V2.0.0 | January 2025

Adaptive Utensil Handles for IKEA IDENTITET
DESIGN WORKBOOK

Overview

This document contains information on the design of the Adaptive Utensils, a set of adjustable and interchangeable 3D printed adaptive utensil handles.

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Contents

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Introduction

Commercially available adaptive utensils are expensive commitments where buyers are unable to trial different styles of handles and determine what best suits their needs. Some purchased sets cannot be returned, which may leave individuals with adaptive utensils that are uncomfortable to use.

The 3D printed Adaptive Utensils play the same role as commercially available adaptive utensils, which is to allow individuals with poor fine motor control to eat independently. However, the 3D printed handles fulfill a different niche in how they are fast and cheap to manufacture, which lowers the barrier-to-entry and lets individuals trial different handle shapes to develop their own preference. Afterwards, users may 3D print more of their preferred handle or purchase a similar commercial adaptive utensil set for long-term usage.

The 3D printed Adaptive Utensils are for individuals who struggle to grasp and manipulate utensils. The affected patient population includes weakness in arm or grip strength, tremors/shakiness, limited range of motion, and poor fine motor skills.

Requirements

- Handles must be significantly larger than a typical utensil handle and feel ergonomic to hold to reduce the strain on fingers
- Must be compatible with at least a spoon and fork.
- There should be as few components as possible to reduce the risk of misplacing them
- Handles should be simple and quick to order/manufacture
- Utensil must be interchangeable with different types of handles
- Adjustable depth for utensil in handle
- Adjustable rotation for utensil in handle
- Utensil must lock in place during regular usage
- Create smooth geometry where possible to improve the overall appearance and feel of the printed handles
- Imitate common shapes for commercial adaptive utensils so users can test those styles before buying them
- Printed handle sets must be cheaper than generic commercial adaptive utensils (maximum $30 CAD per set)
- Use PLA and/or PETG, as they are the most common 3D printing materials

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Research

Commercially Available Options

Special Supplies Adaptive Utensils

Title / Name of device	Special Supplies Adaptive Utensils (4-Piece Kitchen Set) Wide Non-Weighted Non-Slip Handles for Hand Tremors Arthritis Parkinson's or Elderly use | Stainless Steel Knife Fork Spoons - Grey
Link	Amazon Link
Author	Brand: Special Supplies. Distributor: Amazon
License	N/A
Cost	$35.00 CAD

Non-weighted adaptive utensils that are dishwasher safe, have stainless-steel utensils, and ribbed silicone handles for improved grip. Each set includes a fork, knife, curved knife, dinner spoon, and soup spoon.

Requirements Met	Requirements Unmet
G01, G02, G03, G04, F04, NF01	F01, F02, F03, NF02

Useful Design Features

Utensils are dishwasher safe, which makes cleaning quick and easy.

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Vincere Silverware Weighted Utensils

Title / Name of device	Weighted Utensils for Tremors and Parkinsons, Heavy Weight Stainless Steel Silverware Set, Adaptive Eating Flatware Helps Hand Tremors, Parkinsons Aids for Living, Arthritis - Knife, Fork, Spoons, 7oz
Link	Amazon Link
Author	Brand: Vincere Silverware. Distributor: Amazon
License	N/A
Cost	$99.95 CAD

7oz weighted utensils designed to improve stability for individuals with tremors. They are dishwasher safe, but do not have a significantly larger handle like typical adaptive utensils. Each set includes a knife, fork, tablespoon, and soup spoon.

Requirements Met	Requirements Unmet
G02, G03, G04, F04, NF01	G01, F01, F02, F03, NF02

Useful Design Features

The weighted design should help reduce shaky hands from tremors.

Special Supplies Bendable Adaptive Utensils

Title / Name of device	Special Supplies Adaptive Utensils (4-Piece Kitchen Set) Wide Weighted Non-Slip Handles for Hand Tremors Arthritis Parkinson, or Elderly use | Stainless Steel Knife Fork Spoons (Gray Weighted Bendable)
Link	Amazon Link
Author	Brand: Special Supplies. Distributor: Amazon
License	N/A
Cost	$33.40 CAD

6oz weighted adaptive utensils that are dishwasher safe, have bendable stainless-steel utensils, and ribbed silicone handles for improved grip. Each set includes a fork, knife, dinner spoon, and soup spoon.

Requirements Met	Requirements Unmet
G01, G02, G03, G04, F03, F04, NF01	F01, F02, NF02

Useful Design Features

Utensils are bendable for more user customizability.

DIY / Maker Friendly Options

<Links to and quick descriptions of DIY / maker friendly devices that may meet a user's needs>

Fork and Spoon Support

Title	Fork and Spoon Support
Link	Makers Making Change Link
Author	MMC Community
License	Attribution-NonCommercial-ShareAlike4.0 International
Cost	$0-$10 CAD
Test Build (Y/N)	N
Add to Library (Y/N)	Already Added

The Fork and Spoon Support allows people with limited grip strength to hold and use eating utensils. Users can slot the device over their palm for a grip-free usage or hold both handles for a larger grip. The slot fits standard sized eating utensils like forks, spoons, and knives.

Requirements Met	Requirements Unmet
G01, G02, G03, G04, F02, F04, NF01	F01, F03, NF02

Useful Design Features

Compatible with a wide variety of utensils. Clips around the hand and does not require individuals to grip anything.

