Plate Warmer

Maxi Attiogbe,
Ryan Dillon,
Darshan Krishnaswamy

Problem Statement

Individuals with dysphagia or limited esophageal motor function have difficulty swallowing food and require additional time to eat meals, which often leads to hot food becoming cold while they are eating.

Level 1 Requirements

Description of Need:	People who have trouble swallowing require more time to eat meals which may result in food becoming cold while they are eating		Prototype 1: No Lid No water	Prototype 2: Lid No Water	Prototype 3.1: Lid 50.0 °C water	Prototype 3.2: Lid 68.3 °C water	Prototype 3.3: Lid 85.0°C water	Prototype 4: Lid 85.0°C water Handles
#	Requirement Type	Requirement Statement						
1	Functional	The device holds hot water to heat food.	No	No	Yes	Yes	Yes	Yes
2	Functional	The device can be held without risk of burns.	Yes	Yes	Maybe	Maybe	Maybe	Yes
3	Functional	The device can heat food for an hour.	No	No	Yes	Yes	Yes	Yes
4	Physical	The device is food-safe.	Yes	Yes	Yes	Yes	Yes	Yes
5	Physical	The device is easy to use.	Yes	Yes	Maybe	Maybe	Maybe	Yes
6	Physical	The device does not need to be plugged in.	Yes	Yes	Yes	Yes	Yes	Yes
7	User	The user has access to a microwave or some other method of heating up water	Yes	Yes	Yes	Yes	Yes	Yes

Designs at CDR

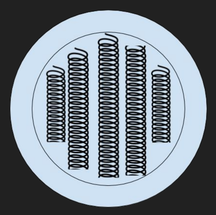


Plate with heated coils (battery or cord)

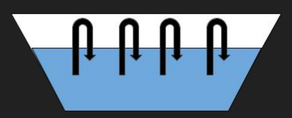


Plate heated with water convection

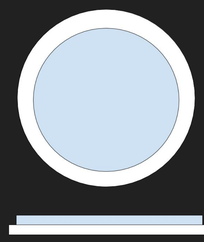


Plate made using conductive heat retaining material

How to Create the Deliverables

1. Adhere a thermal pad to one side of the aluminum disk.
2. Place the assembly over the plastic deep dish plate so that the side of the aluminum disk in contact with the thermal pad is faced downwards.

Prototype 1

This prototype solely consists of the plastic part that contains the water: there is no method of heating the food.

Prototype 2

This prototype has the main plastic dish and a top attachment that consists of an aluminum disc. It contains no water.

Prototypes 3.1-3.3

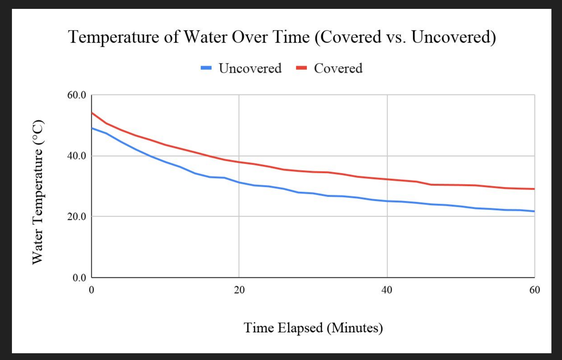
This prototype utilizes an aluminum disc and a silicon thermal pad as the top attachment to the plate, and contains hot water.

Cover Test

The purpose of this design study was to determine whether a covering on top of the water in the plate would help keep the water warm for a longer period of time. If the water was warmer at the end of the hour when it was covered then when it was uncovered, then the prototype would move forward using the aluminum disc as the main section of the top attachment for the plate.

Control Test

The purpose of this control study was to determine how fast the food that the client eats typically cools down, without any heating from an outside source. In order to understand how the product can best continually heat up the food over the course of an hour, the typical cooling rate in a regular dish first needed to be determined.

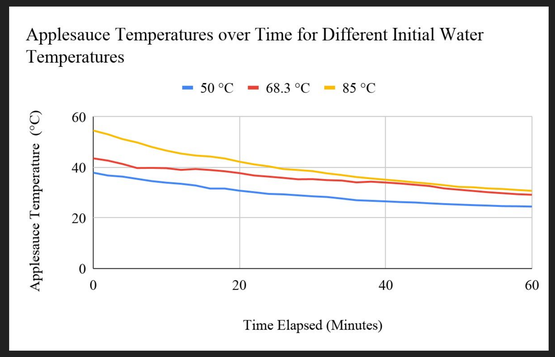


Drop Test

The purpose of this design study was to test the strength and durability of our prototype by dropping it several times from different heights and inspecting it for damage. If none of the parts were damaged after many falls repeatedly, it will most likely not sustain any damage should any accidents occur with the client.

Water Temperature Test

The purpose of this design study is to determine the ideal water temperature for keeping food warm for one hour in our current prototype.



Conclusions and Future Work (Prototype 4)

Water heat retention is improved with the aluminum disc cover. Our prototype is drop-resistant at least to a drop height of 2 m. Finally, an initial water temperature of about 68.3 °C resulted in the lowest Newton's Law of Cooling coefficient ($k \approx 0.018$) and therefore the slowest rate of cooling. Future work includes making 3D printed handles in CAD as part of the top attachment. We would additionally fasten the disk to the bottom portion of our device using velcro straps.