GNG 2101

Design Project User and Product Manual

Levoton Fidget Tool

Submitted by

Team Nandos, Group #14

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Abstract

In this User Product Manual (UPM) provides the necessary information to effectively use the Levoton fidget tool and for prototype documentation. It will elaborate on the general overview of the product to include information regarding the conventions written for this document and the cautions to be taken when using the product. Following that, the document will highlight the general procedures to be taken for each component on the product and display instructions on their use. Additionally, maintenance and troubleshooting will be included following the previous section and be followed by prototype documentation for the Levoton. The manual will then conclude with recommendations and personal reflection on the lessons learnt when undertaking the project. An appendix will be attached to reference the necessary documents for the proper comprehension of the UPM.

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Table 1. List of Acronyms

Acronym	**Definition**
ADHD	Attention-Deficit/Hyperactivity Disorder
UPM	User and Product Manual

1. Introduction

This User and Product Manual (UPM) provides the information necessary for the proper setup and use of the Levoton Fidget Tool. This UPM contains all the relevant information concerning prototype documentation, system overview, maintenance and general setup. Additionally, this document should be consulted before using the product, as it will explain the necessary steps and precautions. This document should also be consulted for general maintenance, and error behaviours that may occur in the product. By following the steps as accurately described in the UPM, the product will be able to continue functioning properly and accurately without any significant issues.

This document will first discuss the product overview, elaborating its properties and functions. The overview briefly explains the cautions and warnings as well. Following, the manual will explain how to set up the Levoton and how to use the product. These sections will ensure that the fidget tool is correctly installed and operated. Troubleshooting and maintenance will be established within as well. This portion of the document is important to ensure that the fidget tool is properly maintained in order to reduce the risk of malfunction and increase the product longevity. The user is also provided with proper information on how to contact the help team for questions about the Levoton. Finally, the manual then explains the product documentation about the previous prototypes, and explains the necessary tools and materials needed for each. The manual will conclude with future recommendations for the product.

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2. Overview

Attention-Deficit/Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder which can cause those affected to act impulsively, have trouble focusing, or be hyperactive [1]. A 2016 American study found that 5.4% of American children at that time were diagnosed with the disorder, however since ADHD is widely underdiagnosed in women and adults, the true percentage of people who are affected is likely much higher [2]. Symptoms of ADHD can cause individuals to struggle at work or school, which is why fidget tools have risen in popularity over the past few years. These tools can help individuals relieve some of their hyperactivity to allow them to focus on their work or tasks.

Our client, a graduate student with ADHD, found that none of the fidget tools on the market properly met their needs. Many of the toys currently available are geared towards children, and as such are made with low quality material, possess bright colours which children find appealing but many adults find distracting. These tools are designed to be broken, lost, and be easily replaceable. In addition, the fidget features on these tools often had features that they did not use or did not provide the full sensation they sought. Our client needed an effective, high quality, adaptable fidget tool to help them focus and manage their ADHD during various day to day activities. Some specific needs that needed to be met were having a tool that was easily sanitized, customizable, durable, and had a professional design with a number of unique high-quality features.

Team Nandos listened to the client statements and identified them that were appropriately organised in the table below.

Table 2. Client Statements Translated Into Needs

Question	Client Statement	Interpreted Need
Typical Uses	The tool can be used in different ways	The product should be adaptable
	The tool can be used on my desk without moving to much	The product includes an optional flat surface
Likes - What the customer would like to see	The product is not clunky or uncomfortable	The product is ergonomic
	The tool has a rough texture or a gradient from low to high	The product mimics the tactile feel of the objects that they are trying to replicate (Quality)
	The tool can be stored in a little box or bag for travel	The product includes a storage unit
Dislikes - What the customer could do without	The tool shouldn't be hard to clean	The product is sanitizable
	The tool shouldn't be limited to one or two things	The product is customizable
	The tool doesn't break easily	The product is durable
Concerns	The tool's buttons should make quiet noise or be able to turn off	The product has adjustable volume control
	The tool can be used in class, labs or during lectures	The product has a professional design
	The tool isn't expensive for a few features	The product should be within a reasonable price range

After careful consideration, the team grouped these needs in terms of importance from 1-5.

Table 3. Prioritization of Client Needs

Needs Grouped	Rating (1-5)
The product is customizable	5
The product is durable	3
The product has a professional/minimalistic design	2
The components mimic the tactile feel of the objects that they are trying to replicate (Quality)	4-5
The product is within a reasonable price range	3-4
The product includes an adjustable volume control	4
The product is sanitizable	2
The product includes optional flat surfaces	1
The product is ergonomic	2
The product includes a box to store all the components	1

Team Nandos identified these needs and created the Levoton, a customizable fidget tool with high quality features aimed to target the needs of adults with ADHD. Our product is sturdy and sticks to a muted colour scheme to appear more professional and appeal to an older audience. The arrangement of the tool is completely customizable, and allows users to change the configuration, swap out features, and have a tool that adapts to their unique needs. Our final design consisted of two interchangeable bases and six unique tiles for the user to fidget with. The tiles each have a fidget feature and can be removed from the base using magnets. Figure 1 shows the final prototype of our desktop base with all tiles inserted.