Universal hand grip for cutlery

Title	Universal hand grip for cutlery
Link	Thingiverse Link
Author	Pole_ergo
License	Creative Commons – Attribution – Non-commercial 4.0 International
Cost	$0-$10 CAD
Test Build (Y/N)	N
Add to Library (Y/N)	N

3D printed handle for flat metal fork/spoon/knife. Must be printed in a soft material like Ninjaflex, where infill density will affect the overall rigidity of the handle.

Requirements Met	Requirements Unmet
G01, G02, G03, G04, F02, F04, NF01	F01, F03, NF02

Useful Design Features

Soft material makes the handle compatible with a wide variety of utensil handles and makes the outer shell conform to the user's grip.

Working Notes

Students who worked on this project wrote digital notes of the development process. Screenshots from each student's working notes have been inserted below.

Handover Documentation and next steps for the Adaptive Utensils.

What is this project:

The goal of this project is to develop cheap 3D printable adaptive utensils. The reason for this is that commercially available adaptive utensils are very expensive. By having access to cheap 3D printed Adaptive utensils, patients will be able to test the utensils to see if they are of any benefit before purchasing the expensive versions. (For a more detailed description of this project see GRH Research Students/Reports/Winter Presentations 2022/Presentations/ Winter2022presentaiton[redacted]).

What is the technical/engineering goal of the project:

Develop 3D printable handles that can attach to the existing utensils being used at the Glenrose

What is the current State of the project:

A current prototype system for attaching 3D printable handles to standard utensils has been developed. Several prototype handle designs have also been developed.

What are the next steps of this project:

- The current prototypes need to be given to the therapists for testing and evaluation. The designs should then be modified based on the feedback given by the therapists and patients.
- Further investigation into using varnish to make the utensils more sanitizable should be investigated.
- There is a concept design for a weight adjustable version of the adaptive utensils. The current design is very large, a next step should be to reduce its size by using smaller weights.

Who is/are the contacts for this project:

The occupational therapists [redacted] and [redacted] made the original request for the project. They should be contacted for evaluating and testing of the prototypes and for other questions concerning this project.

Other information and notes:

- This project is recorded as “Specialized Utensil Handles Trial Kit” in the GRRIT Celoxis project management program. Most of the next steps should be listed in the Task List page for this project.
- The “spoon_fork_handle_dimensions” spreadsheet has the dimensions for the spoon and fork handles of the utensils used at the glenrose hospital.
- The current designs folder contains all of the solidworks models and stl files for the handles along with printing instructions for the handles and other parts.

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Progress & Handover from April 2024

Project Description:

Background
[redacted] proposed making a kit of various adaptive utensil handle shapes that a utensil can be swapped in and out of. This would allow the patient to test out various handles with the therapist to determine what works for them before purchasing one online.

Objectives/Scope:
The core is the main item for redesign; however [redacted] is open to changing the handles if it is needed to make the core work. The core needs to support the utensil handles from above and below, where the previous design supported it only from above, leaving the risk of it being pushed out if a patient uses it with significant force. The design needs to be fit to the standard GRH utensils – 2 different spoons, a fork, and a knife which all have similar but slightly different handle profiles (variations in thickness of handle, and slightly different profiles).

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Alberta Health Services

Rev 1 Notes (Oct. 23-25 2023):

Summary

The main goal of the first iteration is to see if holding the handle in a matching profile is sufficient to support both the top and bottom of the utensil while in the adaptive handles. Additionally, checking to see if the profile can hold each utensil despite small variations in their profile shape. My main concern is any wiggle room from the profile not matching exactly which would make the utensil unusable.

Upon receiving the standard cutlery set, I used the dimensions from the previous design for the core diameter and the locking hole shape because those have proven to work. I cut the profile of the bottom 2 inches of the fork (the largest of the cutlery handle profiles except for the knife which is significantly larger than the rest) into the center of the core, making it thick enough to accommodate: (1) the curve of the utensil handles; (2) the varying thickness of the different utensils; (3) extra room for filling the inner edges with a silicone material for better hold. Then I cut the core in half and included a tab to hold it together (temporarily) while testing the fit.

Results

- Profile fit is very tight. Only fits the smallest of the utensil handles (large spoon)
- Lots of wiggle room forward/backward
- Put a layer of Shore 20 Dragon Skin Silicone in the profile space, which created a good fit with no space or movement
    - I think this will be a good option to help the profile fit for the various handle shapes
- The tab is well dimensioned and holds the body together well from the bottom – need something to hold the top together
    - Adding tabs up at the top may be sufficient for holding the parts together because they can not separate in the adaptive handles. Only concern is for the thicker utensil handles where there is more outwards force, the tolerance on the core might not be strong enough anymore and the tabs might wear out There is limited space for this.
    - Having a shell that goes around the core halves and "clicks" into place. My only concern is that this shell plays the same role as the adaptive handle does so it might be an "unnecessary" step that the therapists will find annoying
- Dot is weak and only barely holds the core in/ from rotating

Action Items

- Model the version with the outer shell with tolerancing adjustments, thicker dot arm, then fill with silicone and test on utensils – aiming to get a profile that will fit 3/4 of the utensil handles (not knife) and to have 2 options to show [redacted] (rev 1 will exhibit the tab option, rev 2 will exhibit the shell option)

Rev 2 Notes (Oct. 26 - Nov 23 2023):

