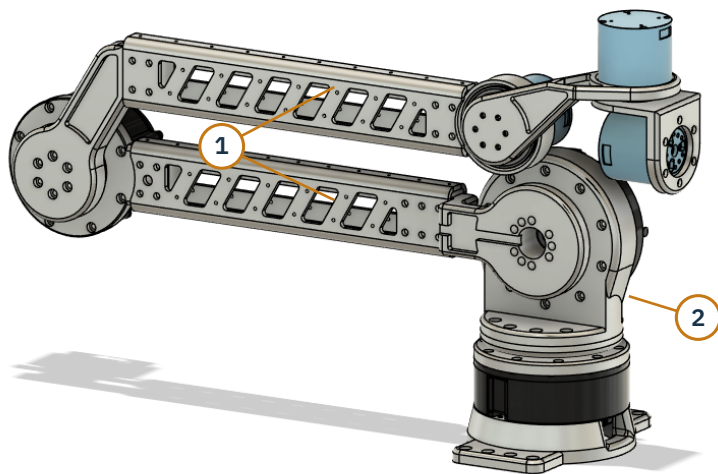


Custom 6-DOF manipulator

Red Rabbit Robotics | Robotics Mechanical Designer | Sep 2025 - Apr 2026

MECHANICAL ARCHITECTURE / JOINT PACKAGING / BUILT HARDWARE



Newer CAD revision for easier assembly at the quoted manufacturer. 1 Truss-reinforced links. 2 Joint packaging.



Earlier built arm in operation (00:20), preceding the CAD at left. Garment mass is not quantified by this image.

Problem & constraints

Replace a commercial YAM arm with a custom manipulator for **2 kg garments and general handling, including boxes**. Joint packaging, structure, and manufacturing cost constrained the design.

My responsibility

I proposed the custom arm and owned its mechanical architecture, joint packaging, and structure.

Teammates handled manufacturing and software.

Evidence: newer assembly-focused CAD and an earlier built arm. The payload and cost below are reported project outcomes, not measurements from these images.

Consequential design decisions

- 1 Develop reusable joint modules.** I developed six joint architectures and explored their integration across seven arm configurations. The work extended beyond one assembled arm.
- 2 Make assembly practical.** The newer CAD revision was oriented toward easier assembly within the capabilities of the lower-cost manufacturer that quoted the work.
- 3 Carry useful architecture forward.** The CAD architecture, joint modules, and structural design principles were reused in subsequent company arm designs.