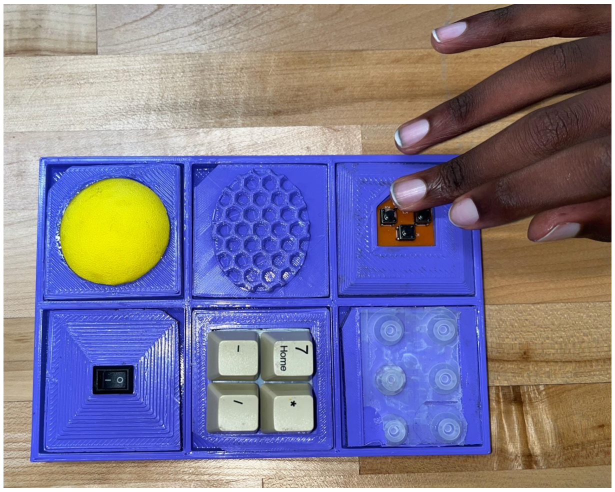

Figure 1. Levoton Base

Team Nandos also has developed an optional handled base, as seen in figure 2. This design is the approximate size of a standard rubik's cube and has a flat bottom so it can be used on a desktop as well.

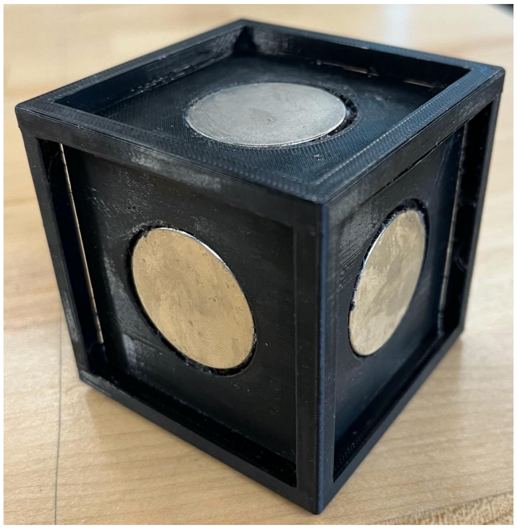

Figure 2. Levoton Empty Handheld Base

2.1 Conventions

There are three major subsystems in the Levoton: the tiles, the base, and the attachment system. In this report, these terms will be used to describe the individual elements of the design. Tiles refer to the unique square-shaped components with fidget features on the surface. The bases describe the forms which house the tiles. The current Levoton design incorporates two bases: a desktop and handheld model. The desktop model is a flat base which can hold up to 6 tiles and was previously shown in figure 1. The handheld model is cubic and can hold up to five tiles. Each tile connects to the base by magnets, which form the attachment system.

2.2 Cautions & Warnings

While the Levoton is intended for users aged 17+, it is still important to outline some cautions and warnings and to emphasize the need to keep the tool out of reach of children. While the product is durable and robust, it can break if dropped or put under excessive force. This may cause sharp edges or small pieces to appear which can harm someone if they get scratched or are ingested. Furthermore, some of the features, should they be displaced or removed in any manner from the product itself, can and are choking hazards. The Levoton also incorporates magnets in its design which can be dangerous if in the hands of small children.

3. Getting Started

As described in the overview, the Levoton consists of 3 subsystems, but the user will mostly focus on using the tiles, as they are the components which provide the sensory stimulation which aid in managing ADHD symptoms. Users are encouraged to experiment with the tiles, understand which ones they enjoy the most, and set up their base with a configuration that suits their needs.

3.1 Set-Up Considerations

Figure 3 shows the final prototype of our desktop base with all tiles inserted in 3 unique configurations. The tiles are all identical in size and square so they can be put in any order or orientation on the base.

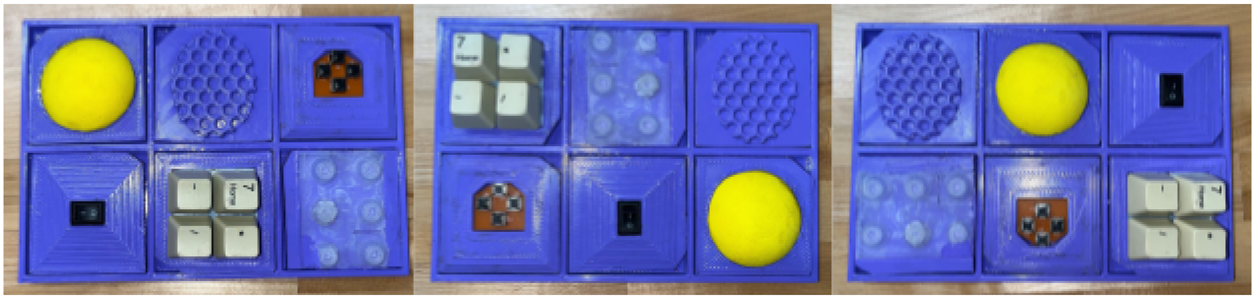

Figure 3. Possible Configurations of the Levoton Desktop Base.

Each tile has a small corner cut off of it so the user can easily pry it from the base to use independently or move it to a different location in the base. A further description of the tiles and base is given in section 4.

3.2 User Access Consideration

Users may work in a wide arrangement of environments including home desks, lecture halls, offices, and libraries. Our wide option of features ensures that users will have an appropriate feature to use regardless of the appropriate noise level for their given work situation. Tiles such as the keyboard or switch emit some clicking noises so they are not appropriate for use when other individuals who are trying to focus are present. As such, features such as the rubber ball, rubber press, and honeycomb are available for users to enjoy without emitting any distracting noises. Users are encouraged to use features of varying noise level at their discretion depending on their working environment.

