UNITED STATES MILITARY ACADEMY
WEST POINT

Team SNIP: Smokeless Nylon Incision Project

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INTRODUCTION

Cargo parachute assemblies are used by the DoD to deliver heavy aerial supply drops. Each of these systems utilizes a component called a reefing line which assists with safe and consistent deployments of the parachute by temporarily restricting the opening diameter of the parachute. The reefing line cutter is an integral component whose function is to cut the reefing line approximately two seconds after deployment, allowing the parachutes to fully open and slow to a safe drop speed. The current reefing line cutter has been in use for 40+ years without redesign considerations, costs upwards of $1,500, and is not reusable.

Figure 1: Opening Sequence for Supply Drops

CHALLENGE

Design an updated, reliable, and cost-effective replacement for the current de-reefing system that will satisfy all thresholds in Table 1. This solution should focus on reliability, cost effectiveness, and compatibility with current systems.

Table 1: Engineering Design Specifications List

Characteristic	Threshold	Objective	Mech	Elec-Mech
Delay Timer	Two seconds	Variable delay options	Objective	Threshold
Cut through two piles of ½” tubular Nylon	With tension acting on nylon	Without tension	Testing	Threshold
Compatible with…	G-11 parachute assembly	G-16 parachute assembly	Objective	Objective
Operating Temperature	30-100°F	-60-140°F	Threshold	Threshold
Operation	No special handling	Pure Mechanical	Objective	Threshold
Rigging Process	Small changes	No changes	Objective	Threshold
Separation Method	Separate	Cut	Objective	Objective

