Semi-Automatic Ergonomic Container Opener

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Abstract

Laboratory procedures often necessitate extensive use of wrists and hands. The current procedure at a local lab requires each technician to open a large number of containers each day, invoking tremendous hand stress and strain. A device is desired to significantly reduce this hand strain during the opening of containers. While manual and automatic container-opening devices are currently on the market, they are targeted for consumer use rather than industrial or laboratory use. More specifically, the majority of automatic container-opening devices do not have the power to open containers fast enough for the technicians of concern, thus these devices would reduce their productivity. A new, automatic device is being proposed to specifically meet the technician's needs; most importantly, the device will be designed to significantly reduce hand strain without negatively affecting workflow.

Problem Definition

MOTIVATION:

- A local commercial food-testing laboratory employs over 400 technicians
- Technicians are required to repeatedly cap and uncap laboratory containers
- Each technician follows a procedure, which involves the uncapping and capping of 50-100 containers per day.
- The repetitive counter-twisting motion that these technicians exhibit daily leads to significant strain on their hands, wrists and fingers.
- The goal is to reduce this discomfort by developing a container opener tool or stationary fixture that assists in the opening of variably-sized containers.

Laboratory containers that represent the containers that the device will be used to open [3].

BACKGROUND:

- The client collaborates with a local laboratory that is interested in ergonomic factors to protect the well-being of its employees.
- An ergonomic container opener is needed because:
  1. Repetitive hand motion has been found to cause basal joint arthritis [1].
  2. The torque required to open containers has been found to be extremely difficult for most users [2].
- Many devices on the market, but none meet the need because they are:
  - *Loud*
  - *Inefficient*
  - *Low durability*
  - *Do not reduce hand strain sufficiently*

Representation of the wearing of cartilage that leads to basal joint arthritis in carpals and proximal phalanx [4].

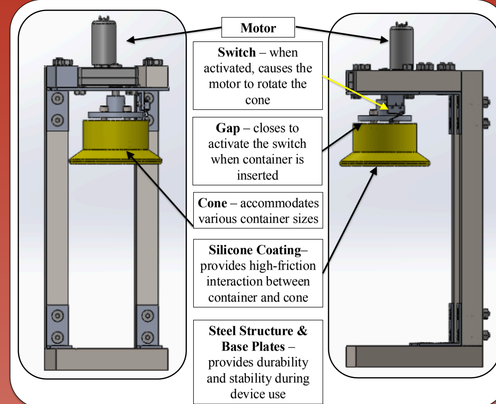
Devices that are currently on the market.
Left: An example of an automatic container opener [5].
Right: An example of a manual device that assists the user with opening containers of various sizes [6].

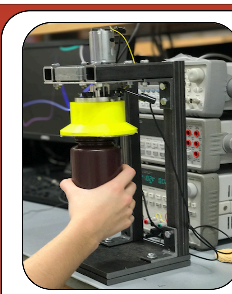
Design Criteria

1. Significantly relieve the hand strain caused from the repetitive opening of containers
2. Open containers with minimal manual intervention → One hand
3. Open containers without interrupting workflow or production → Meet quotas
4. Open at least 100 bottles per day per technician
5. Single device to open containers ranging from 1.25" to 3.5" in diameter
6. Maintain function for over at least 10,000 hours of use
   - ➢ The motor's lifetime is approximately 10,000 hours [7]
   - ➢ All structural materials should tolerate use for over 10 years
7. Be capable of undergoing sterilization
8. Be safe for the user to operate
9. Cost no more than standard laboratory equipment ~$500-$1000

Visual representation of a workflow pattern [8].

Final Design


Motor
Switch – when activated, causes the motor to rotate the cone
Gap – closes to activate the switch when container is inserted
Cone – accommodates various container sizes
Silicone Coating– provides high-friction interaction between container and cone
Steel Structure & Base Plates – provides durability and stability during device use

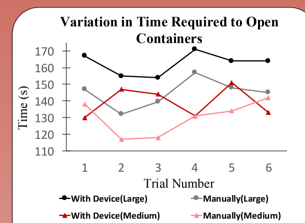


The semi-automatic final container opener in action

A user presses the container upwards into the cone, causing a snap-action switch to activate the motor. The motor revolves the high friction cone (clockwise) until the cover is removed. The user relieves the pressure from the container stopping the motor.

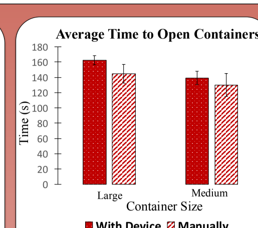
Testing

Variation in Time Required to Open Containers



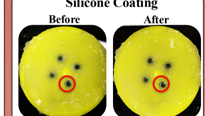
A t-test comparing the times to open containers manually and with the device showed no significant difference in time for both container sizes (p-value = 0.0149 and 0.0397 for large and medium containers respectively) n= 6.

Average Time to Open Containers



Confidence intervals show no significant difference between the time to manually open containers and the time to open containers using the device. n=6. Error bars denote 95% confidence intervals

Wear on High-Friction Silicone Coating



Interior of the cone as a result of continuous opening of containers. ***Left:*** *high-friction silicone coating prior to opening.* ***Right:*** *high-friction silicone coating upon opening approximately 600 containers. Minimal wear is evident on the coating after use, only one small area portrays any loss of coating after testing, denoted by red circles.*

Future Work

- Develop conveniently interchangeable cones to accommodate even more container sizes
  - ➢ Our final device accommodates containers with cover diameters of 1.7" – 3.5"
- Fabricate a protective shield to cover the cone, hub, and motor components of the device
  - ➢ This would further ensure safety of the device while in use
- Produce more devices identical to the final design
  - ➢ This would allow more technicians access to a container opener, therefore reducing hand stress and strain for a greater percentage of laboratory employees
- Provide a power supply for the device
  - ➢ The motor in the final device is a 24 V DC gear motor, meaning that it requires either a direct DC power supply or a DC to AC transformer

A transformer provides the capability to convert input AC voltage to output DC voltage, which is necessary if the user plans to power the device via traditional wall outlet [9].

A DC power supply provides the capability to supply a fixed voltage or current to the device [10].

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