Summary

For the second revision, I am focusing on trying out methods of closing the inner core. With the core having 2 halves that close around the utensil handle, there needs to be some way to keep them together while the whole part is put into the adaptive handle

- NOTE: Prusa is down for maintenance, will have to use the resin printer for prototyping

Results

- Profile fits both spoons and the fork, but not the knife. All 3 have some motion up and down so the width of the upper edge could be brought in (printed in resin instead of PLA so I won't make any tolerance changes based on this evidence; this prototype is more valuable for considering the closure method)
- The collar piece that is supposed to surround the bottom half of the core to hold the sides together broke when being put on, so we have little information on that. Unfortunately this is what I expected with resin printing the part – it is far too brittle to achieve a tight fit around the core or a snap fit into the grooves. This will have to be retested when we can print in PLA. However, while trying to fit the collar to the core, after the hooks snapped off and only the cylinder remained, the collar seemed to hold the pieces together really nicely before it broke. Perhaps just a well tolerance collar without the snap fit hooks and grooves would suffice

Figure 1

- Reprinted design with PETG (Figure 1, left)
  - Tabs on collar snapped off immediately and fit was loose
- Reprinted collar with PLA (Figure 1, middle)
  - Snap tabs stayed on (only just barely) and hooked into the core pieces. The PLA fit was also much more snug than the PETG and I noticed that even without the tabs it stayed on nicely
- Tolerance test rings (Figure 1, right)
  - The tolerance test ring with the tight fit held the core together really well and did not slip off

Two options:

1) Tight fit ring
2) Adjust tabs so they don't break off
   a. My only comment with this design is that I'm not sure they do very much especially when paired with a tight fit
   b. Make snap fit arms longer and flat

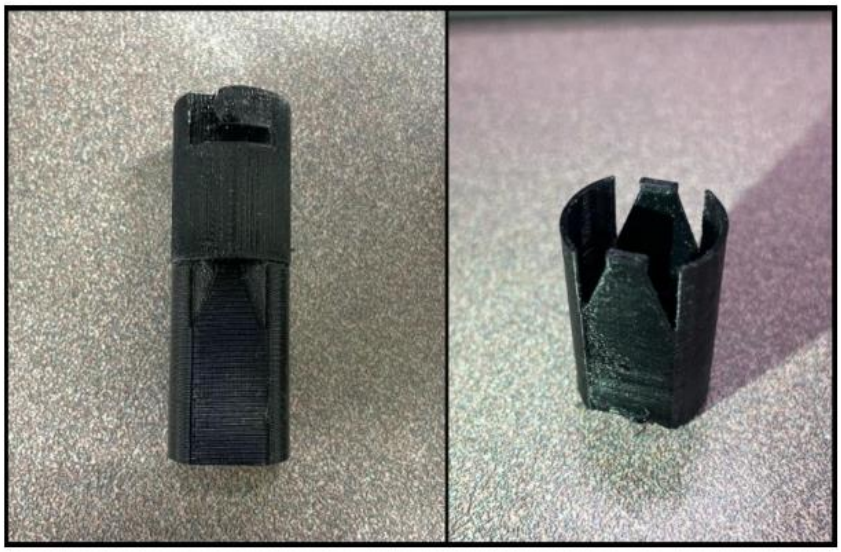

Figure: Snap fit option with longer snap on flat edge (left). Collar has curved sections extend the full height and flat sections for the snap fit (right). The snaps fit in without breaking off, but they don't feel strong enough to be holding it on, I think it staying in place is related to the fit

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Update Meeting with [redacted] and [redacted]

Main topics of discussion:

- Updates on design:
  - Broke the core in half so that it can surround the entire outer edge of the utensil (support from above and below)
  - Silicone layer in cutout profile – helps hold the utensil stationary via increased friction
    - This is the best option for making the single core system work
    - I think it is worth including in any design – it just helps get a nice fit
  - Two options:
    - Snap fit tabs
    - Securing collar – tight fit ring and/or snap fit hooks
- Single core system vs targeted cores
  - How reasonable are the above designs for getting the therapists to use them?
  - How important is it that we have a singular universal core that works for all 4 utensil types versus having 4 separate, matching versions with different cut profiles individual to each utensil handle?
    - The targeted cores would fit in better and be held in place more securely
    - If we are keeping one set of utensils with the kit anyways, it might be just as easy to have unique cores for each utensil. Then they could either never be removed (which would open some more options for a complicated design that therapists wouldn't be interested in), or they could be labelled clearly for which utensil they belong to

Results:

Will make 2 different sets of utensil cores:

GRH Cores (With Silicone)	Ikea Cutlery Cores (No Silicone)

- Made to fit and for use with GRH cutlery
- Will have the silicone walls
- Go with collar design
- Still want snap tabs inside as well
- Singular core system
 	
Changes to make:
- Change profile to fit all 3 utensils (no knife)
- Adjust tabs on PETG core to have tight fit
- Adjust fit of collar to be tighter
- Print orientation
  - On back and file to smooth cylinder --> this will affect the collar fit
  - On front -->
	- Made to fit and for use with Ikea cutlery
	- Made with no silicone
	- Go with collar design
	- Still want snap tabs inside as well
	- Singular core system?
	  - Not sure if possible without silicone
	- Include instructions for how to print and use so people can download and print the files themselves
	- Will need a closer fit on the cutlery handle profile
	
