Space Wire Bender

Team Members: Brandon Peffer, Nicolas Adams, Zeke Blanco, Raul Gutierrez, Oscar Rodriguez
Faculty Advisor: Dr. Micheal Thorburn
Aerospace Corporation Liaisons: Horace Lee, Antonela Pinola
Department of Mechanical Engineering
College of Engineering, Computer Science, and Technology
California State University, Los Angeles

Background

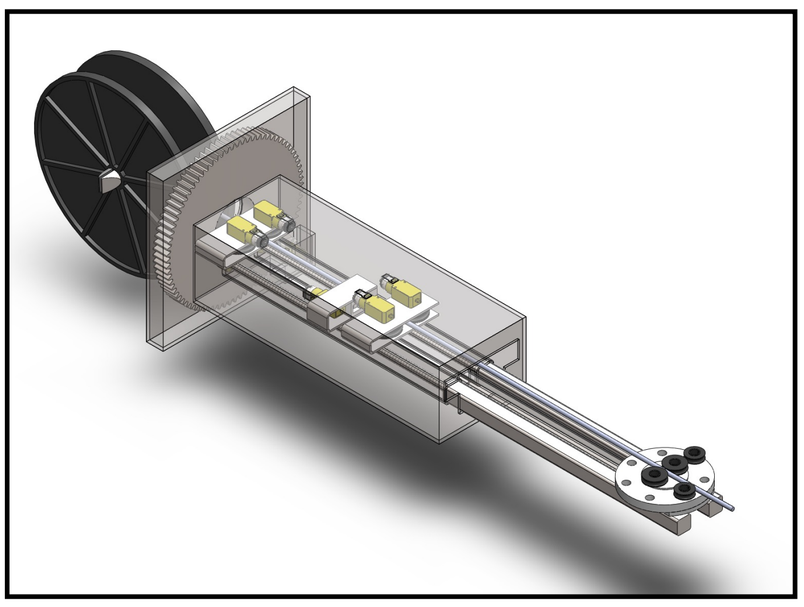
The COSMIC Capstone Challenge asked students to develop a conceptual design of a payload hosted on board a BCT X-Sat Venus Class Bus. This payload must demonstrate an ISAM (In-space Servicing, Assembly, and Manufacturing) capability using three operations. The team researched problems and noticed risks with large-scale construction in space and the sustainability of current design principles in space. Most satellites are designed to function and then be deorbited once they malfunction or are damaged, are exceedingly expensive to make, and are not intended to be repaired.

Objective

Construction of space structures is expensive and time-consuming. To solve these problems, a device is proposed that bends wire to form structures quickly, accurately, and autonomously in LEO for large-scale space construction. This device must fit within the fairing of a BCT X-Sat Venus Class satellite. It must draw wire from a spool, feed that wire into position accurately and quickly, and complete bends to fabricate truss blocks and other shapes as required.