Built

Earlier custom 6-DOF arm

2 kg+

Demonstrated payload

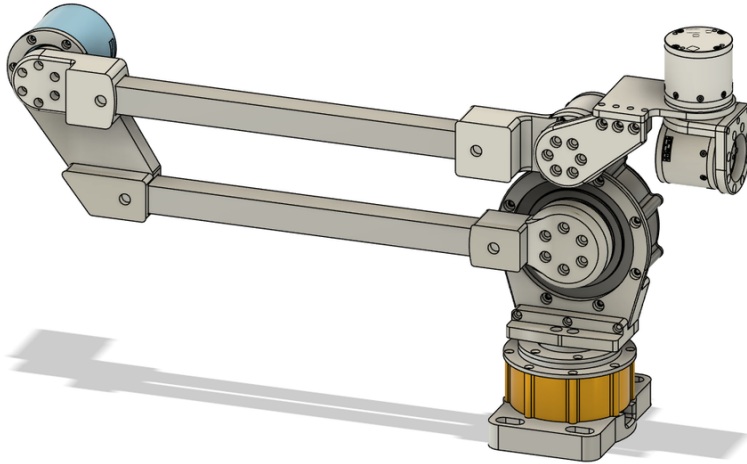
~C\$1,700

Components + manufacturing

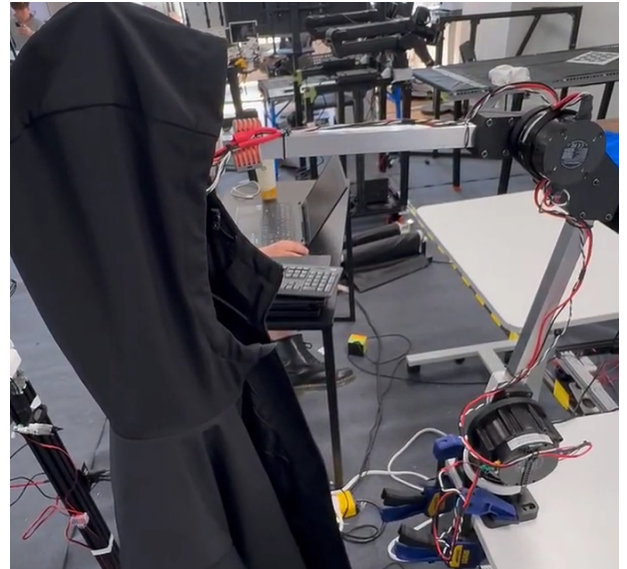
Arm specialization & field validation

Red Rabbit Robotics | Garment-focused arm design and separate portable conveyor

GARMENT MANIPULATION / WHOLE-ARM MASS / SEPARATE HIL RIG



Garment-focused arm CAD: later revision of the page 1 manipulator family.



Later garment-focused arm handling a garment. Owner-supplied wider video frame; no conveyor operation shown.

Specialize the garment arm

The arm shown above is a later, **garment-only design** with payload slightly above 2 kg. Lighter motors helped reduce **whole-arm mass, including motors, by ~70%** versus the page 1 arm.

Separate portable conveyor

Separately, I built a carry-on-sized conveyor from PVC, bearings, and printed components for garments up to XL. It traveled with the robot and enabled continuous HIL testing without manual resets.

Design decisions & observed behavior

- 1 Reduce whole-arm mass.** The garment-only revision used lighter motors to lower self-weight while retaining payload slightly above 2 kg.
- 2 Design for continuous operation.** In the separate conveyor project, the portable rig supported repeated HIL testing without manual resets and traveled with the robot.

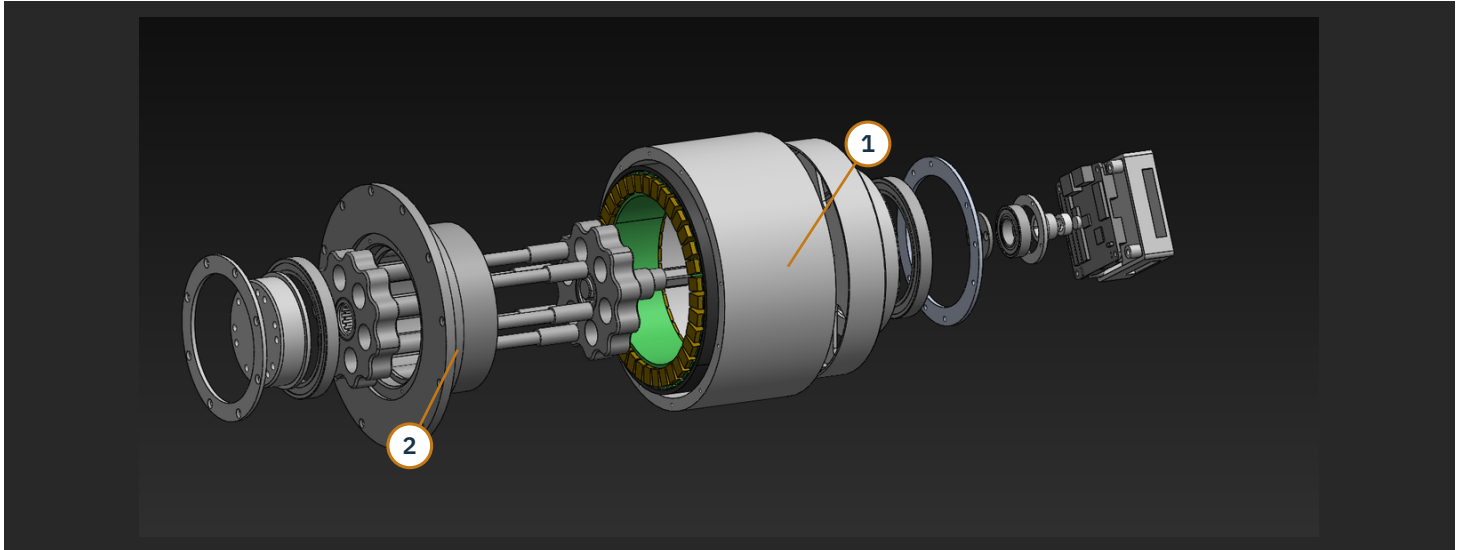
Project-level positioning observation: the software team observed approximately **2 mm camera-assessed vision-guided positioning error** across **100+ runs**, using a camera overlay. Neither image here is measurement evidence.

Measurement limit: mechanical repeatability was not independently measured. The error statistic (average, maximum, or typical) is unknown.

