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CHM 4010 - Medicinal Chemistry

3D Printing Workshop Part II
"Learning to Designs Objects for 3D printing with Tinkercad"

Abstract

The purpose of this workshop was to introduce the various parameters in order to 3D print an object successfully. Finally, various groups were formed in order to come up with a design to solve an issue in the medical or dental fields. Our group chose to work on a design to create a customizable spoon/fork with a large grip, deep spoon bowl, weighted handle, and a sensor that sends haptic feedback when an object is nearby to assist individuals with tremors and the visually impaired. A prototype was designed and reviewed for future improvements.

Introduction

The ability to 3D print an object has transformed various fields by creating objects quickly and affordable. However, there are multiple parameters in the printing process that can affect the quality, durability, and speed. One parameter is the temperature of the extruder. This right temperature depends on the material used, the standard value of 230 degrees Celsius is usually used for printing using PLA or ABS filament, however, flexible filaments usually require lower extruder temperature. The material used for this design is PLA. The main parameter that affects print quality is the layer height. This sets the thickness of each layer that is being printed. The lower the number, the thinner each layer and so the better quality of the object. However, decreasing the layer thickness also means more layers will be needed and the time required for the 3D printing may be significantly increased. Lastly, the PLA or polylactic acid used is thermoplastic polyester. It naturally degrades when exposed to the environment. Therefore, this plastic is used in many industries from water bottles to biodegradable medical implants such as sutures, tissue screws, and tacks. The object created will be stiff and hard which also makes it brittle if it were to be banged multiple times. This sets some limits on the possible designs.

Therefore, the object created falls under the category of assistive technologies. These technologies try to make life and functioning easier for individuals that are impaired. This can include motor functions such as walking and hand movements, home chores, and communication. The object design will include a customizable spoon/fork with a large grip, deep spoon bowl, weighted handle, and a sensor that sends haptic feedback when an object is nearby to assist individuals with tremors and the visually impaired. The tremors can be a result of Parkinson’s, multiple sclerosis, alcohol withdrawal, essential tremors, low blood sugar, nerve damage, and various other complications. To further increase the target group, the device will also contain a small sensor on the bottom of the spoon that can sense when an object is nearby. This would help the visually impaired as well that have similar issues with the conventional spoon.

The technology already exists to assist those with tremors. However, the top six spoons on the market each have a unique aspect to them. No one, to the best of our knowledge, has yet to combine the best qualities of each spoon into one. Therefore, this object will surely be a hit among those that are in search for a better product. The

weighted handle will act as a counterweight to offset the contents on the other end and reduce shakiness. The larger grip allows an easy and comfortable hold as the deep spoon bowl prevents any spilling. Lastly, the product will be customizable to allow the same handle to be replaced with a fork component to keep the product affordable. These features will be greatly appreciated by the target audience of hand tremors.

A study published in the peer-reviewed journal Clinical Rehabilitation in 2009 ran a controlled clinical trial testing the effect of the utensil weight for people with Parkinson's disease. The subjects in the trial were eighteen adults with the disease and eighteen age matched controls. Each participant had to perform a food transfer task with spoons of different weights being 35g, 85g, and 135g. The results showed that the lighter utensil facilitated smoother and higher velocity arm movement in people with Parkinson's disease. This study depicts the need that those suffering from tremors need a unique utensil to function properly.

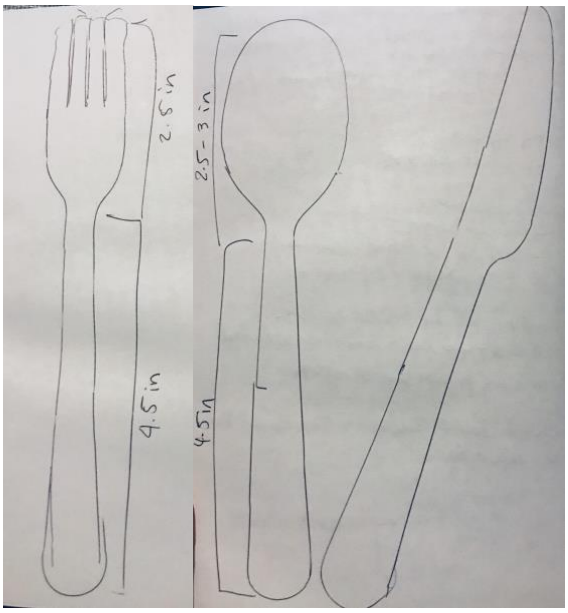
Another study published in the peer-reviewed journal Clinical Rehabilitation in 2002 ran a randomized controlled trial testing the effects of weights on postural hand tremors in subjects with Parkinson's disease. The trial contained fourteen men and two women with the mean age being 67.1 years. They were to hold a spoon of 108g, 248g, and 470g. The tremor amplitude and frequency were then measured. The results found that there were no significant differences in both measurements across all the conditions. This study shows that heavy weight may not be best in trying to stabilize the tremor intensity. With both of these studies in mind, the 3D printed product will try to find the optimal weight needed possibly around thirty grams.