	Changes:
	- Detailed profile of Ikea cutlery set
	- Same tolerancing adjustments as w GRH

Print orientation:

- On back and sand the cylinder smooth
  - Pros: No effect on snap fit tabs
  - Cons: Can change the fit of the collar
- On front and sand contact face smooth
  - Pros: No effect on collar fit; leaves texture in utensil profile for silicone to hold onto
  - Cons: Can change the fit of the snap tabs
- Upright with brim
  - Pros: No supports in utensil profile, supports are attached to the lip, not the circular face where the collar sits
  - Cons: More print material required
- Overall, the snap tabs are most important for location before the collar is attached because the collar keeps the halves together --> print on front

Rev 3 Notes (Nov. 24 - Dec 6, 2023):

Summary

The aim of rev 3 is to split off into 2 separate designs as defined in the discussion with [redacted] and [redacted]. The GRH design mostly just requires tolerancing changes on the inner tabs and the collar and small adjustments to the utensil profile. The IKEA/ make-at-home version requires a new, detailed profile that does not require silicone for security, and then the same tolerance changes as the GRH design. It will also require a brief instruction manual for printing and preparing it at home (this does not need to be done until the design is signed off on by [redacted] and [redacted]. We will also develop a price estimate for each design based on student time to assemble, filament, and silicone used.

GRH Design Progress

- Tolerance test snap tab between halves with PETG (tolerance is on each length)
  - 0.2, 0.1, 0.05, 0.02, 0.01
- Tolerance test collar fit with PETG (tolerance is across the diameter)
  - 0, 0.02, 0.05, 0.1, 0.2, 0.3

Print Orientation

- Print on back – supports left texture on circular surface had to sand it off. Aesthetically ugly. Fits in the collar nicely, but this fit would change every time depending on how much I sanded it
  - Since the collar is the main method for holding the core together, I think this will cause too much inconsistency in the security of the core
- Print on front – supports left texture in utensil crevace and made tolerancing for those depths difficult
- Print upright – has the nicest finish surface, smoothest circular profile, and minimized supports

Silicone pour

- Need to make something to support the halves while the silicone is poured and sets to make sure they remain flat because right now the silicone is pooling more at the bottom which makes the fit secure at the base of the utensil but leaves wiggle room up at the top of the core
- Tape off the upper edge of the core so silicone doesn't drip out

Cost Estimate

Overture Black PETG = $26.99 / 1kg roll
Used filament (for both halves + collar; upright print orientation) = 13.27g
Filament cost = $26.99 * 13.27g / 1000g = $0.36 each

Source silicone
Used silicone = 2.0 g
Silicone cost =

Student hours = 15 mins (overhead cost, not per part)
Student Wage = $21/hr
Student cost = $21 * 0.25 hr / 1 hr = $5.25 per ~10

Alberta Health Services

Meeting with [redacted] (Feb 27, 2024):

Discussion about next steps -- what needs to be included in the therapy kit (which handles, how many utensils and cores), how therapists intend to use them, how they will be given to patients and how replacements will be requested.

Core Comments:

- Shrink profile fit – utensils all shift up when there is no silicone – should be well fit to largest handle (fork)
- Tighter OD tolerance in handle
- Ring changes:
  - Tighter tolerance/ fit
  - Ring comes up higher so that core halves can't pull apart at top
  - Smaller OD than core so that it is not pulled off
- Silicone changes:
  - Less silicone (thinner layer)
  - Firmer silicone

Kit Comments:

- Want 3 complete kits with all handle options
- Separated handles into A-team and B-team for priority in kit (marked A and B on example handles)
- Requesting handles printed from us:
  - Requests will go through [redacted]
  - The handles should be labelled with codes for ease
  - A "catalogue" should be made for students to reference that will organize the different handle types, codes, stl locations,etc

Plan:

Rapid prototype solutions described in the core comments to find a combination that produces a more stable fit for the utensils. 5 iterations were done, only change between iterations was fine tuning the ring fit. See adjustments made below:

- Increased core OD by 0.5mm across diameter
- Shrink profile at entrance to tight fit for largest utensil (fork)
- Adjusted ring ID tolerence = 0.5mm on diameter --> tighter fit
- Ring height (30mm --> 45mm)
- Ring has smaller OD than core halves by 0.5mm radius
- Decreased profile depth from 2.5mm to 1.5mm

Final Iterations:

These last iterations are based on feedback from [redacted] for the GRH utensils, and the process of adapting the core system to fit the IKEA utensils.

In a meeting with [redacted] he said that he would be fine having a different core for the fork and spoon if that meant we could get rid of the silicone. In this case he would want a distinguishing feature on them so the user knows whether it is for the fork or spoon – ideally printed in different colors. Therefore, there are 3 utensil cores we need: GRH Fork, GRH Spoon, and IKEA fork/spoon.

IKEA Utensils:

- Ikea utensils are too wide for the ID of the ring. The ring cannot be made thinner or it will not be strong enough and not be printable. Core OD will have to increase. Impact:
  - Utensil handles will have to be reprinted with a larger ID
  - Utensil cores will need to be printed with a larger OD

Idea:

[redacted] and [redacted] do not mind using the tabs to line up the halves, but it has bothered me for a while. I would like to switch it to a print in place hinge so that the halves cannot be separated from one another. I anticipate this will also help prevent parts from going missing.