4. Using the System

The following subsections provide detailed, step-by-step instructions on how to use the various functions or features of the Levoton Fidget Tool. The Levoton is intended to be used while performing work or school related tasks as a tool to manage symptoms of ADHD and improve focus. As discussed previously, the Levoton consists of three subsystems: the base, the attachment, and the custom tiles. Although they are designed to fit in each of the base systems, the tiles can also be removed and used independently if the user wants a smaller product or only wants one feature at a given time. The product is designed to be flexible and adapt to the needs and likes of the user. The following sections outline each of these subsystems and their proposed uses.

4.1 Sensory Tiles

We have designed six tiles according to the clients needs. While these six tiles cover a range of sensory experiences for the user to explore, Levoton is designed to be customizable and include interchangeable tiles so users are encouraged to configure them in a way which suits their individual needs. The tiles each feature a unique component that the user can fidget with. The user is encouraged to engage with each of these components in a way which satisfies their own sensory preferences, however there is a suggested use for which each tile was designed to fulfill and is described below.

4.1.1 Honeycomb Tile

The honeycomb tile is a texture tile which is pictured in figure 4.

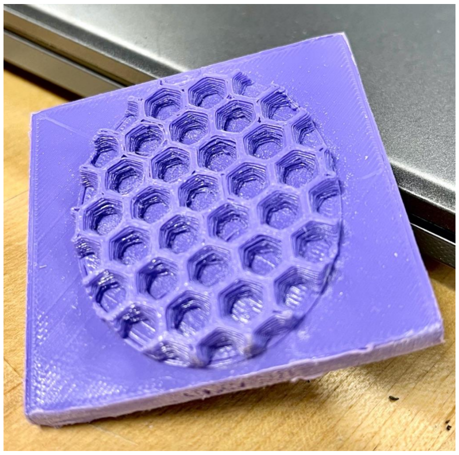

Figure 4. Honeycomb Sensory Tile.

The user can use this tile to run their thumb over and has a rough and unique texture. This particular tile emits no noise, so can be used in environments where noise must be minimized such as libraries and lecture halls.

4.1.2 Switch Tile

The switch tile provides the user with a high resistance feature and low clicking noise. Figure 5 a shows the entire tile and 5 b shows the tile in use. Note that in both of these images the tile has been separated from the base.

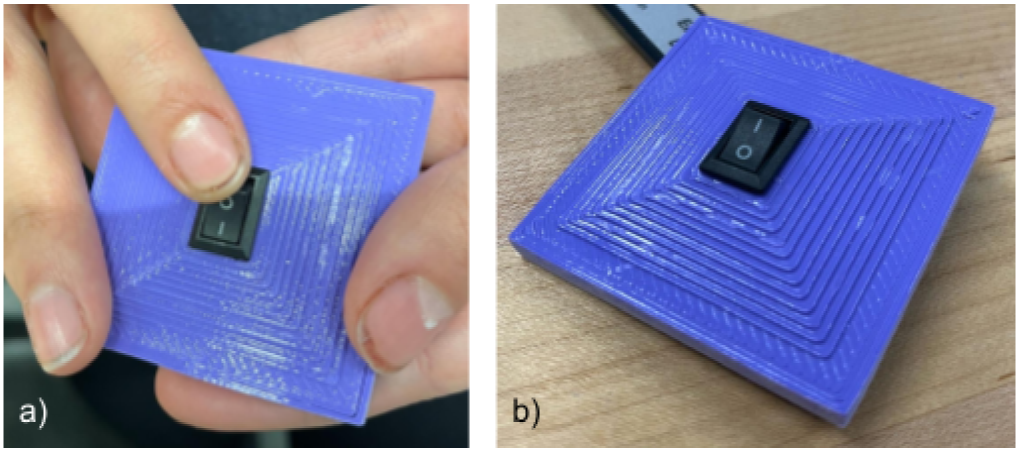

Figure 5. Kinesthetic Switch Tile.

The user simply flicks the switch to get a satisfactory sensation. This tile has low noise levels while in use and is appropriate for most environments.

4.1.3 Keyboard Tile

The keyboard tile features a repurposed keyboard with four keys. This tile, which is shown in figure 6, produces a clicky sound and a low resistance when in use.

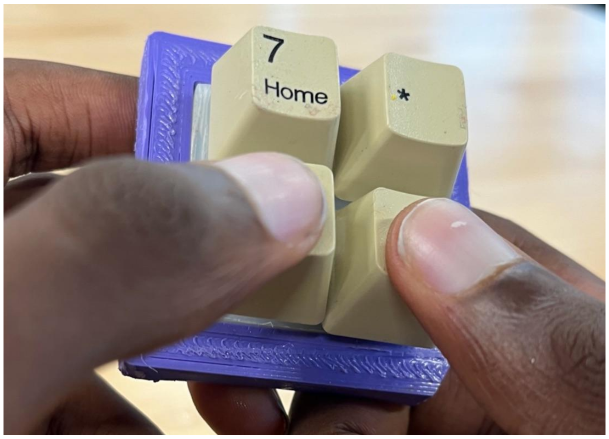

Figure 6. Keyboard Tile.