The product also caters to the visually impaired demographic as well. These individuals struggle with similar issues when eating and often would need the help of others. The sensor would provide a vibration in the arm when the spoon is above the content. This would allow the ability to eat independently as they can easily tell where the contents are located on the plate. There is currently nothing on the market to help those visually impaired to dine independently. It is essential to promote mealtime independence not only to build independence but to promote social acceptance as well. This hole in the market is great for a new product to help this demographic as well.

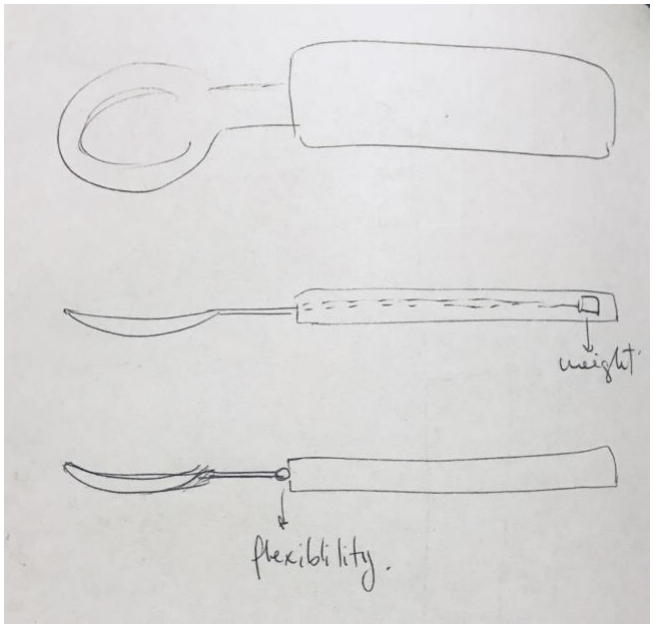
A few possible roadblocks on the way to the final product include finding the optimal weight for the handle to allow smoother movements, choosing the best food-safe material that can withstand various temperatures, testing the haptic feedback to

see if it is noticeable, figuring where to place the sensor for a fork version, and a functional sensor that can accurately sense various size and shapes. These roadblocks can be overcome via testing and trials to try and maximize the effectiveness of the product.

Conventional utensils measurements

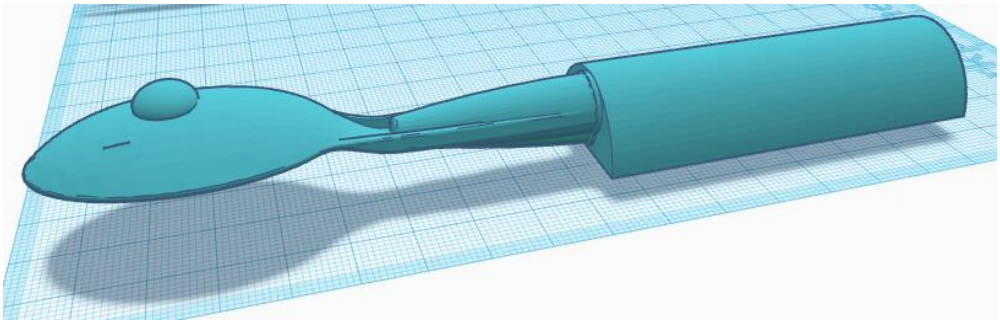


Initial sketch (various)



Results and discussion

Tinkercad prototype



Our first idea was to start with a conventional set of utensils and to compare them with what's available on the market. We realized the utensil should have some sort of mechanism that would compensate tremor movement in patients so the food would stay on it. We thought about providing flexibility in the juncture between the grip and the spoon but didn't work on this direction because marketed products with the alternative--a weighted mechanism--seemed to work better.

In the middle of our design we found new evidence showing the contrary. A 2002 study shows that there is no justifiable reasons to recommend a weighted utensil to tremor patients. We also found a study showing that light utensils work better, and we decided to keep working with this idea on mind.

Also, at first we had a curvy design but decided to do the larger firmer grip. We wanted a kit but narrowed it down to a customizable utensil for spoons and forks, so, instead of having to design many items, a handle with a hole to put either utensil inside would suffice the task.

We decided to add a sensor for the blind since the idea seemed never being explored before, and in fact no evidence of the contrary was found.

Conclusion

A prototype of a utensil to help tremor patients to eat has been designed using the knowledge acquired during the 3D printing workshops.

The next steps of the project would include figuring how to give mobility and/or stability to the utensil, since weighted ones are not specifically recommended. More reading needs to be done and a decision needs to be made on about this aspect.

Addressing the roadblocks mentioned before would be part of the nexts steps too. Priority will be given to finding the optimal weight for the handle.

References

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