

# **CASE STUDY: SOLVING A COMPLEX CAP CLOSURE CHALLENGE**

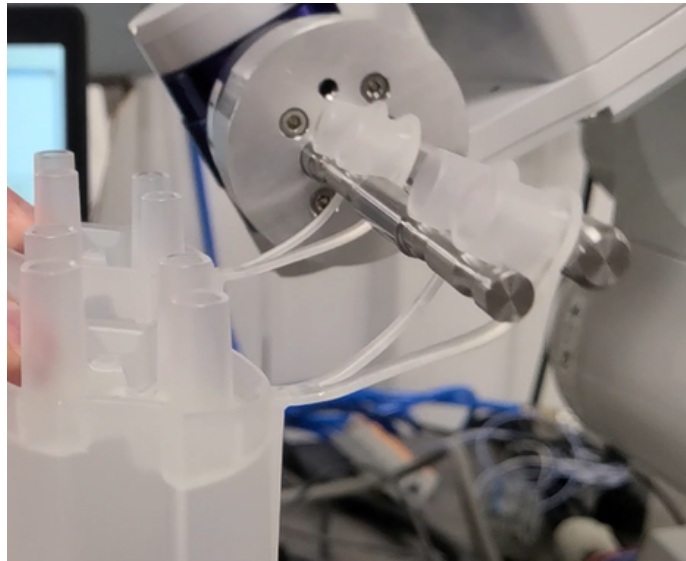
HOW ITERATIVE ENGINEERING AND THE EPSON C4 SIX-AXIS ROBOT  
DELIVERED A ROBUST, MAINTENANCE-FREE CAP CLOSING STATION  
FOR A GLOBAL MEDICAL DEVICE OEM.



## OVERVIEW

Tessy Automation was awarded the largest piece of equipment in company history by one of the world's leading medical device manufacturers. The project centered on an automated assembly and inspection system for a medical vacuum filter a complex consumer-facing product requiring precision, speed, and reliability at every station.

While a machine of this scale presents numerous engineering challenges, the team encountered one that stood above the rest: closing tethered caps on the filter's inlet ports in a way that was robust, repeatable, and fast enough to meet cycle time.



## THE CHALLENGE

The medical vacuum filter features tethered caps that must be closed over inlet ports before the finished product reaches the end user. The engineering requirements were clear but demanding:

- **Robustness:** The cap closure had to perform consistently across thousands of cycles without degradation.
- **Repeatability:** Every closure had to meet the same quality standard no variability, no misalignment.
- **Cycle Time:** The station had to keep pace with the broader system throughput without becoming a bottleneck.

Complicating matters, the filters were closely pitched, limiting the physical space available for tooling and actuation. The team needed a solution that could work within tight mechanical constraints while still meeting all three performance targets.



