Automated Bioanalytical Tube Capping Device

Advisor: Dr. Chris Brace (Dept. of Radiology)
Client: Dr. Robert Radwin (ISyE, BME)
Team: Jake Jaeger, Alec Onesti, Sam Perez-Tamayo, and Katie Werth

BME Design

Overview

- Problem Statement
- Background
- Design Specifications
- Designs Considered
- Design Matrix
- Future Work
- Acknowledgements/References

BME Design

Problem Statement

https://www.kch.nhs.uk/patientsvisitors/patients/tests-and-scans (1)

- Commercial testing laboratory requests an ergonomic uncapping device
- Technicians repetitively uncap and cap up to 700 sample tubes each day to fill a high-speed analyzing machine
    - Causes significant hand and finger strain
- Aim to develop a product that will reduce the required manual effort without disrupting the technician's current workflow pattern

BME Design

Background

- About one-third of all occupational injuries are the cause of repetitive motion and/or exertion (ergonomics) [2]
- 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 [3]
- Severe cases may even cause permanent disability
- Not only do companies lose an employee, but they also have to worry about legal complications

BME Design

Background - *Existing Designs*

Capit-All Screw Cap
Tube Capper/Decapper

PaR Capper

LabElite DeCapper

BME Design

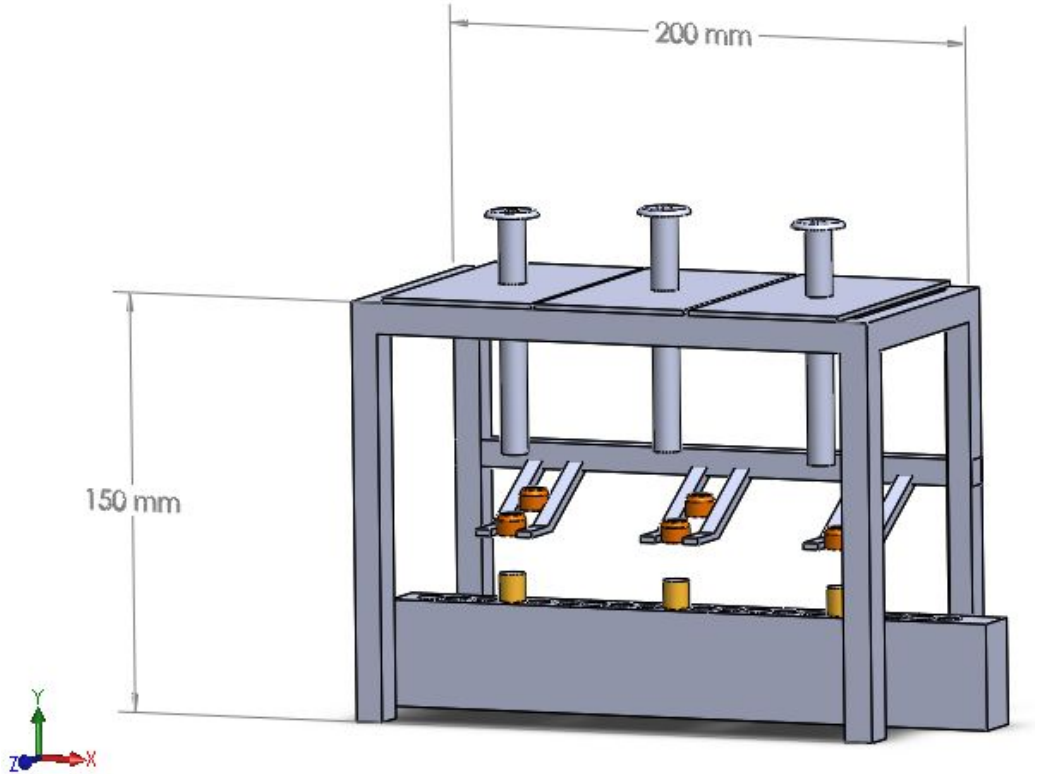
Design Specifications

- 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

BME Design

The Plunger

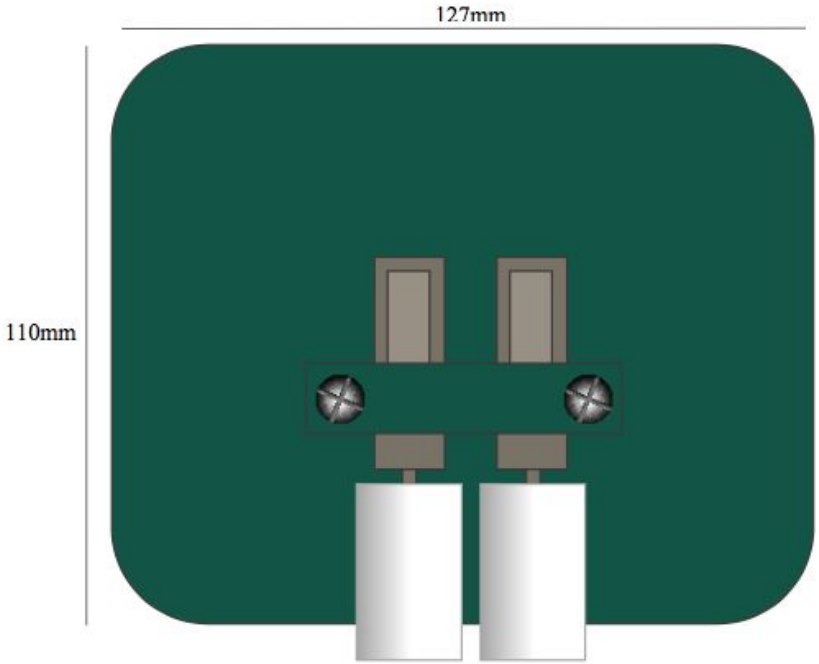
- Capping Design
- Three rotating pillars that plunge down and twist on sample tube caps
- Accommodates for three types of sample tubes provided by the client
- Spring-loaded mechanism to return plungers to original resting state after use



