

Automated Bioanalytical Tube Capping Device

Team: Sam Perez-Tamayo, Alec Onesti, Jake Jaeger,
Jonathan Evans, David Fiflis

Client: Dr. Robert Radwin

Advisor: Dr. Thomas Yen



Overview

- Problem statement
- Background
- Design specifications
- Designs considered
- Design matrix
- Future work
- References/acknowledgements

Problem Statement

The repetitive uncapping and capping of twist-top test tubes is taking a physical toll on the lab technicians at a local Madison laboratory. We have set out to construct a device capable of reducing some of this physical stress. Whether manual or automatic, the device should be able to remove the top from the test tube, hold it until the work on the contents of the test tube is completed, then securely screw the top back on in a more efficient manner than the current process. This would ideally minimize the risk of injury as well as the maximize time for more important work.



Background

- About one-third of all occupational injuries are the cause of repetitive motion and/or exertion (ergonomics) ¹
- Motions that cause Carpal Tunnel Syndrome (CTS): Wrist flexion/extension, ulnar/radial deviation, and forearm supination/pronation
- Lab technicians cap and uncap 500-700 test tubes/day, leading to increased risk of CTS and other physical problems
- CTS results in more days away from work than any other workplace injury ²
- Severe cases may even cause permanent disability
- Not only do companies lose an employee, but they also have to worry about legal complications

Background - Existing designs



Capit-All Screw Cap
Tube Capper/Decapper



PaR Capper



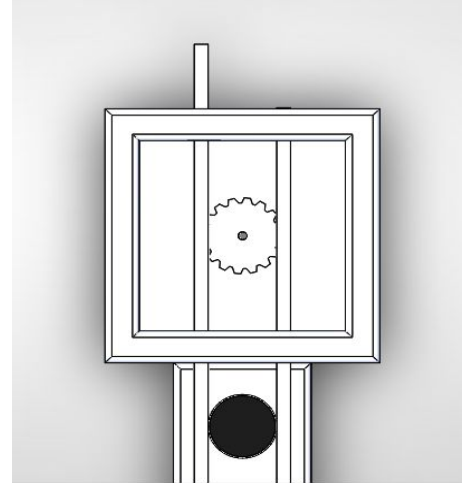
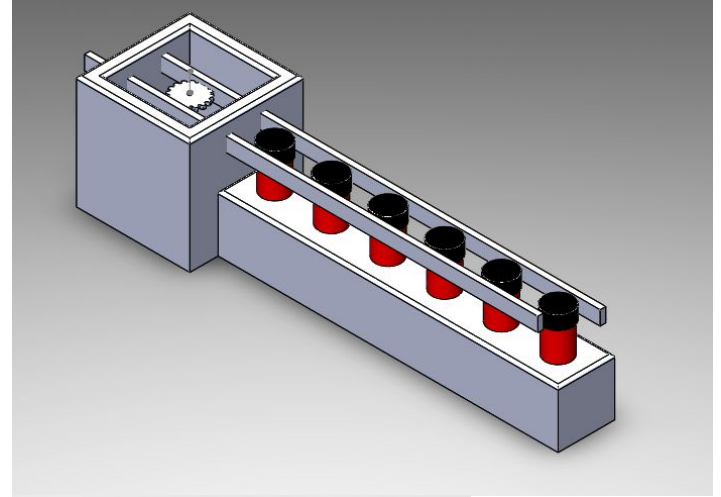
LabElite DeCapper

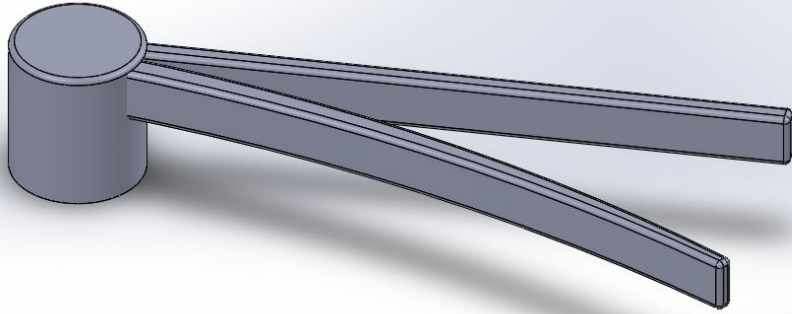
Design Specifications

- Stand-alone
- Minimize size; should be able to fit in lab space of limited workspace
- Low cost
- Low maintenance
- Designed for heavy use; uncap and cap roughly 10,000 test tubes per month
- Must be more efficient/fast than manual individual uncapping and capping
 - Preferable to uncap/cap multiple test tubes simultaneously
- Compatible with multiple sizes of test tubes
- Must work every time
- Easy for one technician to teach to another
- Ensure no cross-contamination