DESIGN

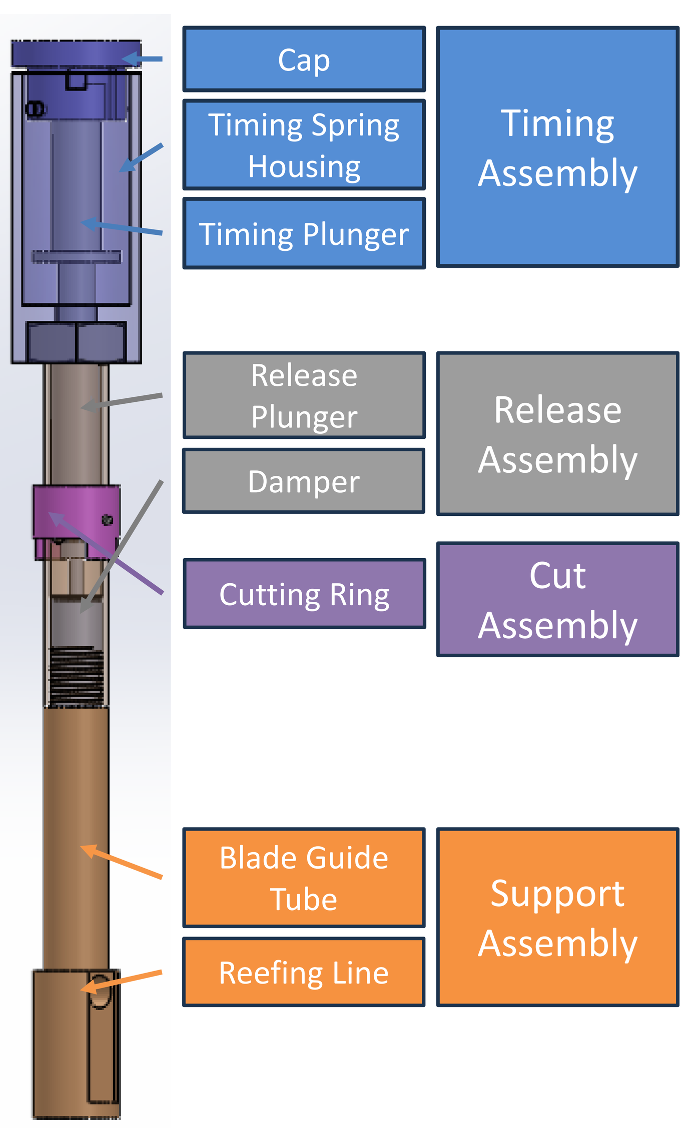


Figure 2: Mechanical Assembly

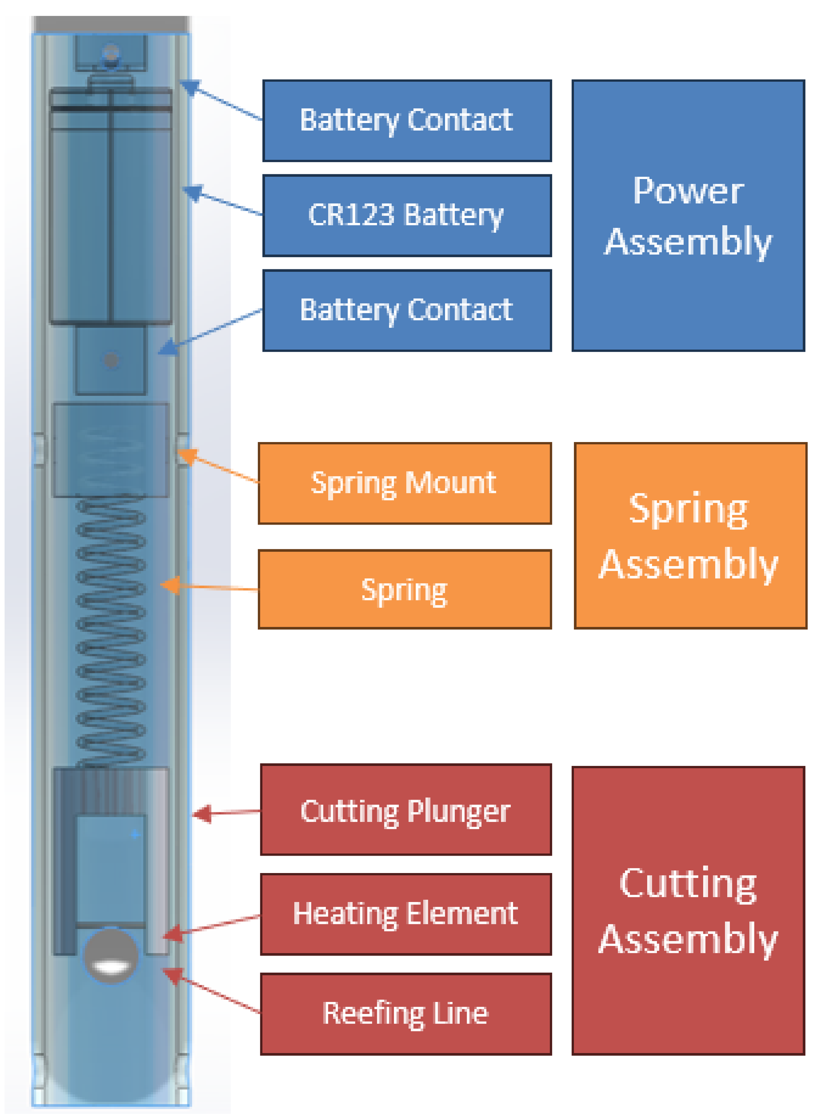


Figure 3: Electro-Mechanical Assembly

PROTOTYPE

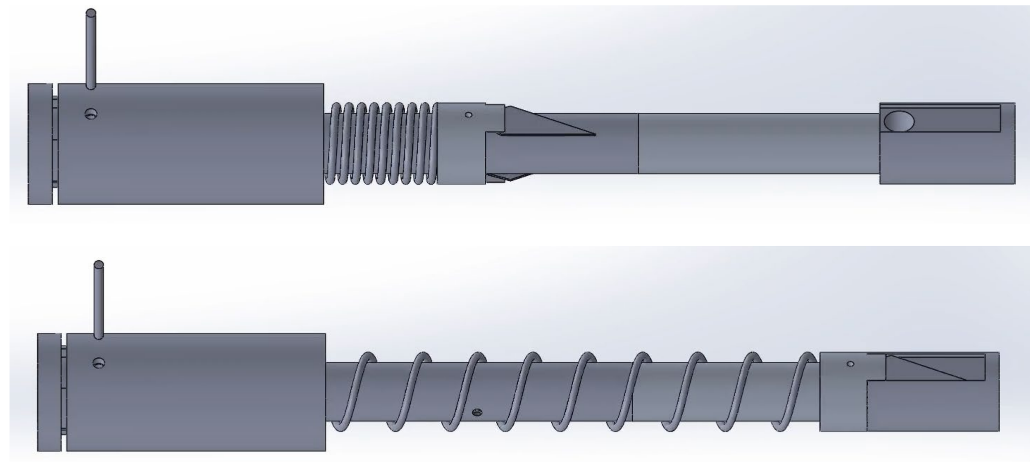


Figure 4: Mechanical Design Before and After Cutting

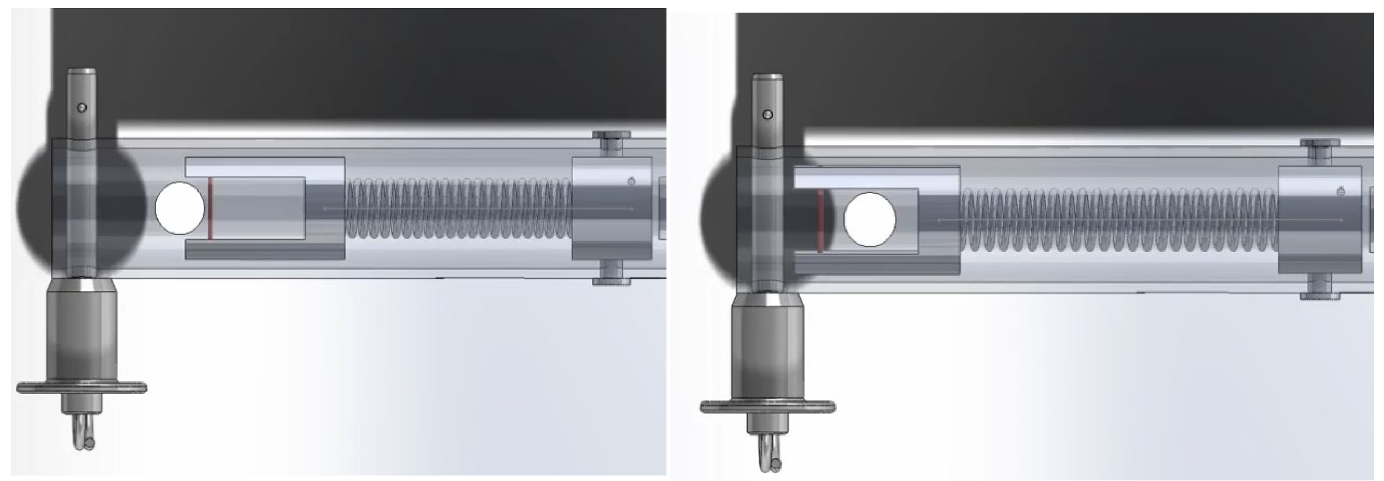
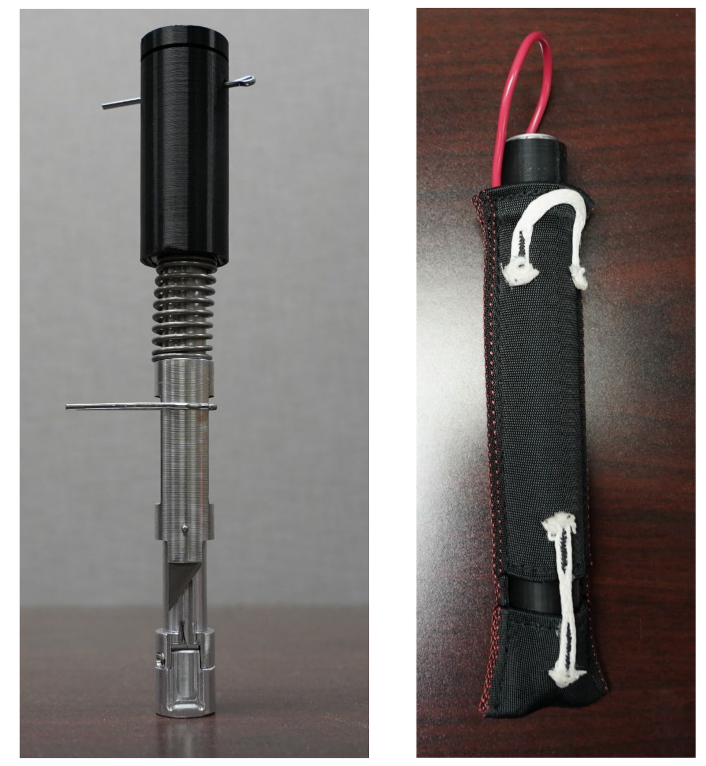


Figure 5: Electro-Mechanical Design Before and After Cutting



a) b)

Figure 6: Final Prototypes. a) Mechanical Design. b) Electro-mechanical Design

ANALYSIS

MATLAB and SolidWorks simulations for the heating time of the wire and the nylon in contact with the heating element determined that the electro-mechanical solution would be simple, yet effective within the time constraints. An ordinary differential equation modeling the position of the damper under a force of linearly changing magnitude offered proof of concept for a fully mechanical timing solution.