The noise produced by this tile means it should be used in environments where noise is permitted such as study halls and private workstations. This feature is not appropriate for classroom use.

4.1.3 Rubber Tactile Tile

The rubber ball tile provides the user with a soft, rubbery sensory feature to contrast the rough quality of the honeycomb. It is completely silent and is appropriate for use in all areas. Figure 7 shows the layout of this tile.

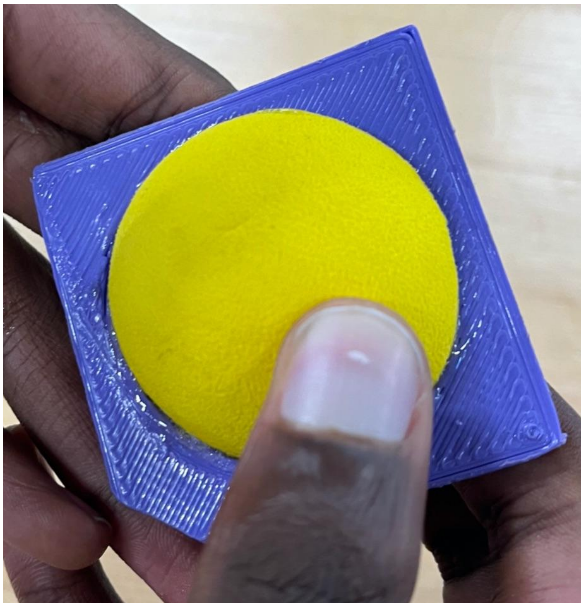

Figure 7. Rubber Tactile Tile.

4.1.4 Rubber Press Tile

The rubber press tile is similar to the keyboard tile in that the user presses down on the raised surfaces and experiences light resistance. They differ in the level of noise emitted– the rubber press tile is silent and appropriate to use in any environment. Figure 8 shows this tile in its entirety.

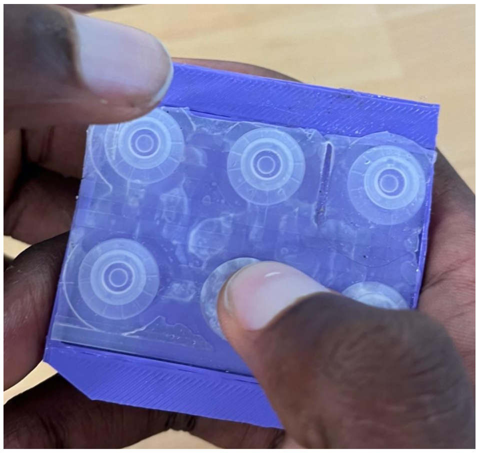

Figure 8. Rubber Press Tile.

4.1.5 Button Tile

The button tile provides a similar clicking and pressing sensation to the keyboard tile, and emits low clicking sounds. The layout is pictured in figure 9.

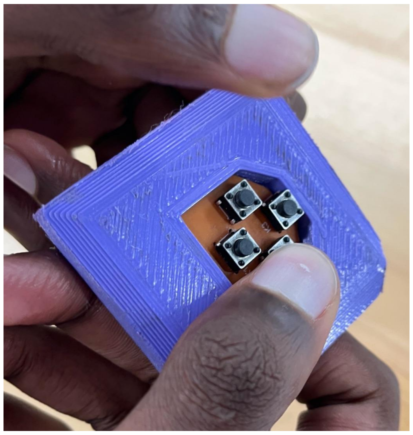

Figure 9. Button Tile.

4.1.6 Blank Tile

We have included a series of blank tiles for the user to attach and configure at their discretion. The blank tiles permit the user to use the cube base (as described in the next section) on flat surfaces. It can balance on their desk and they can set it down without risking damage to the other tiles. The blank features also allow the user to hold something simple while doing their work or while fidgeting with other features. The tile is pictured in figure 10 set into the cube base.

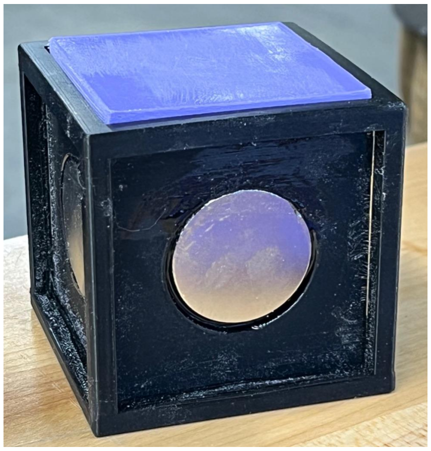

Figure 10. Blank Tile in Cube Base.

4.2 Base System

The base system consists of two independent structures which each feature six indents to house the sensory tiles. The cube base is a handheld design which is intended to be used on the go or while being held in the users hands. This base is shown in figure 11. It features one flat surface which allows this base to be used on a desktop as well. The cube consists of five indents for tiles, each with magnet set within, as will be described in section 4.3.

