

## 1. About Me

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**McGill University**

B.Eng. Mechanical Engineering  
Class of 2026

## DESIGN PHILOSOPHY & APPROACH

My approach to design starts by breaking a complex problem down to its core functions: what does this system actually need to do, and what is the most direct way to achieve each function? From there, I rebuild upward into an assembly that works effectively and consistently.

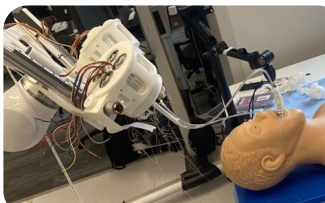
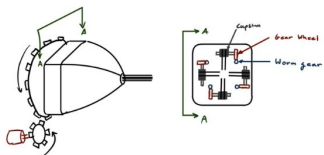
Because most of my work has been in prototyping, I draw on whatever best serves each function. Sometimes that's off-the-shelf hardware like gears, screws, shafts, shaft collars, and bearings, where precise mechanical behavior matters. Other times it's custom 3D printed housings and geometry, where the assembly needs a shape no catalog part provides.

## SKILLS & TECHNICAL EXPERTISE

**Mechanical & Prototyping:** Mechanism design, CAD (SolidWorks, AutoCAD, Revit), 3D printing & rapid prototyping (FDM/SLA), FEA, CNC machining

**Software & Hardware:** Python, MATLAB, Java, Arduino

## Portable Soft-Robotic Platform for ENT Surgery



### 2.0 Overview

Physical prototype setup featuring tendon-actuated continuum robot testing on a medical mannequin.



### THE PROBLEM & SOLUTION

**The Problem:** Rigid-body surgical robots, such as the Da Vinci system, are highly effective but are not well suited for the tight, curved anatomy of the ear, neck, and throat.

**Our Solution:** Our multidisciplinary team designed a portable, tendon-actuated continuum ("soft") robot capable of safely navigating this complex anatomy.

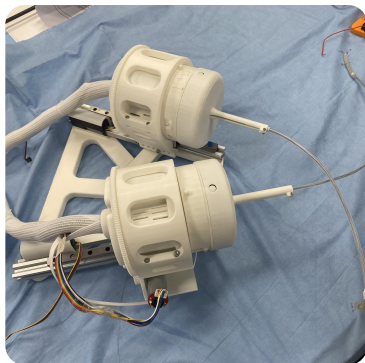
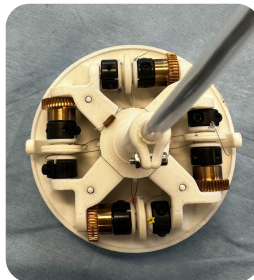
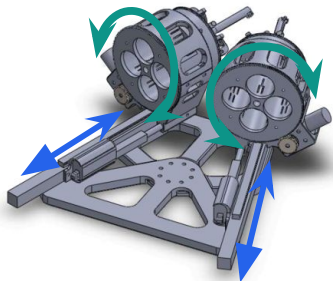
**The Result:** We manufactured and successfully tested the final prototype on a medical mannequin. *Received the McGill Engine Capstone Design Prize for our work.*

### MY ROLE & RESPONSIBILITIES

Working as part of the McGill SuPER Lab, spearheaded physical product development for the platform.

- Responsible for end-to-end mechanical design of hardware
- Conceptualized, CAD-modeled, and 3D-printed custom components
- Assembled the complete mechanical system

## 2.1 Cassette Configuration



### Four-Way Symmetric Assembly:

Compact design integrating internal antagonistic drive capstans and global rotational axis.

### THE PROBLEM & SOLUTION

**The Problem:** Controlling a two-segment, S-curving end effector required compact tendon routing and the entire system needed to be able to rotate and translate horizontally.

**The Solution:** Established radially symmetric, four-way layout. Entire system is mounted on a rotating mount which is then mounted on a linear actuated rail.