Cycloidal actuator | architecture

Personal mechanical design study | Dec 2025 - Feb 2026

CAD STUDY / ASSEMBLY UNBUILT / ACTUATOR-OUTPUT TARGETS



1 Frameless motor package. 2 Cycloidal reducer group. V2 exploded CAD shows the nested architecture and separate assembly groups.

44 / ≥ 140 Nm

Continuous / minimum peak output torque targets

60 rpm

Output speed target

11:1

Selected reduction

Problem & constraints

Develop a compact humanoid-leg actuator concept, motivated by a fast-running leg. The goals combine low reduction, backdrivability, torque, and packaging within a **120 mm diameter x 80 mm maximum envelope**.

My responsibility

I developed the mechanical CAD concept, explored transmission geometry, and considered manufacturing feasibility and cost. A frameless motor is available; **the actuator assembly was never built**.

Consequential design decisions

- 1 Package reduction inside the motor.** The architecture nests the cycloidal transmission within the frameless motor package to address the compact envelope.
- 2 Choose a lower-ratio concept.** V2 moved toward 11:1 with backdrivability and interaction with external loads as design objectives. These behaviors remain untested.

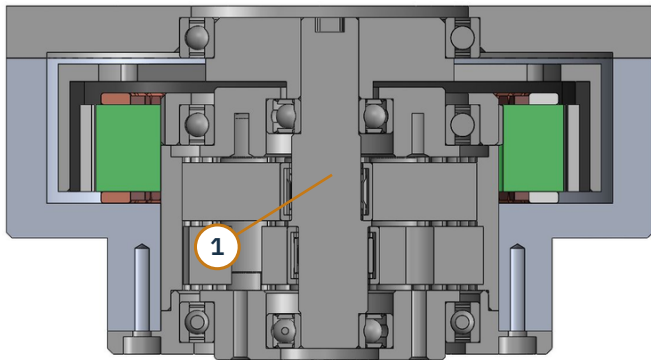
Current status: CAD evidence only. No completed contact FEA, physical testing, or FOC development.

Cycloidal actuator | design evolution

Geometry exploration, mixed-material interfaces, and manufacturing feasibility

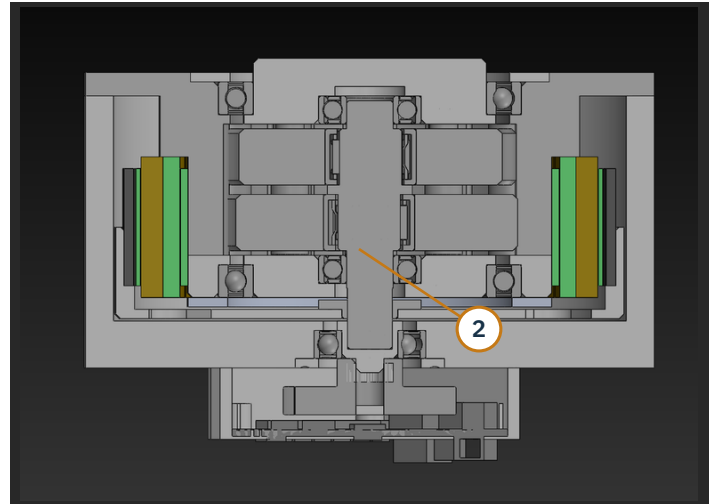
V1 TO V2 / PRESSURE ANGLE / EVIDENCE & LIMITS

V1 / HIGHER-RATIO LAYOUT



1 Initial transmission and motor packaging. Higher reduction; pressure angle was not a primary criterion.

V2 / LOWER-RATIO LAYOUT



2 Revised internal packaging. Lower reduction and closer attention to pressure-angle behavior.

DESIGN EVOLUTION / VIEWS NOT TO COMMON SCALE

Higher ratio and initial packaging → 11:1 concept and geometry exploration

Geometry choices

I compared **pressure angle versus rotation angle** in the ME Virtuoso online visualizer, including changes to eccentricity. The comparisons informed geometry choices; original plots and calculations were not retained.

Material interfaces

I considered differential thermal expansion between an **aluminum body** and **4140 steel gear components**. This was an interface consideration, not completed quantitative thermal or contact-stress validation.

Decisions, evidence, and next phase

- 1 Revisit geometry with the ratio.** V2 balanced lower reduction and interaction goals with pressure-angle behavior, available space, and mass considerations.
- 2 Estimate a complete single unit.** The ~US\$800 estimate includes the frameless motor, purchased parts, and machining. It is not a built-unit cost or a validated commercial saving.