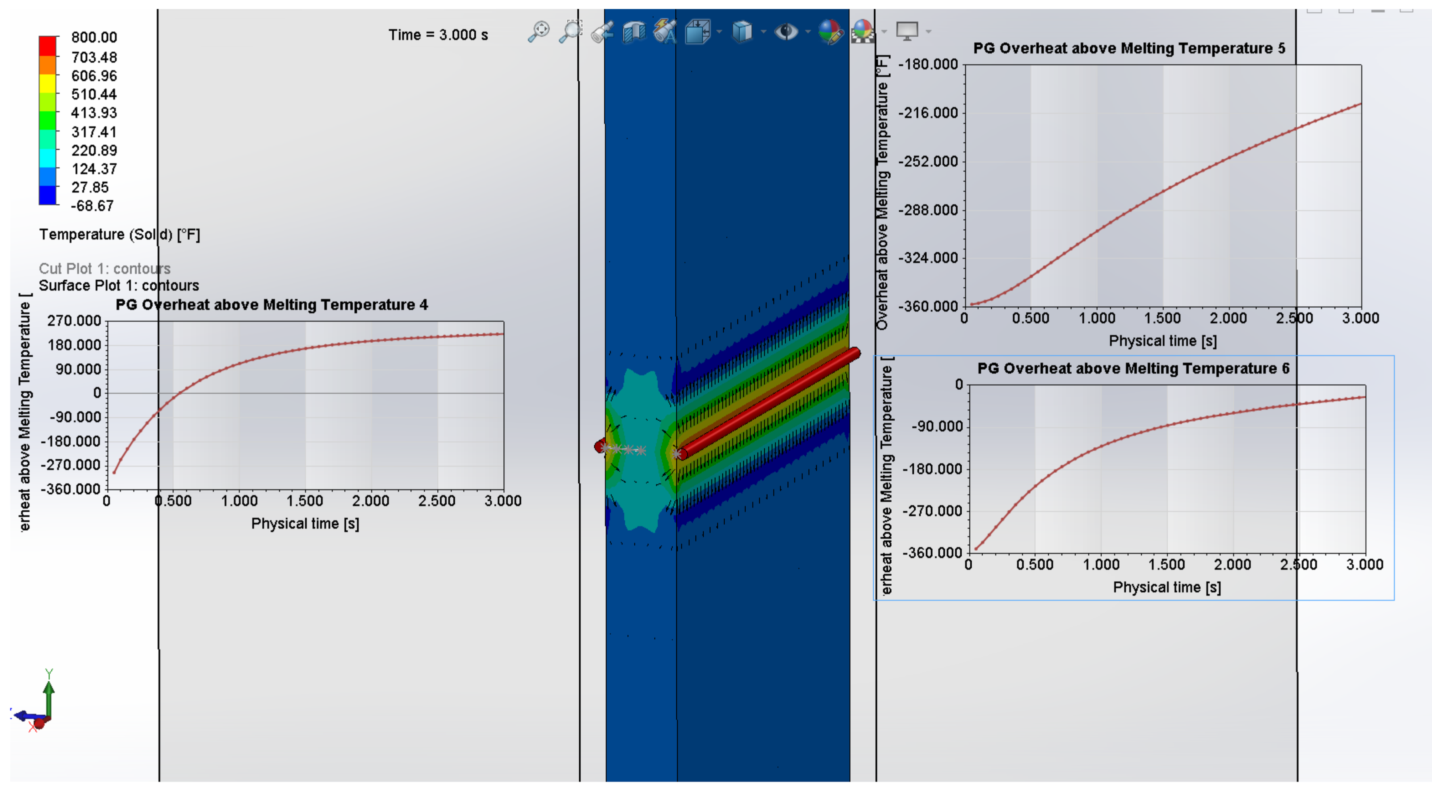


Figure 7: SolidWorks Simulation of Time to Reach Melting Point of Nylon-6

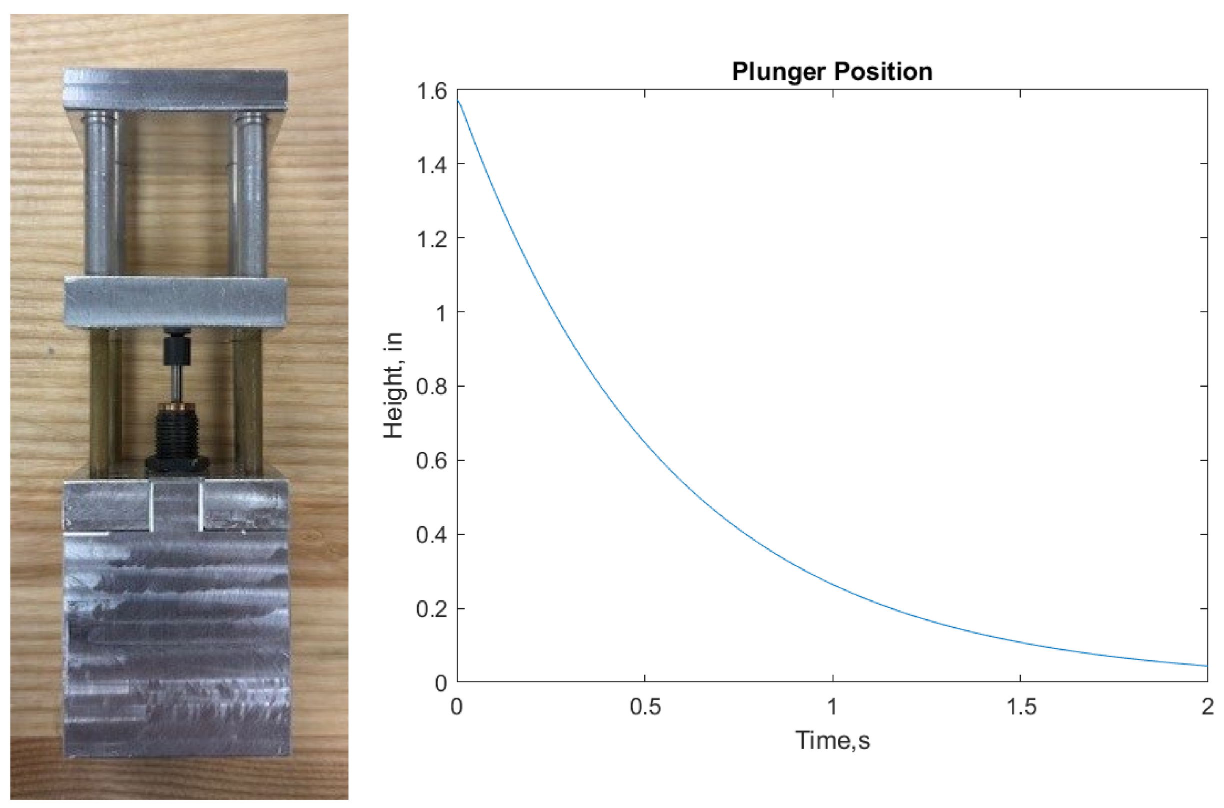


Figure 8: Damper Testing and Modeling

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FOLLOW-ON WORK

Further implementing the testing plan

- Test reuse of expendable components: batteries, heating wire, precision blades.
- Cold temperature, wind tunnel, and impact test.

Iterative design process

- The electromechanical design’s strength will be evaluated to determine whether more robust materials are required to withstand impacts in operation. Wiring will be further refined.
- The mechanical design will simplify components to reduce manufacturing lead time and manufacturing requirements.

CONCLUSIONS

Two competing solutions were developed to produce a superior reefing line cutter. Both the mechanical and electromechanical solutions are viable and meet all the threshold specifications. Both solutions are significantly more cost effective than the current device which enables more training and capabilities for the warfighter. These solutions