

Budget

- Updated Budget
- Budget Breakdown
- $5,000 from GA-EMS
- Travel Budget
- Device Manufacturing Budget
- Planned Total
- $3,350
- Leftover
- $1,650
- May attempt a second design to prototype should funds allow

Budget Breakdown		
Device Manufacturing Budget:	Travel Budget:	**Leftover:**
$350	$3,000	**$1,650**
Total =	**$3,350**	

Travel Budget			
Description:	**Price ($):**	**Quantity:**	**Source:**
Gas (To and from Phoenix)	$50	1	Gas Station
Parking (Airport)	$14	5	Airport Lot
Flight (Round Trip)	$580	3	American Airlines
Uber (Airport – Hotel)	$70	2	Uber
Hotel (Two Rooms)	$200	4	Average online
Uber (To and from GA)	$200	N/A	Uber
Total Cost =	**$3,000**		

Device Manufacturing Budget			
Part Description:	**Part Price ($):**	**Quantity:**	**Source:**
Aluminum Bolt	$1.50	2	Amazon
Gate Latch	$6.88	4	Amazon
Nitinol Wire (2.4 mm)	$9.96	2	Amazon
Aluminum Block	$36.99	1	Amazon
Screw	$2.25	4	Amazon
Spring	$3.99	1	Amazon
Nuts	$0.50	4	Amazon
Total Cost =	**$92.46**	**($150 allotted to account for tax/shipping)**	
Manufacturing Total: $150	**Testing Total: $100**	**Repairs Total: $100**	**Final Total: $350**

Figure 8: Budget Plan

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Questions?