I also made a little block that can be placed into the bottom of the core profile to be used for the smaller utensil (for the GRH utensils the fork fits without the block and the large spoon fits with the block added). This pushes the smaller utensil up so that it fits the profile.

Meeting with [redacted] (Apr 12, 2024):

Pitched the utensil handles with the print in place hinges and removeable blocks. He liked the hinge a lot. Said he would rather have 2 separate handles (preferably printed in different colors so the therapists can easily tell them apart) than have the little block piece that will go missing.

To do:

- Build the block piece into the core for GRH utensils
- Make a catalogue and "instructions" to go in the set
- Begin printing out the 3 sets of handles and cores to put in the hospital
    - Need to find a container to put the sets in – [redacted] says to get [redacted] to get these for us

Catalogue

Need a catalogue for clinicians to request replacement parts. See “Adaptive Utensils Catalogue”

Inventory of GRH adaptive utensil handles:

Code	Description	Status	Filament (g)	Price ($)
A1	Velcro strap support	1		
A2-S	Finger/thumb supports - small	1		
A2-L	Finger/thumb supports - large	1		
A3-S	Sphere - small	1		
A3-L	Sphere - large	1		
A4	Weighted – needs redesign	0		
B1-S	Straight handle - thin	1		
B1-L	Straight handle - thick	1		
B2	Ellipse handle	1		
B3	Finger grip indentations	1		
B4	Curvy handle	1		

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Alberta Health Services

Handover

Breakdown:

- Cores with print in place hinge and outer ring shell
- IKEA utensil cores have a larger OD than the GRH utensil cores because the cutlery is larger
    - The handles in Celoxis are all fit to the GRH core size
    - Will need to make copies of all the handles and edit them to fit the IKEA cores
- All Solidworks files are in Celoxis

Next steps GRH:

- Print cores in different colors of PETG (fork in one color, spoon in the other – still need to purchase the other color, ask [redacted])
- Finish catalogue:
    - Images of core handles (in correct colors)
- Print more sets of handles and assemble into the adaptive utensil kits (should all include one of each handle type, one of each core and their corresponding utensil, a copy of the catalogue)
    - Talk to [redacted] about getting containers for the kits, we are going to try get the hospital to get these for us
- Redesign the weighted handle to fit the new cores

Next steps IKEA sets:

- Tolerance test fit for increased handle ID for IKEA handles
- Make a copy of all the handle types in celoxis with the larger ID
- Upload to thingiverse or wherever they want it to end up

Contacts:

[redacted]

Adaptive Utensil Handles for IKEA IDENTITET

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Progress from December 2024

Adaptive Utensils Progress - Dec 2024

Prepared by [redacted]

Handover (from Apr 2024)

Breakdown:

- Cores with print in place hinge and outer ring shell.
- IKEA utensil cores have a larger OD than the GRH utensil cores because the cutlery is larger.
  - The handles in Celoxis are all fit to the GRH core size.
  - Will need to make copies of all the handles and edit them to fit the IKEA cores.
- All Solidworks files are in Celoxis.

Next steps GRH:

- Print cores in different colors of PETG (fork in one color, spoon in the other – still need to purchase the other color, ask Mike).
- Finish catalogue:
  - Images of core handles (in correct colors).

- Print more sets of handles and assemble into the adaptive utensil kits (should all include one of each handle type, one of each core and their corresponding utensil, a copy of the catalogue).
  - Talk to [redacted] about getting containers for the kits, we are going to try get the hospital to get these for us.
- Redesign the weighted handle to fit the new cores.

Next steps IKEA sets:

- Tolerance test fit for increased handle ID for IKEA handles.
- Make a copy of all the handle types in celoxis with the larger ID.
- Upload to thingiverse or wherever they want it to end up.

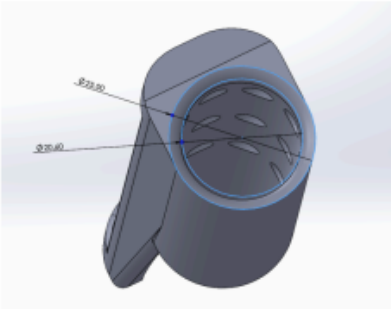
Progress from May 6th – May 24th, 2024

Cores

- Printing forks in black PETG, spoons in white PETG.
- Maybe use markers to differentiate GRH & IKEA.

Handles

- New IKEA handles modelled.
  - Added 2mm to any diameter-relevant dimensions (i.e. wider by 2mm).
- GRH tolerance edited:
  - If the outer shell of the print is too small, the tolerance between the inside of the handle and the core will be too tight (I presume due to contraction during cooling)
  - Specifically, if the outer shell diameter is less than ~13.8mm larger than the inner diameter, then the inner diameter must be increased by 0.2mm
  - Note – no tolerance tweaks were necessary for the IKEA handles
- **Handle nominal inner diameters:**
  - 20.4mm (GRH, standard)
  - 20.6mm (GRH, small outer shell)
  - 22.4mm (IKEA, standard)



Tolerance Example:

The outer diameter of this handle is 25mm, only 4.6 larger than the (original) inner diameter. If 20.4mm ID is used, the core would not fit inside the handle. Thus, 20.6 is used to loosen the tolerance for the thinner handles.

