Tethered Asteroid Line Offload Navigator (TALON)

Roy Anderson, Jorge Arredondo, David Gomez, Huy Nguyen, David Perez
Faculty Advisor: Kazi Md Masum Billah, NASA Mentor: Cassie Bowman
Mechanical Engineering Program – College of Science and Engineering
University of Houston Clear Lake

ABSTRACT

- Team TALON is developing a controlled cable deployment mechanism for the low-gravity surface of asteroid Psyche.
- The design uses controlled payout, tensioning, and straightening to reduce tangling and protect cable integrity.

PROJECT BACKGROUND

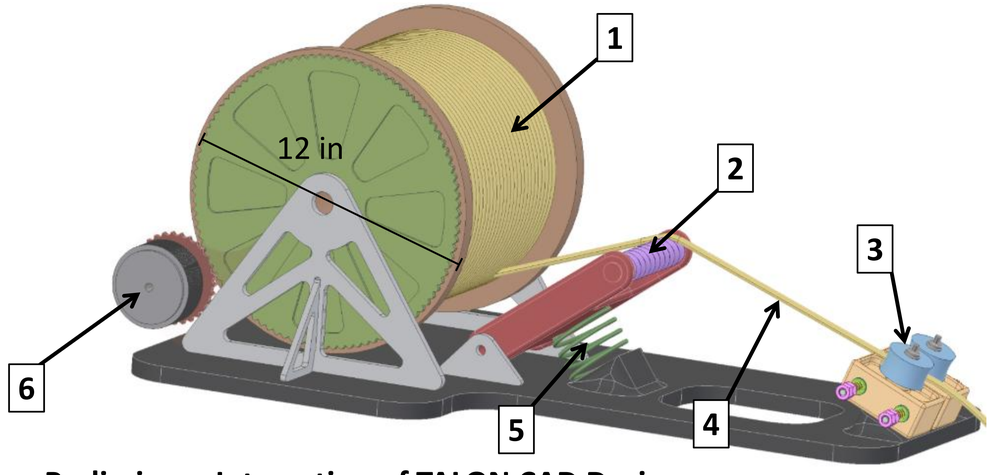
- Psyche's extremely low gravity (1/68 of Earth's) reduces surface contact forces, making conventional cable dragging and tensioning difficult to control.
- Stored cables often retain their coiled shape (cable memory) after deployment, an issue previously observed during the Apollo 12 mission.
- Previous tether mission indicate that inadequate tension can result in slack, binding, and uncontrolled payout.



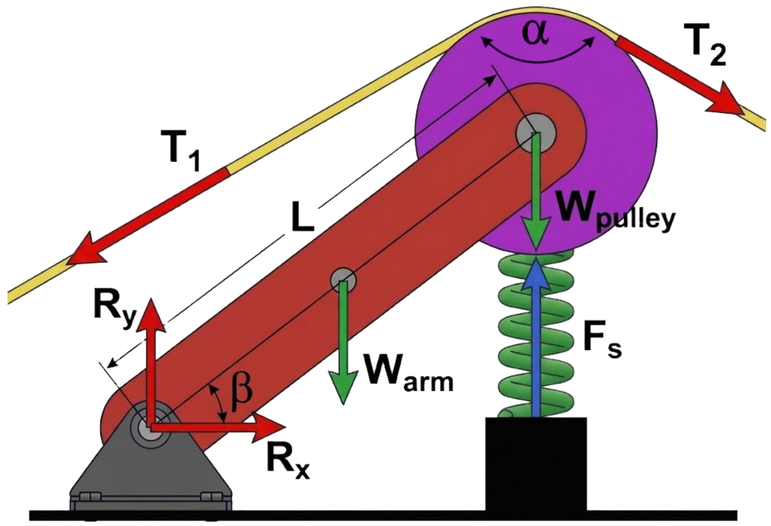
OBJECTIVES

- Develop an autonomous mechanism to deploy 1,000ft (scaling to 1km) of cable across Psyche's surface
- Straight-line deployment, no tangling
- Actively regulate cable tension and slack
- In-line straightening (removes coil "memory")
- Verified continuity post-deployment

RESULTS & DISCUSSION



Preliminary Integration of TALON CAD Design



Free Body Diagram of Spring Tensioning Mechanism

Item No.	Part
1	1km Spool of Cable
2	Lever Arm & Roller
3	Wire Compressor Extruder
4	Cable
5	Spring Attachment
6	Spool Motor

Physical Parameters:
$Arm\ length = L$
$Pulley\ Radius = r_p$
$Spring\ Length = L_0, L_s$

Dependent Variables:
$Pulley\ force = F_p$
$Pulley\ Speed = N$

Performance Targets:
$Cable\ Tension = T$
$Deployment\ Speed = V$

End Goal:
$Spring\ Force = F_s$
$Spring\ Rate = k$

Assumptions and Parameters:

$$T = 9\ lbf$$
$$V = 4\frac{in}{s} = 0.33\frac{ft}{s}$$
$$r_{bend} \geq 4.4\ in \rightarrow r_p = 6\ in$$
$$L = 15\ in$$
$$Arm\ angle = 45°\ from\ horizontal$$
$$Cable\ angle(\alpha) = 120°$$
$$Spring\ lengths:\ L_0 = 8\ in,\ L_s = 6\ in$$
$$w_{pulley} = 5\ lb$$
$$w_{arm} = 10\ lb$$

Spring Analysis:

$$N = \frac{60V}{2\pi r_p} = \frac{60(4)}{2\pi(6)} = 6.37\ RPM$$
$$F_p = 2Tcos\left(\frac{\alpha}{2}\right) = 2(9)cos\left(\frac{120}{2}\right) = 9\ lbf$$
$$F_s = F_p + w_{pulley} + 0.5w_{arm}$$
$$F_s = 9 + 5 + 0.5(10) = \mathbf{19\ lbf}$$
$$k = \frac{F_s}{(L_0 - L_s)} = \frac{19}{(8-4)} = \mathbf{4.75\ \frac{lbf}{in}}$$

FUTURE WORK

- Build and test a physical prototype of the spool-tensioner-straightener assembly next
- Finalize motor selection and run FEA for sizing
- Integrate features from other concepts to boost reliability

CONCLUSIONS

- Established preliminary development of a Psyche cable deployment mechanism
- QFD, Pairwise Comparison, and Decision Matrix selected the Cable Tensioner design
- CAD and calculations support design feasibility

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REFERENCES

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