## THE SOLUTION

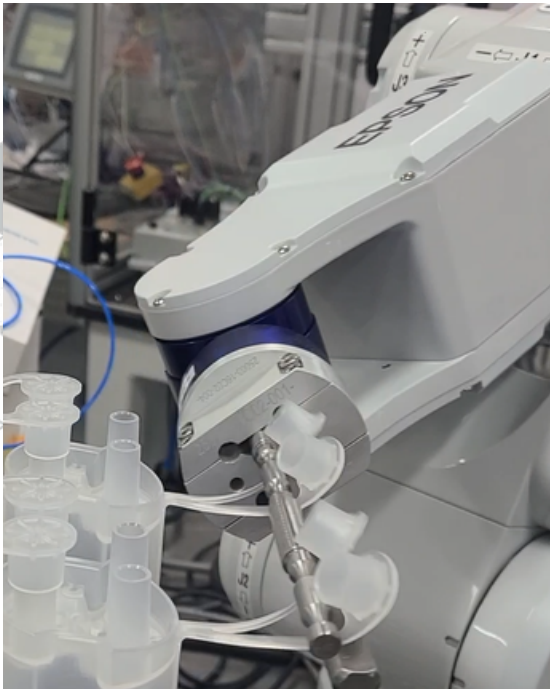
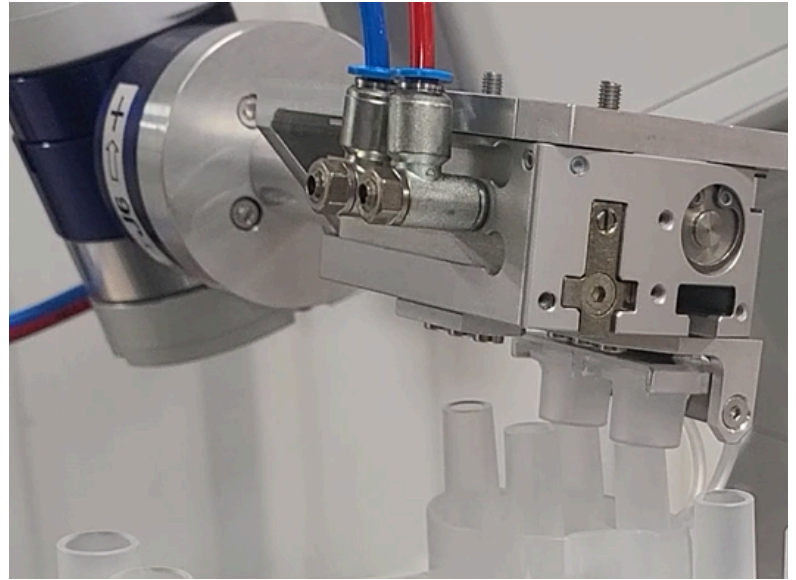
Tessy Automation's engineering team pursued two design iterations, each building on lessons from the last.

### ITERATION 1:

#### PARALLEL GRIPPER APPROACH

After weeks of concepting, the team developed an initial design utilizing a parallel gripper mounted to an Epson C4 six-axis robot. The gripper applied tension to the tether near the filter housing, locating the caps in dedicated tooling. The C4 managed the complex motion required to close the caps on each port.

This approach proved robust and repeatable, but it fell short on cycle time. The close pitch of the filters allowed only one set of caps to be closed per robot, creating a throughput limitation that the production schedule could not accommodate.



### ITERATION 2: ACTUATOR-FREE DESIGN

The team's breakthrough came from a fundamentally different approach: eliminating the actuators from the end-of-arm tooling entirely. The redesigned tool used two stationary fingers mounted parallel to each other and to joint six of the Epson C4 robot.

Rather than relying on a mechanical actuator to grip the tether and position the cap, this design leveraged the robot's own sixth axis. By rotating joint six, the C4 clamped the tether under tension and positioned the caps with precision replacing mechanical complexity with programmatic control.

The result was a station that could close two sets of caps per robot, achieving the required cycle time while maintaining the robustness and repeatability proven in the first iteration.



## THE SOLUTION & RESULTS

After numerous refinements, the final station delivered on every requirement—and then some:

- **Reliability:** Near-zero failures across extended production runs—including edge-case filter conditions the line would rarely encounter.
- **Maintenance:** The simplified end-of-arm tool design effectively reduced maintenance requirements, with no actuators to service or replace.
- **Tuning:** Minimal tuning required—the programmatic approach through the Epson C4's joint six provides consistent performance without ongoing mechanical adjustments.
- **Cycle Time:** Closing two sets of caps per robot met production throughput targets, keeping pace with the larger system.

This project demonstrates how Tessy Automation's iterative engineering process paired with the precision and versatility of the Epson C4 six-axis robot can turn a complex mechanical challenge into an elegant, low-maintenance solution. By replacing actuator-driven complexity with intelligent robotic motion, the team delivered a station that is simpler, faster, and more reliable.



### About Tessy Automation

Tessy Automation, based in Meadville, PA, specializes in designing, building, and integrating custom electro-mechanical automation solutions. With a 34,000 sq ft facility, a dedicated Solution Center, and a team of over 60 engineers and specialists, Tessy Automation delivers turnkey assembly and inspection systems for manufacturers in the medical device and consumer products industries.

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