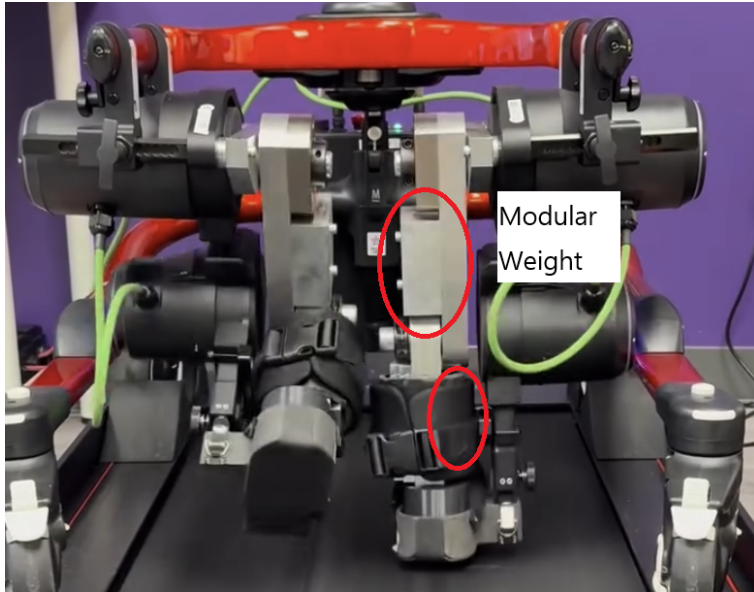
Engineering work remaining: contact and bearing loads, heat treatment, manufacturing fits, operating clearances, thermal behavior, and bench evaluation.

Outcome: revised CAD concept and a clearer geometry/packaging direction. Performance claims remain design targets.

Trexo Robotics | validation hardware

Mechanical Engineering Intern | Mississauga, ON | Jan 2025 - Apr 2025

LOAD DEFINITION / MODULAR FIXTURE / PRODUCTION SUPPORT



Owner-annotated fixture frame: red circles mark modular weight locations. The inner aluminum fixture blocks are my design; testing was company-run.



Trexo platform context. This platform photo is not presented as my fixture design.

Loading inputs: limb lengths + segment weights by age group → configurable fixture weights

Problem & individual responsibility

Represent pediatric gait loading across age groups from infants to pre-adults. I researched limb lengths and average leg-segment weights, **defined loading, and designed a modular fixture.** The company ran the durability test program.

Production and workflow support

I modified motor housing geometry around an **IP44 ingress-protection requirement.** Testing was completed and more than 100 modified housings were manufactured. My scope was mechanical housing design.

Consequential design decisions

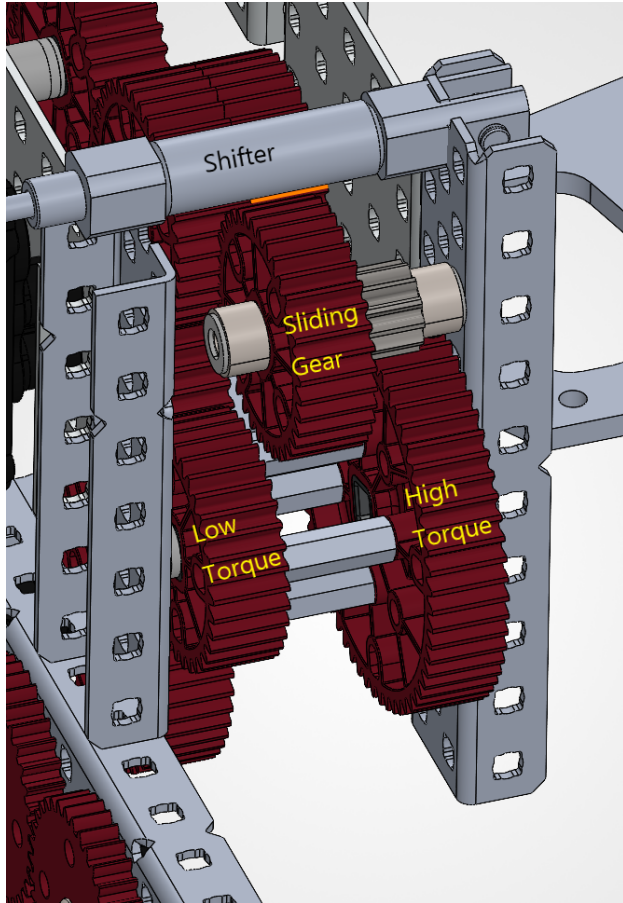
- 1 Use age-dependent inputs.** Anatomical segment lengths and weights informed representative loads instead of one fixed mass for all cases.
- 2 Make weights modular.** Square blocks provide modular thigh/shin loading; the inner aluminum fixture blocks are my mechanical design.
- 3 Automate an assembly-wide task.** My SolidWorks VBA script exported part STEP files and associated drawing PDFs across an assembly or BOM, replacing manual file-by-file exports.