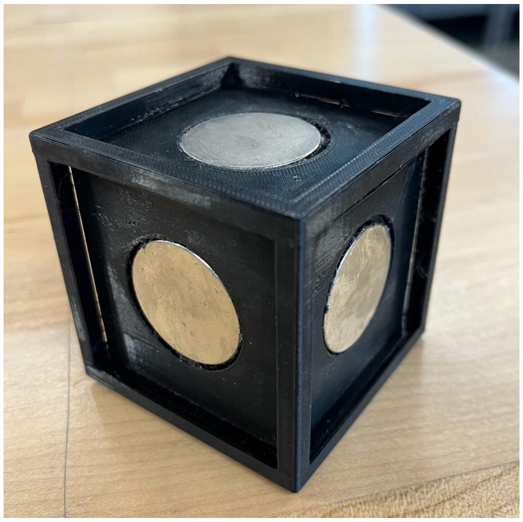

Figure 11. Cube Base Without Tile.

The flat base is a flat configuration of the 6 indents which is designed specifically for desktop use. This base is shown in figure 12 with all of the components included. In each of these base systems, the attachment system allows for the tiles to be removed and configured to the users preference.

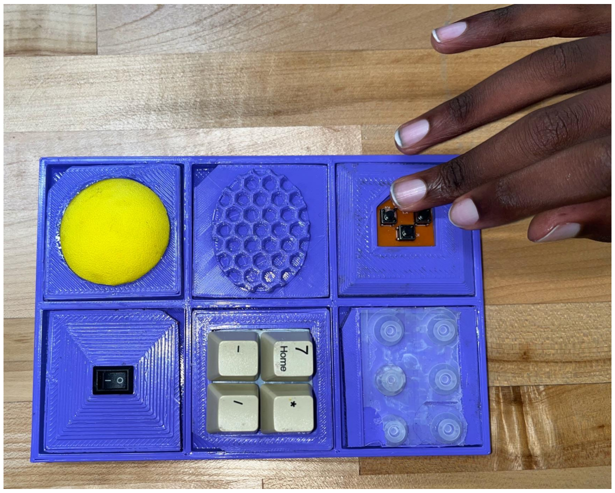

Figure 12. Desktop Base With Tile.

4.3 Attachment System

Each indent in the base is embedded with a magnet and each tile has a section of sheet metal adorned on the back. This magnetic system offers a sturdy connection between base and tile, but also permits the user to remove the tiles to rotate or reconfigure their arrangement. This attachment system is designed to be as dynamic and easy to use as possible. The user can simply pry each tile from the base to modify the arrangement. Each tile has been designed with a notch in the corner to make this process easy.

The attachment system makes it possible to rearrange the tiles into any configuration and swap them out if needed. Removing the tiles from the base means they can be used

5. Troubleshooting & Support

In this section, we will be covering proper maintenance of the Levoton Fidget Tool, what steps to undertake if a component breaks, and who to contact for further support.

5.1 Maintenance

Proper maintenance is essential to ensure the functionality of the tool, as well as keeping it sanitized. Since the bases and tiles consist of different pieces, they will be split into two sections.

5.1.1 How to clean the bases

To clean the bases, you will need dish soap, warm water, and a clean cloth. Remove all the tiles from the base and use a damp cloth in a mixture of warm water to thoroughly wipe the surfaces of the magnets to remove any build up. Gently wipe the rest of the bases with the mixture, and then wipe the soap off with clean water. Leave the bases out to dry, and optionally spray them with disinfectant.

5.1.2 How to clean the tiles

The metal plates and outer surfaces of the tiles will be washed similarly to the bases, with warm soapy water and a cloth. However, the features themselves need to be cared for individually. To clean the grooves of the Honeycomb Tile, use a toothpick to scrape along the corners. To avoid ruining the mechanisms of the Switch Tile, Keyboard Tile, and the Button Tile, use Isopropyl Alcohol to clean and disinfect them. For the Rubber Tactile Tile, wash the ball with soapy water before letting it sit to dry out. You can repeat this as many times as necessary to clean it from natural oils produced by our hands. The Rubber Press Tile can simply be cleaned with warm soapy water.

5.1.3 Storage instructions

It is recommended to store the unused tiles on the currently unused base to prevent any accidental separation of the components. When placing the cube base on a flat surface, ensure to rest it on the blank tile.

5.2 How to deal with broken parts

In the event that a tile or base breaks and loses its functionality, or poses a safety risk, it is recommended to collect all the pieces and store them somewhere safe (such as a plastic bag). From there, the STL files at https://makerepo.com/srube010/982.gng2101-a14nandos can be used to 3D print replacement pieces, and the BOM in section 6.3.2 can be used as a reference to purchase any replacement parts. If you are unable to salvage any of the parts from the broken piece, you may discard it.

5.3 Support

For any emergency, or in the event of harm to oneself, please contact 911.

In the case that further information or general assistance is required, please direct any questions or concerns to one of our team members at aging092@uottawa.ca, or leave a comment on our MakerRepo project page at https://makerepo.com/srube010/982.gng2101-a14nandos. They can be reached out to help with concerns or malfunctions with the product. You might be asked to provide a picture of the product for the team to provide proper assistance. We will respond to you as soon as possible.

Section 6.3.2 contains our BOM for the final prototype. This consists of the external parts we purchased for the final product. All base and tile models have been uploaded to MakerRepo, and can be found using the link above. Feel free to reference these if any tiles need to be replaced.

6. Product Documentation

6.1.1 Prototype I

Prototype I focused on giving a general overview representation of the product. This prototype features a three-dimensional digital comprehensive model to showcase the design of the system. This allowed for us to gain a better understanding on component placement and product aesthetic.