can be used in conjunction with each other for increased redundancy, or further testing can determine the best solution and validate each solution. Each provides a significant launching point for future development.

Table 2: Engineering Design Specifications List

Bill of Materials - Mechanical Design		
Part Number	**Item Description**	**Price Total**
3742K11	Adjustable Shock Absorber with Inch Threaded Body Mount	$88.38
5544N21	Trade Number 21, 1.575" Long x 3/8" Wide Blade. **Pack of 5.**	$2.80
1986K527	302 Stainless Steel Corrosion-Resistant Compression Springs	$13.81
2EYZ7	Aluminum Rod 7075: 1 in Outside Dia, 12 in Overall Lg,	$22.33
1986K525	302 Stainless Steel Corrosion-Resistant Compression Springs. 1.5" Long, 0.845" OD, 0.685" ID. **Pack of 6.**	$35.82
1968T82	High-Strength 2024 Aluminium Tube 0.083" Wall Thickness, 5/8" OD	$38.42
94846A214	Medium-Strength Steel Thin Hex Nut Grade 5, 5/8" - 18 Thread Size	$5.96
1750T24	Multipurpose 304 Stainless Steel Round Tube	$37.52
	Prototype: Total Cost of Materials	$245.04
	Current Device: Total Cost	$1500.00

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