# Tech Titans — Cantilever Lift Bridge (Junior Design Competition 2024)

**Role & Result:** *Team Lead (concept & build lead; created the solution architecture and assembly plan). Outcome:* ***Top-5 overall***.

**Project Overview**

I led and collaborated with a four-member team at Toronto Metropolitan University to conceive, design, and build a cantilever lift bridge for the 2024 Junior Design Competition, earning a Top-5 placement. Our solution integrates water-based hydraulic actuation with a string-assist support path to deliver smooth, controlled lifting and reliable locking under load.

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**Objectives**

- Achieve controlled vertical lift via hydraulics.
- Increase clearance height to allow objects to pass under the deck.
- Improve locking and range of motion for repeatable operation.
- Maximize strength and stability so the bridge tolerates significant loads.

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**Architecture & Mechanisms**

- Cantilever lift configuration with deck supported by pillars; a string support shares load with the hydraulics to reduce stall and jitter.
- Hydraulic subsystem: paired water-filled syringes + tubing generate pressure to lift/close; interfaces were reinforced (glue, tape, rubber bands) to mitigate leaks where tube I.D. didn't match syringe nozzles. One syringe was filled and balanced to smooth open/close behavior.
- Structure & materials: two 12-inch cardboard plates reinforced with popsicle sticks for stiffness; straws guide the string path; paper clips and rubber bands provide compliant joints. Two 3-inch cardboard risers elevate the deck to fit the syringe geometry.

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**Build Process (highlights)**

1. Hydraulic setup & sealing (fit mismatch → reinforced joints).
2. Deck reinforcement; string path routed through straw guides.
3. Pillar alignment and deck-lift tests; syringe clearance shimming.
4. Iterations to reduce friction, backlash, and pressure transients.

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**Challenges & Root Causes**

- Pillars: insufficient lateral stiffness → global instability under lift.
- Hydraulics: leakage at syringe–tube joints due to diameter mismatch; pressure transients created non-uniform motion.
- Axle/string path: friction/backlash contributed to uneven up/down movement.

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**Improvements Implemented & Proposed**

- Structure: add cross-bracing; consider balsa/stiffer sections to raise buckling load; verify weight distribution across supports.
- Hydraulics: match tubing to syringe nozzles; try different syringe diameters to tune force–stroke trade-offs and reduce leakage risk.
- Testing: prototype earlier; frequent load tests to refine locking geometry and repeatability

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**Results**

- Achieved functional lifting with water-based hydraulics assisted by string tension, demonstrating the core mechanism and range-of-motion goal. Reliability gaps were identified (pillar stiffness, leak points) with a clear path to stability via bracing and proper hydraulic sizing. Placed in the Top-5 overall at the Junior Design Competition.

**Figure 1.** Tech Titans lift-bridge prototype

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**Skills & Tools**

Rapid prototyping; structural reinforcement; basic fluid power (hydraulics); leak-proofing methods; test-driven iteration; build sequencing; team leadership and coordination.

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**Supplementary materials**

The complete project package including the slide deck, build notes, and demonstration clips—is available here: JuniorDesign_competition. The prototype was conceived and executed by Gaber Soltan (Team Lead), together with Touka Zain El Dein, Mariam karanib, and Mazen Awad.