6.1.2 BOM (Bill of Materials)

Table 4. Prototype I - Bill of Materials

Item Number	Part Name	Description	Quantity	Unit Cost	Extended Cost
1	3D Printer Filament	For tiles and misc. parts and features	N/A	0	
2	Rubber Ball	For a sensory tile	1	$0.00–2.67	
3	Adhesive Magnetic Squares	For Attachment system	90	$0.18	$16.00
4	Thin Steel Sheet	For Attachment System	1	$14.99	
5	Epoxy	For Attachment System	1	$8.28	
6	Thumbstick	For Joystick Tile	1	$9.99	
Total Cost					$41.97

6.1.3 Equipment List

The following is a list of equipment and software used to develop the prototype.

- ☐ CAD Software Program (Soldiworks)
- ☐ Ultimaker 3D printer
- ☐ Clamp
- ☐ Sandpaper
- ☐ Epoxy
- ☐ Measuring tape

Some of these items, including the clamp and the sandpaper might not be needed if further development of materials and manufacturing methods is made.

6.1.4 Instructions

With consideration to this being the first prototype, our team focused on creating proof of concept. We based our model after carefully considering the most viable parts of each conceptual design presented. The tool was created using Solidworks, a 3D CAD software, to help us better understand the intricacies needed for our product.

6.1.5 Testing & Validation

Testing for the first prototype was geared on which concept better respected and met the conditions required by our client. Through these, our model underwent changes before becoming the final product.

Concept Feasibility - The requirements for the base system were based on the modularity of the product. The weight, size, portability, and grip were the biggest factors in deciding which design would better fit the requirements set by our client. The requirements for the tile system was centred around the functionality, effectivetity and creativity of the tile concepts. Finally, the attachment system was weighted on the reliability, weight, and maintainability. Through the process of elimination, each concept was ranked with the highest number being the chosen concept.

Table 5. Decision Matrix - Base

Selection Criteria	**Fold-out Box Base (Ella)**	**Openable Cube Base (Tye)**	**Simple Portable Cube (Sophia)**	**Desktop Base (Alexzander)**	**Cube Frame with slots (Sacha)**
Portability	5	5	5	3	5
Assembly	4	4	3	5	5
Maintainable	3	5	5	4	3
Grip/Traction	2	1	2	5	4
Sanitizable Rate	4	5	5	4	2
Reliability	3	4	3	5	3
Cost	3	4	5	3	5
Weight	4	4	2	3	3
Total Score	27	32	30	32	30

Table 6. Decision Matrix - Tile

Selection Criteria	**Texture Tile Feature (Ella)**	**Button Tile (Tye)**	**Simple Square Texture Tile (Sophia)**	**Switch Gradient Tile (Sacha)**
Assembly	5	4	5	5
Maintainable	5	4	5	3
Sanitizable Rate	4	2	4	4
Reliability	5	3	5	3
Cost	5	3	4	3
Total Score	24	16	22	18

Table 7. Decision Matrix - Attachment

Selection Criteria	**Magnetic attachment (Ella)**	**Velcro Attachment System (Tye)**	**Mechanical Attachment (Sophia)**	**Sliding attachment System (Alexzander)**	**Circular Twisting System (Alexzander)**	**Lock-on attachment System (Sacha)**
Portability	5	4	3	5	5	4
Assembly	5	4	4	5	3	5
Maintainable	5	3	5	4	4	4
Grip/Traction	4	4	4	5	5	4
Sanitizable Rate	5	3	5	4	4	4
Reliability	5	3	3	4	5	4
Cost	3	5	5	3	3	4
Weight	4	5	5	5	5	5

Total Score	36	31	34	35	34	34

Visualization Test - The chosen concepts were modeled to depict the final product. This prototype was made to represent the overall design of the Levoton fidget tool. This moel helped our team grasp the concepts of the design and overview the challenges that would occur along with the design. Through the modeled concept, we were able to decide on the placement of the magnets and the tiles as well as their approximate size and shape. The results of this test were recorded using images and helped us further convey our solution to the client.

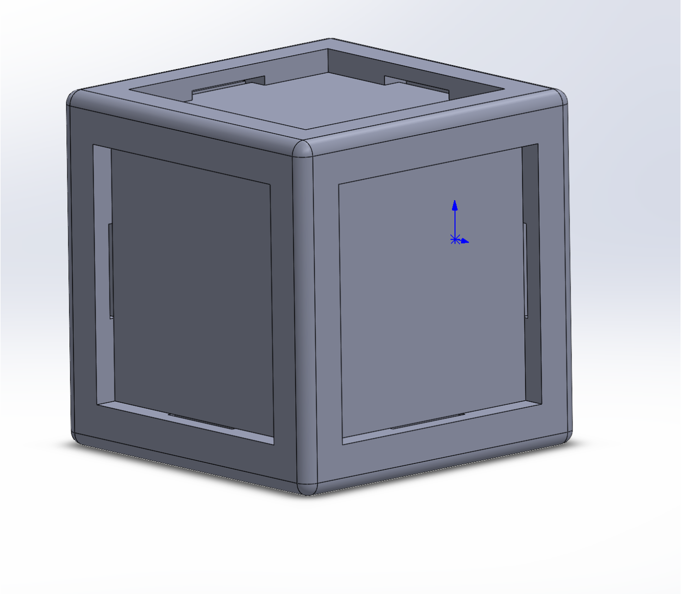

Figure 13. The model is made using CAD software. The cube base design has rounded corners for ease of grip. It is cut to make place for the adhesive magnets as well as placement for the mechanical slots