Catalogue/Models

- Updated file names to match code name and description.
- Updated catalogue images, instructions, names, and descriptions.
  - The instruction pictures were made poorly in MS paint.

Cost Description

- PETG is ~$30 per spool -> $0.03/gram for PETG.
- PLA is ~$24 per spool -> $0.024/gram for PLA.
- Allocating an average of 4 minutes of student preparation, post-processing, and maintenance time per handle. The student rate is $21/hour, which adds $1.40 on top of filament costs.

Code	Description	IKEA Filament (g)	IKEA Price (CAD)	GRH Filament (g)	GRH Price (CAD)
A1	Velcro Strap Support	32.22	2.17	29.57	2.11
A2-S	Finger Support (Small)	50.77	2.62	48.29	2.56
A2-L	Finger Support (Large)	49.01	2.58	50.72	2.62
A3-S	Sphere (Small)	20.85	1.90	21.15	1.91
A3-L	Sphere (Large)	45.43	2.49	47.80	2.55
A4	Weighted (PENDING)	/	/	/	/
B1-S	Straight (Small)	25.06	2.00	25.28	2.01
B1-L	Straight (Large)	50.82	2.62	49.76	2.59
B2	Ellipse	32.79	2.19	34.41	2.23
B3	Finger Grip Indentation	25.58	2.01	25.73	2.02
B4	Bike Grip	30.16	2.12	30.30	2.13
C1-S	Spoon Handle Core	10.45	1.71	9.07	1.67
C1-F	Fork Handle Core	10.43	1.71	9.62	1.69
C2	Handle Core Shell (x2)	3.59 (x2)	1.62	3.27 (x2)	1.60
Total Weight/Cost of 1 Set		**390.75**	**29.15**	**388.24**	**29.07**

Adaptive Utensil Handles for IKEA IDENTITET
DESIGN WORKBOOK

Questions for [redacted]

- Containers for kits?
- Upload to Thingiverse?
  - Is the goal to have these sets be open source? Then anyone can make their own kits?
- What's the plan to continue manufacturing?
  - I'd estimate 1 week per set, but I also don't want to be making these for the rest of my work term.
- Need to obtain more GRH utensils if making more kits.
- Thoughts on marker code labels? Redundant?
- Weighted handle will need a completely new design. Still want to move ahead with it?
  - If so, need to source different weights that will work better with the cores. Who will be supplying them?
- Need more universal cuffs.
  - I was told that I shouldn't be supplying them. Should they be added to the overall cost of the kits?
- Are 3D prints cleanable with IPC cleaners?
  - Can only sanitize by baking/heat treating at 50°C.
- These 3D prints are not food safe.
  - Filament might wear down nozzle and deposit metal into prints. A dedicated food safe stainless-steel nozzle would be required.
  - Filament itself is not food safe.
  - Bacteria grows between layer lines and cannot be cleaned easily.
- Food-safe coating for all the handles?
  - Resin, varnish, polyurethane spray, etc.
  - Thick layered coating cannot go inside the handles or else it will ruin the tolerances.
  - Will add a significant amount of cost and student time.

Meeting with [redacted] (June 13, 2024)

Previous Questions w/ Answers

- Containers for kits?
  - [redacted] will find containers.
- Upload to Thingiverse?
  - Will eventually upload to some sort of file-hosting site, whether it be Thingiverse or our own website.
  - Goal is to allow patients to replace their preferred handles by ordering prints from 3rd party businesses (library, Kijiji, etc.), which reduces strain on GRH resources.
- What's the plan to continue manufacturing?
  - The current 3 sets will be used as demonstration/trial kits. Patients can test out different handles for free. Once they find one that they like, they can either print their own handle or buy a commercial handle similar to the printed model.
- Need to obtain more GRH utensils if making more kits.
  - [redacted] will help with this if necessary.
- Thoughts on marker code labels? Redundant?
  - Will be renaming the handles; codes will be obsolete. No labels required anymore.
- Weighted handle will need a completely new design. Still want to move ahead with it?
  - Yes, weighted handles are important. Research and design a model for it.
- Need more universal cuffs.
  - Made in GRH. Not my job to put them in kits; will need to write a note on the catalogue saying, "universal cuff not included".

- Are 3D prints cleanable with IPC cleaners?
  - Heat treating at 50°C probably not hot enough to kill all bacteria. Any hotter will risk warping the PLA.
  - No significant findings on using a UV sanitizer box to clean FDM 3D prints.

Print Hygiene Plan

- 3D prints are not food safe and cannot be wiped to clean.
- No coating/varnish will be applied to the handles.
  - They are viewed more as "disposable", where it's easier to replace a handle than to invest significant time into extending one's lifespan.
- Good hand hygiene will be practiced before and after by anyone using or preparing the handles.

General Notes/Feedback

- Commercial adaptive utensils cost about $25 per utensil and are not interchangeable.
- A/B groups not relevant. Refer to handles by their shapes instead of codes.
- Make horizontal lines to indicate where the snap hole layers are inside the handles.
  - Should be engraved, try to avoid supports.
- Current instructions & pictures are good enough, but I would like to make them clearer and easier to understand.
  - Should include notes for troubleshooting, labeling the arrow/snap lines.
- New descriptions for catalogue that say the commonly relevant patient types.
- [redacted] to provide descriptions of the types of patients who would use certain handle shapes.
- Need to better differentiate the IKEA and GRH handle sets.
- [redacted] took an IKEA set to informally test with some patients.