Parallel Bars

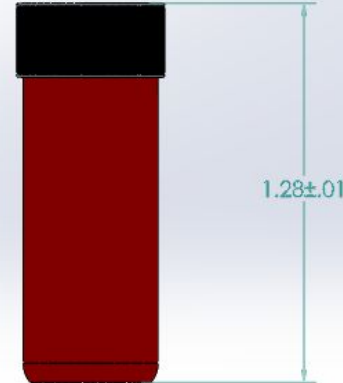
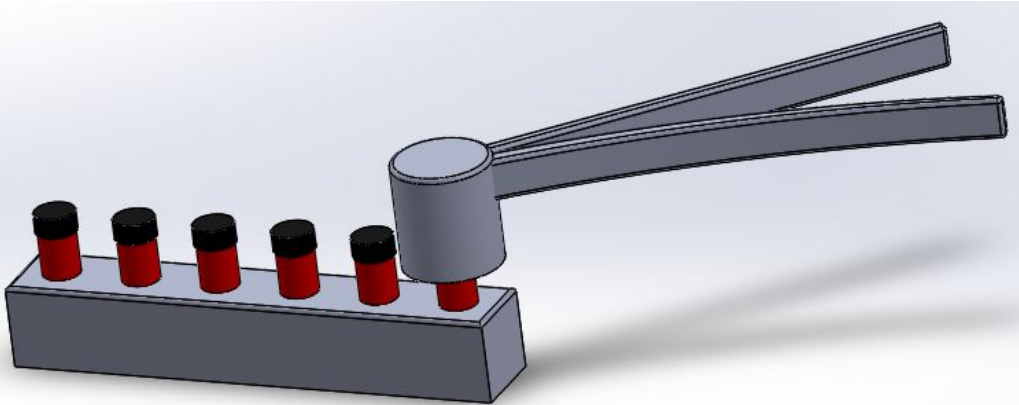
- Two bars pinch the caps of tubes and move in opposite directions, horizontally
- Allows for multiple tubes to be capped and uncapped at the same time
- Test tubes held stationary at the base (allows them to remain in test tube rack)
- Potential issue could be how caps are placed in and taken out without cross contamination





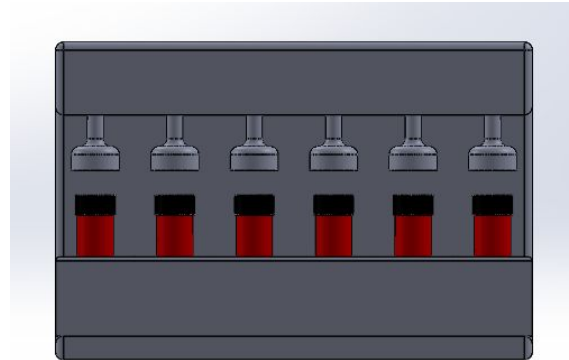
Single Grab

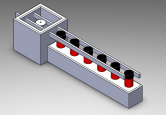
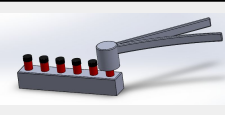

- Device uncaps and recaps a single tube at a time
- When handles squeezed, torsion applied to cap and removed



Multiple Grab

- 6 rotating heads that are used to uncap test tubes
- Test tube rack is lifted up to rotating heads and then removes cap
- Could be designed to have either more or less rotating heads



Design Criteria (Weight)	Parallel Bars 		Single Grab 		Multiple Grab 	
Reduction of manual effort (20)	4/5	20	1/5	5	3/5	15
Speed (20)	4/5	16	1/5	4	4/5	16
Success rate (15)	4/5	12	3/5	9	3/5	9
Versatility (10)	3/5	6	5/5	10	2/5	4
Durability/longevity (10)	3/5	6	5/5	10	4/5	8
Ease of fabrication (10)	3/5	6	4/5	8	3/5	6
Teachability (10)	4/5	8	5/5	10	4/5	8
Cost (5)	3/5	6	5/5	10	3/5	6
Safety (5)	5/5	5	5/5	5	5/5	5
Size (5)	4/5	4	5/5	5	4/5	4
Total	89		76		81	

Future Work

- Calculate torque required to twist test tube cap securely on
- Determine method that is able to adapt to multiple test tube heights
- Decide which design best fits clients needs
- How to prevent test tubes from slipping while being capped and uncapped
- Focus on avoiding contamination
- Formulate plan for testing designs

Future Work - After Client Visit

- All tubes are uncapped then placed in device
- Only sterile caps are used to re-cap tubes
- Find solutions to new difficulties:
 - Multiple tube diameters
 - Different height/diameter tubes in same testing rack
 - Caps are internally threaded and externally
 - Capping and uncapping are different processes
- Capping/uncapping relatively easy
- Arrange second visit to lab to present early model of design(s)



Acknowledgements

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References

- 1: “Common Injuries.” Accessed October 14, 2016. <https://vistalab.com/common-injuries/>.
- 2: Minnihan, Richard. “Carpal Tunnel Syndrome: A Rising Statistic Among Laboratory Workers.” *Bioscience Technology*, April 8, 2003.
<http://www.biosciencetechnology.com/article/2003/04/carpal-tunnel-syndrome-rising-statistic-among-laboratory-workers>.

Questions?