[View the company-published fixture demonstration](#)

UWAT VEXU | dual-speed transmission

Mechanical Lead / Head Designer | Waterloo, ON | Sep 2023 - Mar 2025

GEAR PACKAGING / PNEUMATIC SHIFTING / SERVICE ACCESS



My dual-speed transmission CAD, used at Worlds in the 2024-2025 season. Labels identify the shifter, sliding gear, and torque paths.

PROBLEM & CONSTRAINTS

Fit a dual-speed drivetrain transmission inside an **18-inch robot envelope**, while managing mass, gear engagement, and repair access.

MY RESPONSIBILITY

I designed the layout, gear placement, drivetrain attachment, packaging, and pneumatic shift mechanism from scratch. Competition outcomes and robot integration were team efforts.

Observed outcome

The mechanism worked in its initial implementation and could shift while the drivetrain was moving. No full-load shifting or measured shift-time claim is made.

Consequential design decisions

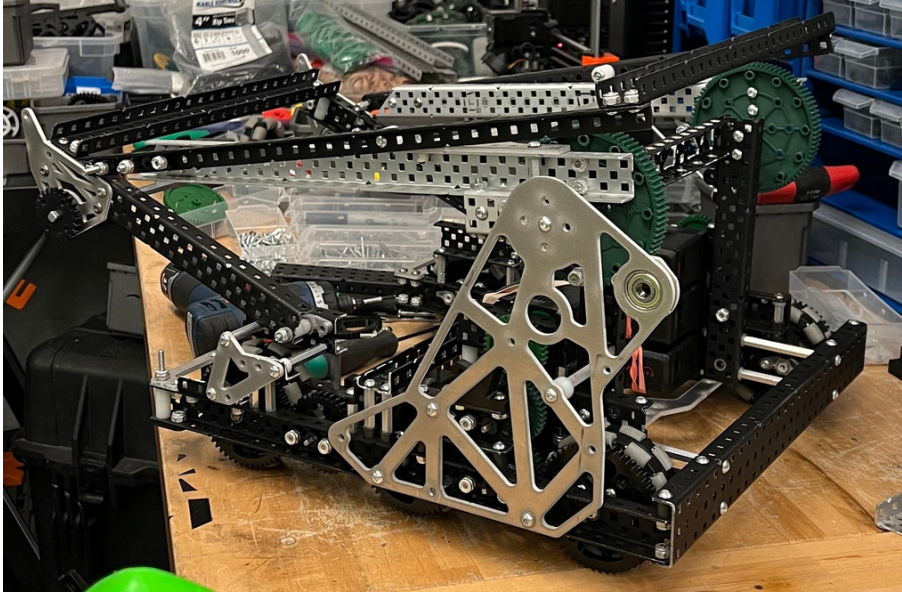
- 1 Select ratios with one moving gear.** A pneumatic shift mechanism moved one gear between low and high ratio selections. The compact gear layout and drivetrain attachment were designed together.
- 2 Consider entry into mesh.** I considered the shifting crown gear's tooth-entry angles and the mechanism guiding its movement, focusing on consistent engagement.
- 3 Design access before assembly.** I arranged the pneumatic mechanism and polycarbonate mounts so fasteners could be reached for disassembly and reassembly, anticipating difficult pneumatic fastener access.

Evidence: supplied labeled CAD and owner-reported operating behavior. Exact ratios and quantitative shift performance are not asserted.