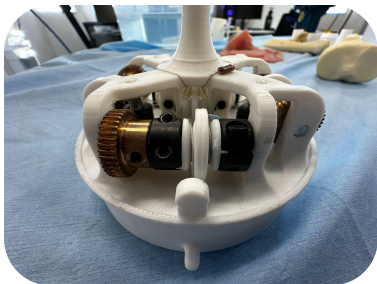
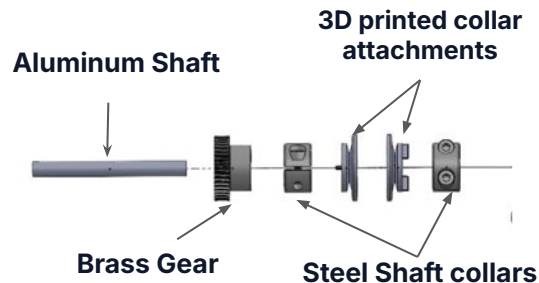
### MECHANISM & RESULTS

- **Internal Antagonistic Drive:** 4 units drive pairs of tendons via counter-oriented capstans on single shafts.
- **Global Rotation:** Symmetric routing lets the body rotate globally via an external gear interface.

**The Result:** 8 tendons provide independent S-curve motion while global rotation enables intuitive surgical tool reorientation.

**The entire design is mirrored with an identical unit to provide control of two end effector tools**

## 2.2 Capstan Tensioning and Torque Transfer



**Shaft Exploded View Assembly:** Off-the-shelf steel collar provides high-torque shaft grip while a 3D-printed attachment holds the tendon.

### THE PROBLEM & SOLUTION

**The Problem:** Mounting and tensioning individual capstans under immense worm gear torque required removable, adjustable components that wouldn't slip on the shaft or require complex machining.

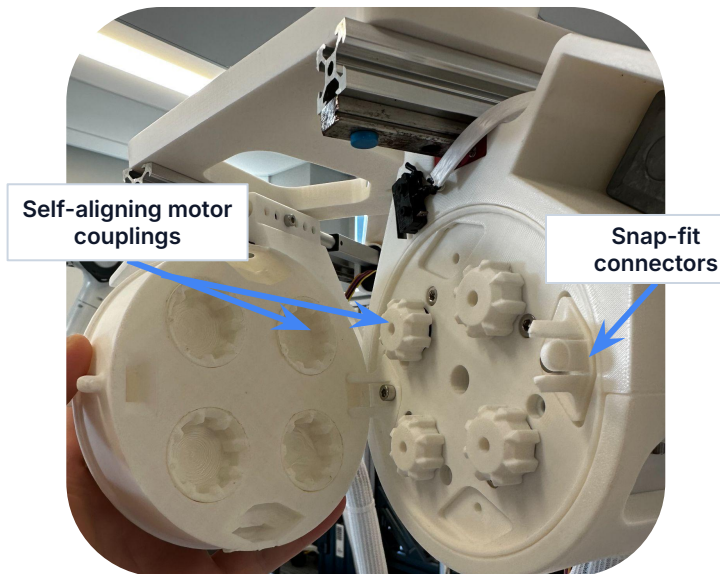
**The Solution:** Broke the assembly into two distinct sub-components, decoupling the mechanical shaft grip from the complex tendon geometry.

### DESIGN SUB-COMPONENTS & RESULT

- **Off-the-Shelf Grip:** A standard two-piece steel shaft collar bites into the aluminum shaft for a tight, high-torque grip.
- **Custom Geometry:** A 3D-printed attachment holds the tendon, featuring a flange locked by the steel collar's internal grooves.

**The Result:** Creates a seamless torque path with easy tendon tie-off built cleanly from one catalog part and one simple print.

## 2.3 Motor Housing and Cassette Interface



**Quick-Release Self-Aligning Interface:** Coupling with angled grooves guides components into alignment for seamless snap-fit attachment.

### THE PROBLEM & SOLUTION

**The Problem:** The surgical cassette must be disposable and sterilizable, while heavy drive motors must be reused. Requires a reliable quick-release interface.