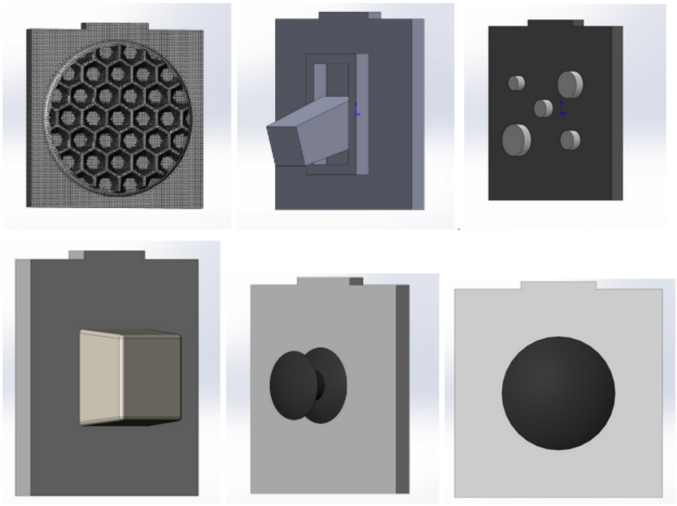

Figure 14. The model tiles are made using CAD software. Each title fits a necessary feature highlighted from our client.

6.2.1 Prototype II

Prototype II mostly focuses on the essential workings for the system- that is to say focuses on the tile system and its functions. This prototype featured three printed models of the base and the tiles with all the other mechanical components. This prototype allowed for various tests to occur on the finer details that 3D modelling could not exactly define. Test such as grip and traction were carried out, as well as weight and durability. Additionally, this prototype was crucial to understanding the details needed during the 3D printing process to get the exact specifications needed for our product. With this printing and testing period, crucial details such as the minor details between printers and the quality of the material used for printing were brought up and examined in greater detail. All considered, this prototype was a crucial step in the design process and was especially important in the production of the fidget tool as the data collected through it was essential.

6.2.2 BOM (Bill of Materials)

Table 8. Prototype II - Bill of Materials

Item Number	Part Name	Description	Quantity	Unit Cost	Extended Cost
1	3D Printer Filament	For tiles and misc. parts and features	N/A	0	
2	Rubber Ball	For a sensory tile	1	$0.00–2.67	
3	Adhesive Magnetic Squares	For Attachment system	90	$0.18	$16.00
4	Thin Steel Sheet	For Attachment System	1	$14.99	
5	Epoxy	For Attachment System	1	$8.28	
6	Thumbstick	For Joystick Tile	1	$9.99	
Total Cost					$41.97

6.2.3 Equipment List for Prototype I

- ☐ CAD Software Program (Soldiworks)
- ☐ Ultimaker 3D Printer
- ☐ Measuring Tape
- ☐ Keyboard

6.2.4 Instructions

The base and each tile were all printed for a specific feature. They were first 3D modeled and then printed. The keyboard tile and the honeycomb tile were the first tiles printed, shortly followed by the base. After printing, each tile is measured to ensure that the degree of error is not exceeded and weighted to keep lightweight.

6.2.5 Testing & Validation

The testing phase for the second prototype was conducted through a series of trial and error with three designated tiles as the target for the tests. The multiple tests conducted were mostly physical by nature.

Size - The base system and the keyboard tile were both tested to ensure that the dimensions for the components to be attached fit properly. The keyboard title was printed with a thick infill and a wide area that made for the keyboard piece being loose and falling out with relative ease. For the base system, the magnets were shown to be small to fit and therefore had to be remeasured. Additionally, the printed tiles were much larger than the base due to original changes in the design to incorporate the features.

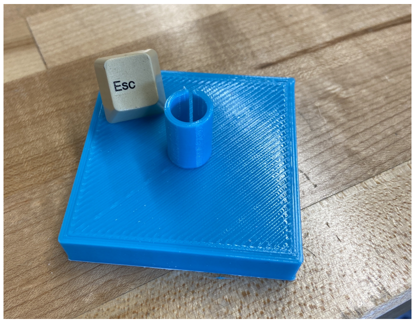

Figure 15. The keyboard tile being too tall and wide to incorporate the keyboard piece in a proper manner.

Assump. Weight - The keyboard tile and the honeycomb tile were both printed around the same time with different infills and it was shown that honeycomb with the lighter infill broke easily compared to the keyboard tile. However, the nozzle size used to print the honeycomb tile provided more texture and detail than the one used for the keyboard tile.

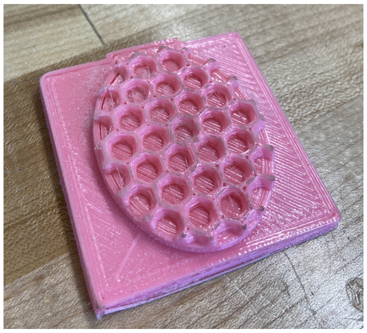

Figure 16. The honeycomb tile is easily scratched and scuffed due to the low infill used in the printing process.