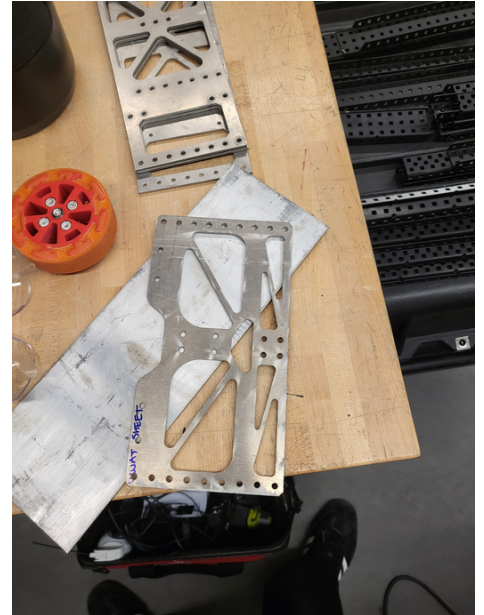
UWAT VEXU | design through fabrication

Mechanical design leadership, peer reviews, and manufacturing workflows

TOP-DOWN CAD / CNC WORKFLOWS / TEAM DEVELOPMENT



Application example: waterjet-cut plates installed on a team robot. This is not the 2024 first-seeded robot or an FEA result.



FEA-informed pockets in a waterjet-cut structural plate; a separate fabrication example.

1st seed

2024 Worlds division / team result

6 to 15

Mechanical team growth

~3 weeks

Reported iteration-time reduction

Problem & responsibility

Competition deadlines made avoidable collisions and manufacturing rework costly. I led mechanical design, established top-down CAD standards and CNC workflows, and recruited and mentored designers. Fabrication and competition performance were team contributions.

Outcome & status

The team earned **first seed in its division at 2024 Worlds with a different robot**. The ~3-week iteration reduction is a reported comparison with earlier improvised cycles.

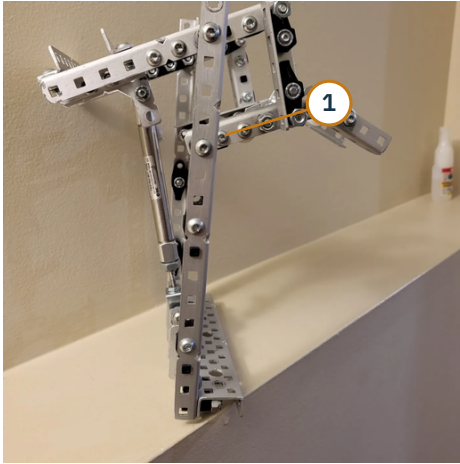
Consequential design decisions

- 1 Review before machining.** Structured peer reviews caught kinematic collisions and DFM constraints before parts reached fabrication.
- 2 Make workflows teachable.** Shared CAD and manufacturing practices supported growth from six to fifteen mechanical team members.
- 3 Connect design and manufacture.** Top-down CAD and CNC workflows gave the team a common path from assembly intent to manufacturable parts.

VEX Tipping Point | field mechanisms

Design, build & pit operations | British Columbia | 2020 - 2022

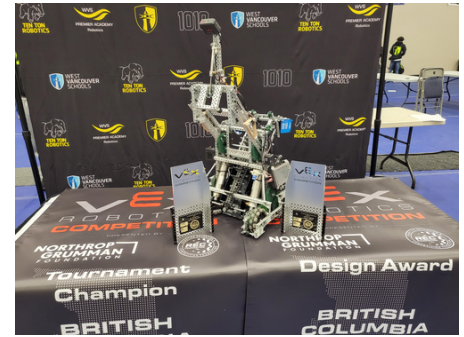
LINKAGE SYNTHESIS / COMPACT PACKAGING / PIT REPAIR



1 Clamp installed on the center workshop robot, not the award robot at right.



Workshop mobile-goal lift test; the clamp at left was installed on this robot.



1010A - 2022 BC Mainland Championship (Provincials).

Problem & constraints

Design mechanisms that fit the competition robot, stay within mass limits, and can be repaired between matches. I designed and built multi-bar linkages and kickstand mechanisms, and supported pit operations.

Individual work & team result

My scope covered mechanism design, build, and pit repair. Team 1010A earned **Tournament Champion and Design Award at the 2022 BC Mainland Championship (Provincials)**; the award robot did not use the clamp shown at left.

Consequential design decisions

- 1 **Tie sketches to hardware quickly.** Notebook sketches led to CAD and testing on the robot in the same week, keeping linkage synthesis connected to the physical mechanism.
- 2 **Package for a queue-side rebuild.** Compact linkages and quick-change mounting supported practical pit repair rather than only a visually clean assembly.
- 3 **Use the match cycle as feedback.** Spares, checklists, and failures between matches shaped subsequent hardware iterations.

ROBOTICS MECHANICAL DESIGN / JANUARY 2027 CO-OP

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