3D Print Hygiene Risks

3D printed parts cannot be cleaned easily; thus, IPC may change policy and not allow the use of printed handles. Current steps to reduce risks are:

- Requiring good hand hygiene practices from anyone before or after touching the handles
- Thoroughly wiping the handles with alcohol at least once a month.
  - Handles may be soaked in hospital cleaners if deemed necessary. Bleach will cause color loss in the prints, but no major degradation otherwise.
- Demonstration handle sets are easy and cheap to replace, new handles can be ordered with quick turnaround.

Meeting with [redacted] - July 9, 2024

Catalogue Tasks for [redacted]

- Handle Descriptions
  - Relevant patient population
  - Deliberate uses for therapy (i.e. use sphere handle to train grip)
- Catalogue Pictures
  - Swap out for new, cleaner pictures
- Instructions
  - Completely revamp instructions and make them look nicer
  - Little descriptions on each step

- Write out limitations and uses for 3D printed handles
  - Not dishwasher safe
  - Mainly to test handle shapes before committing to buy/print some to keep

Future Tasks for [redacted]

- Make design changes for engraved arrow and snap lines
- Research and design weighted handle
- Work on a short video tutorial, maybe with [redacted]
  - Demonstrate proper assembly and usage of utensils
  - Too difficult (or just impossible) to design unbreakable adaptive utensils

Feedback from [redacted] - Aug 21, 2024

Problems

- Handle fits are not consistent
  - Focus on fixing key 4 handles first (bike, straight large, universal cuff, finger/thumb support)
  - Focus on IKEA set for now
  - Ellipse handle does not fit at all
- Shell gets stuck in handle sometimes when pulling utensil out
  - Occurs during regular usage, but especially when exerting force perpendicular to the utensil sliding direction. This applies a moment to pivot the core assembly such that the shell is pressed against the inside of the handle and sticks in place when the core is pulled out
  - Need to use fingers or thin screwdriver to dislodge the shell from the handle
- Core does not hold utensils in place
  - Utensils slide in further if pushed hard
  - Try mirroring the gripping ball

Further Testing - Aug 26, 2024

Shell Slippage

- Inserting core to second layer 5 times
- Pulling core out as straight as possible, bending perpendicular to sliding direction, and twisting about sliding direction

Handle Type	Pulling Approach	Slip Occurrence (#/5)
Straight Large	Straight	1/5
	Bending	4/5
	Twisting	1/5
Straight Small	Straight	0/5
	Bending	0/5
	Twisting	0/5
Bike Grip	Straight	0/5

	Bending	0/5
	Twisting	0/5
Universal Cuff	Straight	0/5
	Bending	0/5
	Twisting	0/5
Finger/Thumb Support	Straight	0/5
	Bending	4/5
	Twisting	1/5

The shell getting stuck in the handle was due to a model error in Straight Large. I fixed the issue in both the GRH and IKEA versions, but I must check all handles to make sure they are fully defined.

The ball lock in the core has worn down significantly. It still locks into place fine, but it will become an issue with increased usage for the trial sets.

Progress from Aug 27 - Sept 13, 2024

- Started using revisions. Everything changed in this section will be renamed with "_Rev02" at the end
  - Models used for the first sets will sit in a folder named "AU SW Rev01"
- For now, I will be focusing on perfecting the bike, straight large, straight small, universal cuff, finger/thumb support handles for the IKEA utensils
  - These will be referred to as the **Key 5 Handles**

Core Changes

- Mirrored the ball lock, now there are 2 per core. This holds and snaps significantly better than the single ball lock core
  - It is slightly more difficult to insert the core into the handle, but feels more stable

Core Wear

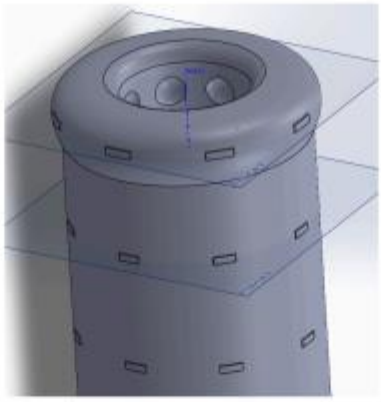
- Ball locks wear significantly pretty quickly. But having 2 ball locks per core makes them hold stronger within the handles
- Tested durability by sliding core to the second layer, then rotating by 2 sockets clockwise and counterclockwise
  - 3 Cycles: the tip of the ball was slightly dulled already
  - 10 Cycles: dulled to a ~2.3mm diameter flat spot. No significant effect on hold yet
  - 20 Cycles: ~2.5mm diameter flat spot. Slightly weaker hold
  - 30 Cycles: ~2.8mm diameter flat spot. Similar hold
  - 40 Cycles: ~3.0mm diameter flat spot. Similar hold
  - 50 Cycles: ~3.2mm diameter flat spot. Similar hold
  - 60 Cycles: ~3.4mm diameter flat spot. Slightly weaker hold
  - 100 Cycles: ~3.8mm diameter flat spot. Slightly weaker hold
- Based on the flat spot diameter of another core, it is estimated that a core should be replaced after ~150 cycles. Patients/therapists are not expected to count each usage of the core, this test was more to gain a better understanding of the core durability/longevity

