Multi-Use Laparoscopic Stapler

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Background

- Medtronic's Signia™ surgical stapler cuts tissue and deploys staples in a Tri-Staple™ pattern, but current technology is limited by single-use firing capability, leading to wasted time and increased surgery risk

Full Signia™ System

Cartridge Reload

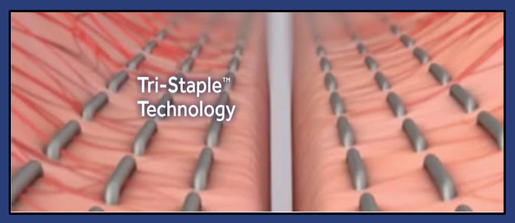
"Trocar" (Instrument Port)

Objective

- Reduce time and risk during surgery by developing a staple transport mechanism to enable multiple reloads without removal from the trocar
- Use Medtronic's agile product development method to iteratively prototype a proof of concept through sprints

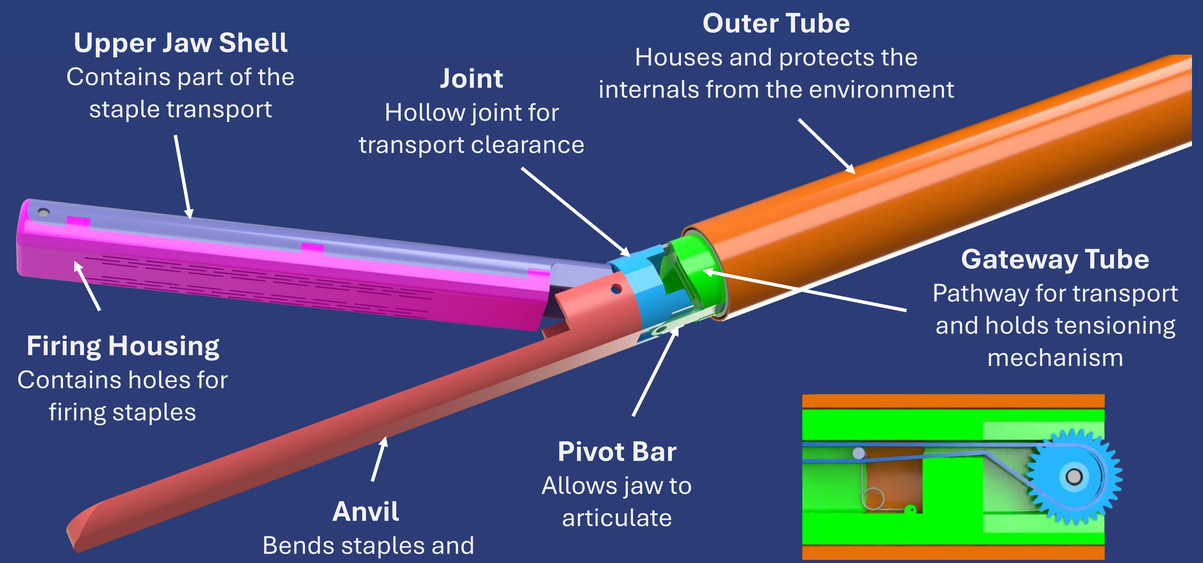
Requirements

- Stapler is reloadable without removal from the trocar
- Maintain Tri-Staple Technology pattern
- Jaws can articulate 45º in both directions
- Fits in 12mm trocar at 1x scale



Medtronic's Patented Tri-Staple Pattern

Insert Through Trocar → Articulate & Clamp → Staple & Cut → Unclamp → Return to Neutral → Transport New Staples → Repeat Until Empty → Remove From Body

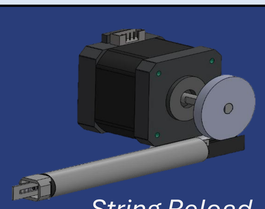


Gear and Belt Assembly (Proximal)

Initial Ideation Sprint

- **Goal:** Decide between reloadable and multiple cartridges
- **Outcome:** Selected String Reload for further development

Bolt-action Reload



String Reload

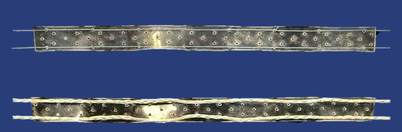
Jaw and Conveyor Belt Sprint

Transport Mechanism Prototype

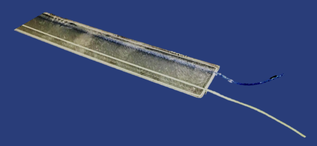
- **Goal:** Solve transportation issues with string reload and redesign jaw
- **Outcome:** Successful transport testing, unsuccessful articulation testing, further belt development during following sprint

Belt Sprint

- **Goal:** Fix articulation concerns and finalize the belt material
- **Outcome:** Dynamic tensioning mechanism and continuous mesh belt system



Belt and "Lily Pad" Prototypes



Molded Silicone Belt With Inlayed Cables

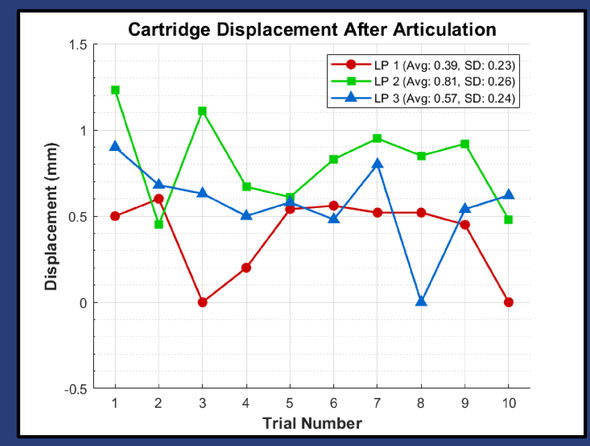
A sincere thank you to Hannah Steketee, Erin Morell, Dr. Kelsey Scalaro, and the CU Design Center Team

Final Sprint

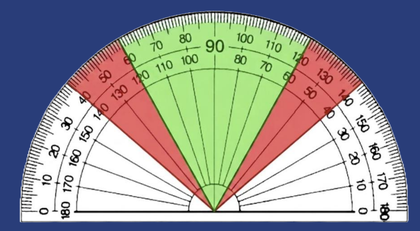
- **Goal:** Develop a 3x scale prototype and address cable shear-out failure
- **Outcome:** Hernia mesh and molded silicone belt for staple suspension and transport, torsion spring tensioning mechanism, fully operational prototype

Test Results

- GO/NO GO plate initially proved staple alignment
- Cartridge alignment examined across 10 trials, with average displacements of 0.39–0.81 mm across the three lily pads



Cartridge Alignment Test Data



Articulation Test Visual

Impact and Future Work

- Prototype → market ready product:
  - Integrate with Signia System
  - Alter firing mechanism
  - DFM adjustments for 1x scale
- **Contribution to Medtronic's IP in the form of a provisional design patent**