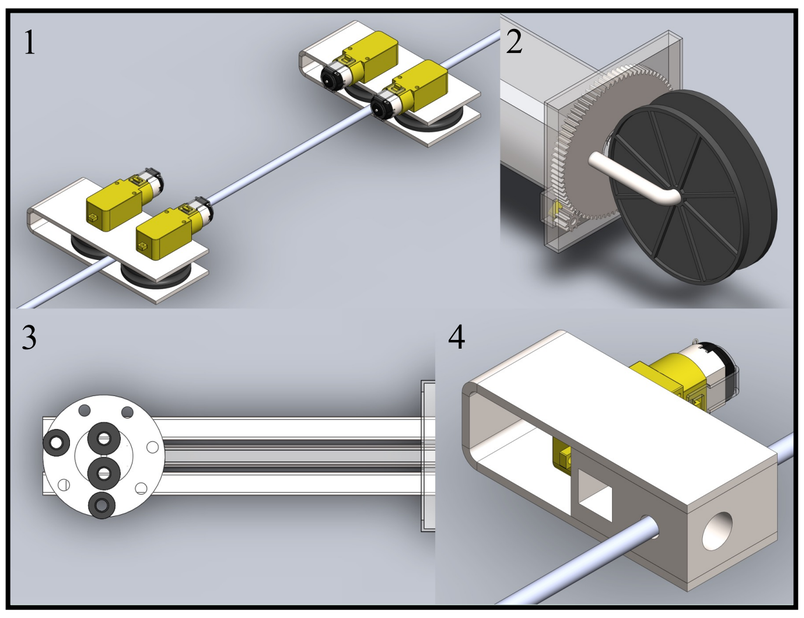
Space Wire Bender Design

System & Controls



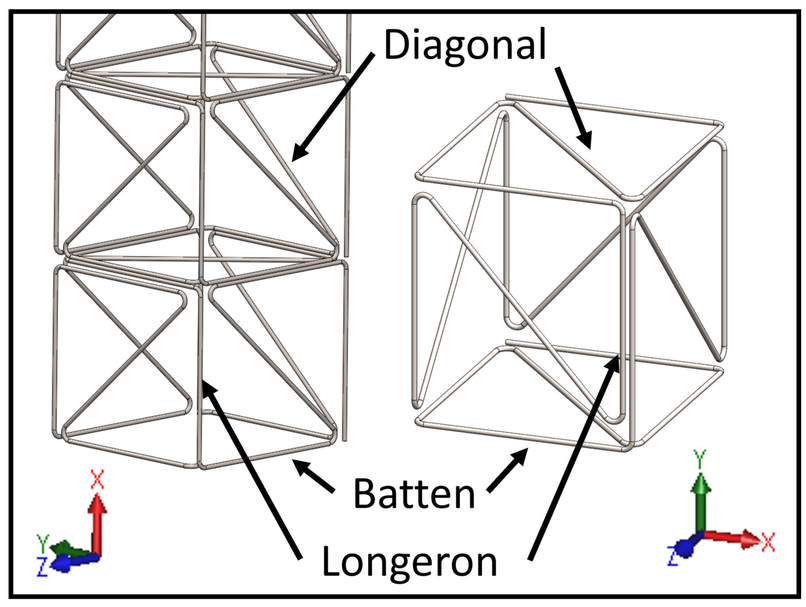
- The final design is 27"x11"x11" in compact form, weighs 61 kg and aims to use 220-240W of power
- The technology's conceptual design highlights that it is created for 6 years operational life in LEO (Low Earth Orbit)
- Material selection is based on preexisting and approved satellite materials (E.g., Ti-6Al-4V shell, Kapton insulation, and D2 steel bender heads)
- Low risks mitigated by design, critical failure risks mitigated by redundancy of motors and failsafe operations monitored by sensors
- Overall technological readiness level of 2 highlighting a completed conceptual design for initial stepping-stone of ISAM ecosystem

Subsystems



1. Feed
   - Rollers pull the material from the spool into place for other processes along with the bending head deployment allowing for accurate positioning
2. Rotator
   - Large gear located on the back of the device holds the spool of material, this allows the spool to be rotated 360 degrees
3. Bender
   - A rotary draw bender bends the material to the desired angle in both clockwise and counterclockwise directions
4. Cutter
   - An enclosed cutter cuts the wire so the final truss can be removed from the device to be used in other processes. Contains and stores all generated debris within

Truss Blocks



- 316 SS wire, AWG 4 (0.204”) dia.
- SmallSat structures, supports & fasteners

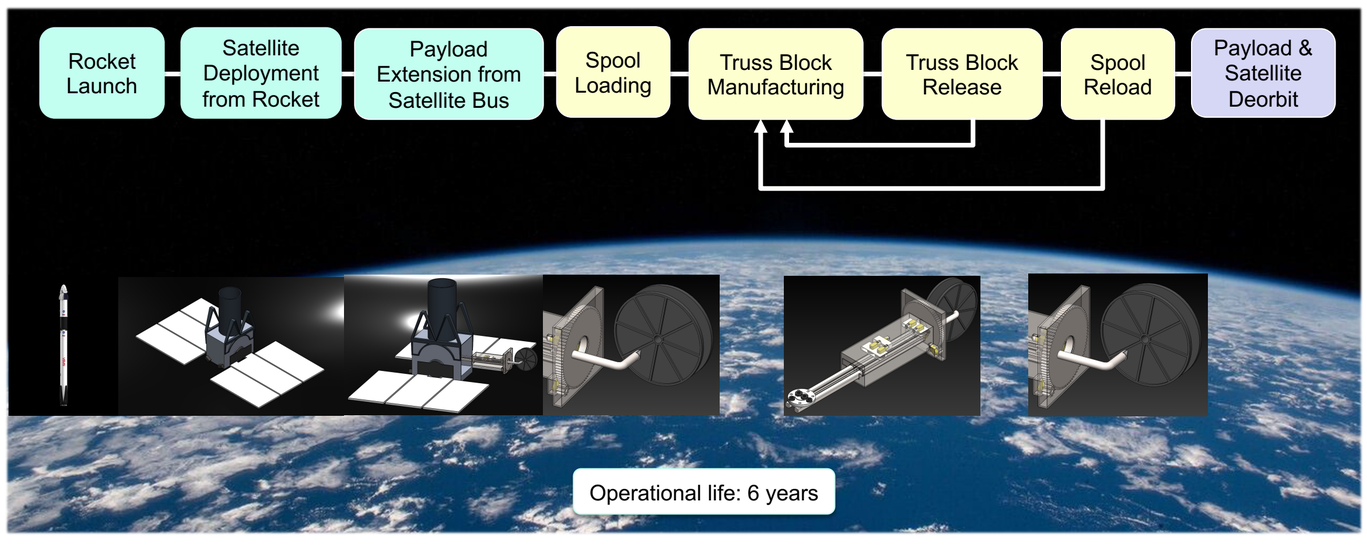
- Modular Truss Blocks
  - Blocks (3D): cube, pyramid
  - Panels (2D): rectangle, triangle
  - Complex shapes

- Supports
  - Brackets, connectors

- Fasteners
  - Wire ties
  - Wire snap fits

- Application & Impact
  - SmallSat booms, frame panels
  - SmallSat factory
  - Scaled up to larger satellites

Projected Operation Lifecycle



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