Shell Issue Solution

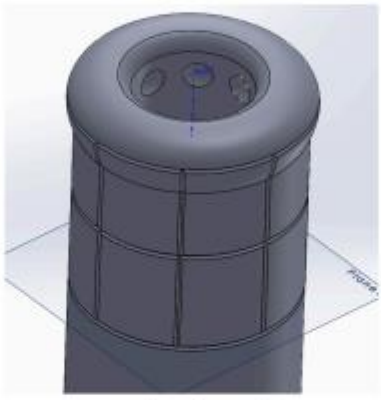
- The shell only gets stuck inside the Straight Large and Velcro handles
  - The Straight Large issue was due to a poor model that didn't scale up when increasing the diameter for the IKEA set. The model was fixed and fully defined to prevent any further scaling issues
    - Shell no longer stays stuck in handle
  - The Velcro issue is likely due to the different print angle which would change/tighten the tolerance. I increased the inner diameter by 0.2mm (now 22.6mm).
    - Fit is similar, and shell no longer stays stuck in handle

General Model Updates for Key 5 Handles

- Checked all models and edited all sketches to make them fully defined
- Reworked the grips for Finger Support Small to be fully defined and have even thicknesses
- Partially closed the bottom ends so the cores cannot be inserted the wrong way. There is still room available to clean inside from the bottom if required
  - In most cases, used a Boss Extrude with 0.60mm internal offset and 1mm height into the handle. Then add a 0.6mm 45° Chamfer to make it printable without supports
- Added printed texture to indicate where the locking sockets are in the handle. Testing to compare indented vs extruded and also continuous bands vs discrete blocks
  - Aligning texture to indicate where the top of the core must be. The first marker layer is 4.5mm below the top of the handle, where the other 2 layers are at 20mm spacings below the first.
  - **Decided not to do this**



Extruded textures



Engraved continuous lines

Progress from Oct 17 - Oct 21, 2024

Testing and Feedback

- Printed a set of 5 utensils and gave them to [redacted], who then gave them to [redacted] for testing. In short, [redacted] did not test them and just said that they were ready (Oct 4, 2024)

Model Updates

- Decided not to do any printed texture to indicate the internal sockets. It is much easier to feel around for the sockets (improves with experience)
- Solely focusing on the IKEA set for now. Updated the other 5 handle types with fully defined sketches and a partially closed bottom hole

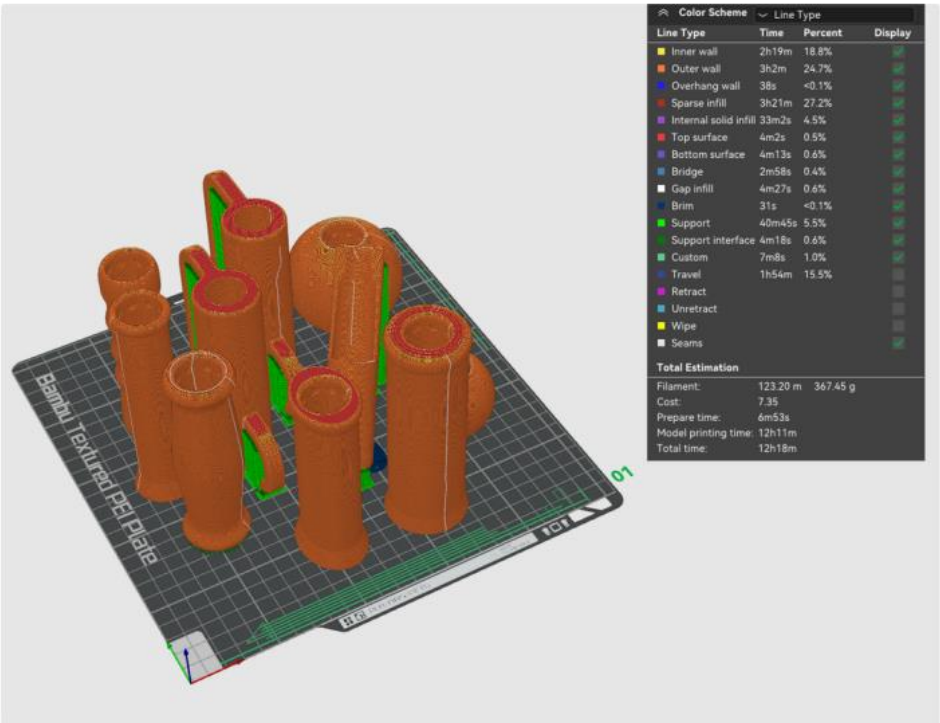
Catalogue

- Updated pictures, reworded some sections, and reformatted tables
- Currently on Rev03 (2024/Oct/21)

Revisited Cost Estimate

- PETG is ~$30 per spool -> $0.03/gram for PETG.
- PLA is ~$25 per spool -> $0.025/gram for PLA.
- Allocating an average of 5 minutes of student preparation, post-processing, and maintenance time per handle. The student rate is $21/hour, which adds $1.75 on top of filament costs.

The mass of all 10 handles is 367.45g; they are printed in PLA, which will cost $9.19 The mass of 2 cores and 2 shells is 24.10g; they are printed in PETG, which will cost $0.72. The overall material cost is $9.91, then accounting for student time (5 mins for every 2x handles or 2x core assemblies), the total cost is $20.41. For neatness, I will round it down to $20 CAD per set (or $10 CAD for materials only).



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