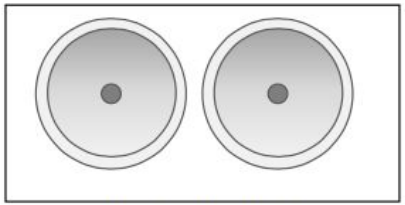
BME Design

The Uncapper 2.0

- Uncapping Design
- Iteration of our past semester's design
- Now incorporates multiple rotating cones to uncap multiple sample tubes at a time
- Uses high-friction coated cones to grip onto sample tube caps and remove



Front Face View

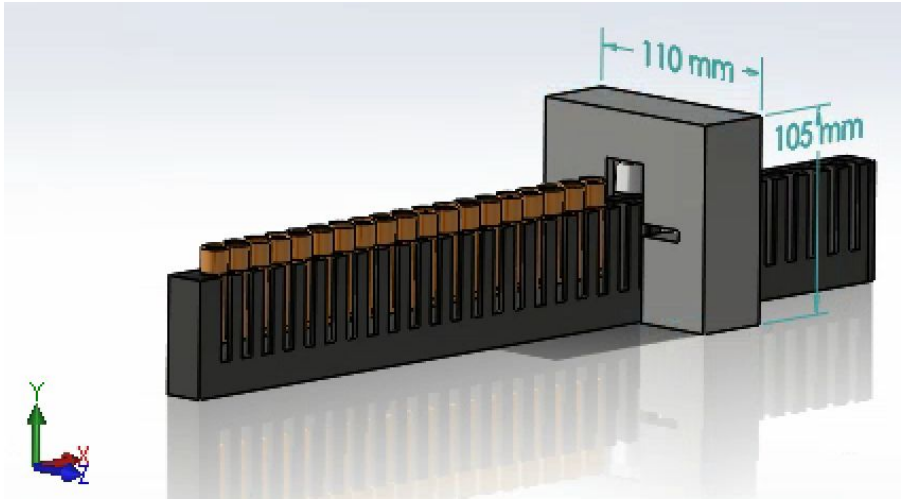


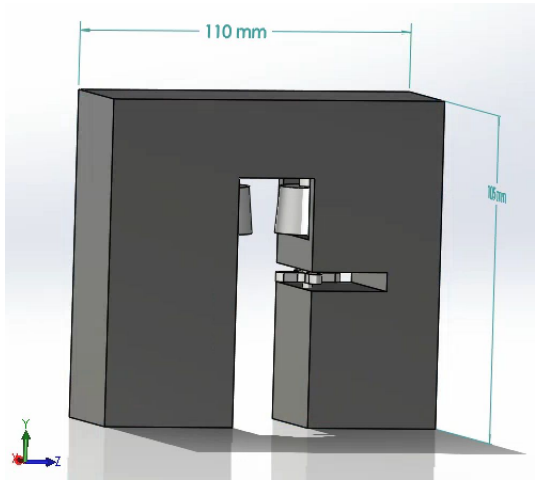
Bottom Face View
(outer diameter = 22.97mm)

BME Design

The Slide-Through

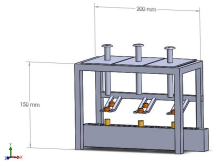
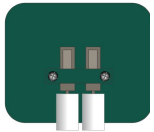
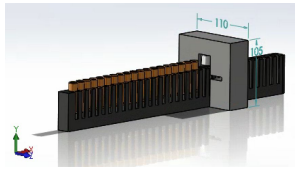
- Uncapping Design
- Two rubber, rotating drums connected to motor system via flexible shaft
- Bottom sprocket to eliminate sample tubes slipping
- Slide rack through the device to uncap tubes





BME Design

Design Matrix

Design Criteria (Weight)	Plunger 		Uncapper 2.0 		Slide-Through 	
Reduction of Manual Effort (20)	3/5	**12**	2/5	**8**	4/5	**16**
Speed (20)	3/5	**12**	3/5	**12**	5/5	**20**
Impact on Workflow (15)	3/5	**9**	5/5	**15**	4/5	**12**
Reliability (15)	4/5	**12**	4/5	**12**	4/5	**12**
Versatility (10)	3/5	**6**	5/5	**10**	3/5	**6**
Ease of Fabrication (10)	3/5	**6**	5/5	**10**	4/5	**8**
Safety (5)	5/5	**5**	5/5	**5**	5/5	**5**
Cost (5)	4/5	**4**	5/5	**5**	4/5	**4**
Total	**66**		**77**		**83**	

Future Work

- Discuss preliminary designs with the local lab - rankings
- Prototype the Slide-Through design
- Test our design
- Fabricate final design

BME Design

Acknowledgements

Thank you to our advisor, Dr. Brace, and our client liaison, Dr. Radwin for their help in the design process thus far.

BME Design

References

1: King's College Hospital. Accessed February 12th, 2017. https://www.kch.nhs.uk/patientsvisitors/patients/tests-and-scans.

2: "Common Injuries." Accessed October 14, 2016. https://vistalab.com/common-injuries/.

3: 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.

BME Design

Questions?