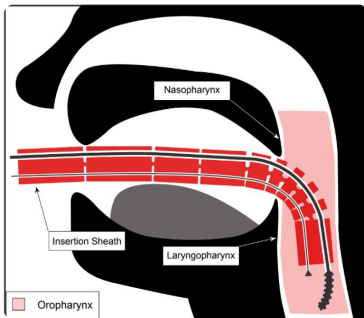
**The Solution:** Designed a motor coupling attachment with self-aligning angled grooves that force components into perfect rotational alignment upon push-together.

### MECHANISM & RESULTS

- **Angled Physical Guides:** Grooves force components into alignment regardless of initial rotational angle.
- **Single-Motion Operation:** Attach or detach cassette effortlessly in fast-paced clinical settings.

**The Result:** Intuitive snap-fit connection that completely eliminates manual alignment in clinical environments.

## 2.4 Surgical Insertion Sheath



**Multi-Segmented Polymer Sheath:** Engineered for pure snap-fit assembly to provide anatomical stabilization and integrated tool routing.



### THE PROBLEM & SOLUTION

**The Problem:** Soft-robotic catheters lack independent rigidity, requiring structural guidance to safely navigate tight throat geometry without tissue trauma.

**The Solution:** Designed an all-plastic, multi-segmented sheath utilizing pure snap-fit joints. This eliminates all secondary fasteners to optimize Design for Assembly (DFA).

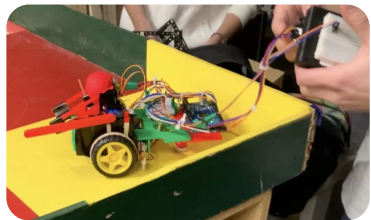
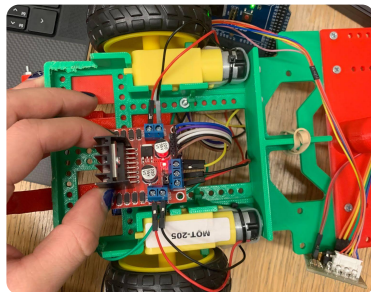
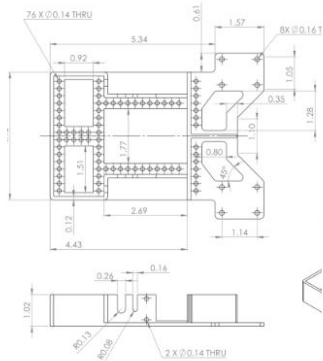
### MECHANISM & RESULTS

- **DFA-Optimized Snap Fits:** Interlocking polymer segments snap together directly by hand, reducing the BOM
- **Integrated Multi-Lumen Routing:** Internal channels guide the catheter and borescopes simultaneously, keeping optics aligned with the surgical tool.

**The Result:** Delivers a rigid, anatomically contoured corridor that stabilizes flexible tools while cutting assembly down to simple, tool-less push-fits.

### 3. Featured Project - McGill Design Challenge

## 3. Remote Controlled Vehicle



**Modular 3D-Printed Chassis:** Custom 79.4g lightweight chassis with integrated M3 mounting grid and weight relief.

### THE PROBLEM & SOLUTION

**The Problem:** Navigate a course (30° slope, lift, target) under a 12"<sup>3</sup> volume, 4-motor, and \$120 budget constraint. Mechanism failures required rapid pivoting.

**The Solution:** Engineered a highly adaptable core architecture and strategic off-board power management to easily iterate subsystems.

### ADAPTATIONS & RESULTS

- **Rapid Subsystem Swaps:** Pivoted directly from failed scissor lift to direct-drive bar lift & 60° gravity ramp.
- **Off-Board Power (690g):** Relocated power supply off-chassis to ensure max torque for the 30° incline.

**The Result:** Vehicle successfully completed all course objectives, demonstrating that built-in modular redundancy is key to rapid design pivots.