Material Difference - The base system and the tile system were both printed using different materials. The base proved to have a smooth but expensive material that ultimately stained easily and proved to go through wear and tear easily. Comparatively, the tile system's material was durable and had a rougher texture, which proved to be a benefit for our client in this case. The material was also available at a lower cost than the one used for the base.

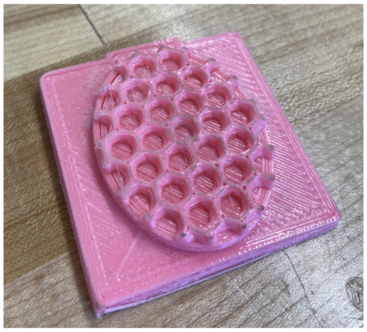

Figure 17. The base system easily torn after testing in the magnet placement. Additionally, the little holes shown when testing the durability using a needle through the base.

6.3.1 Prototype III

Prototype III was the combination of the whole product and the subsystem brought together. This physical and comprehensive model proved to be the final and accurate representation of our final product. The tests during this phase centered around the client satisfaction and overall functionality of the prototype.

6.3.2 BOM (Bill of Materials)

Table 9. Prototype III - Bill of Materials

Item Number	Part Name	Description	Quantity	Unit Cost	Extended Cost
1	Rubber Ball	For a sensory tile	5	$0.00–1.5	$6.87
2	DIYMAG Permanent Disc Magnets	For Attachment system	24	$1.12	$26.99
3	Thin Steel Sheet	For Attachment System	1	$37.99	$37.99

4	Epoxy	For Attachment System	1	$8.28	$8.28
Total Cost					$80.13

6.3.3 Equipment List for Prototype III

- ☐ CAD Software Program (Soldiworks)
- ☐ Ultimaker 3D printer
- ☐ Clamp
- ☐ Sand paper
- ☐ Epoxy
- ☐ Measuring tape
- ☐ Scraper to remove print from printer
- ☐ Magnets
- ☐ Rubber ball
- ☐ Keyboard
- ☐ Repurposed Toys

6.3.4 Instructions

The bases and the tiles all start from 3D printing. They were first 3D modeled and then printed. For the honeycomb and blank tiles, all that was required was 3D printing and sanding, as shown in figures 19 *a* and *b*.

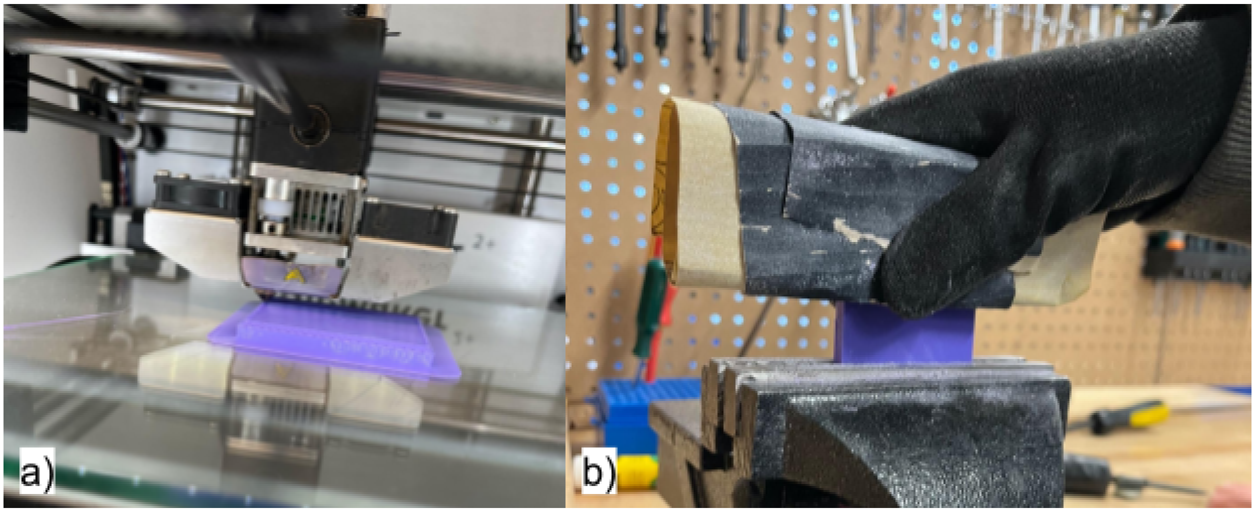

Figure 18. Printing and Sanding the Tiles.

The switch tile was 3D printed and then a repurposed switch was pressed into the tile and secured with epoxy. The keyboard tile was constructed using a keyboard provided to us by our client. First we 3D printed the tile and then dismantled and cut the keyboard to get 4 keys and the mesh beneath the keys. These were then secured to the tile using epoxy.

The rubber press tile was also 3D printed and then mesh from the dismantled keyboard was used and secured with epoxy. The rubber ball tile was 3D printed and then a rubber ball was cut and secured to the tile using epoxy. The last tile, the button tile was 3D printed with a groove in the shape of the buttons we repurposed from a toy. The buttons were placed in the groove and secured with epoxy. Then each tile had a small portion of sheet metal secured to the back.

For the two bases they were first 3D printed, in the case of the cube base further steps needed to be taken. For the cube magnets had to be added into each of the faces. These magnets makeup our attachment system and were secured using epoxy, as seen in figure 20.

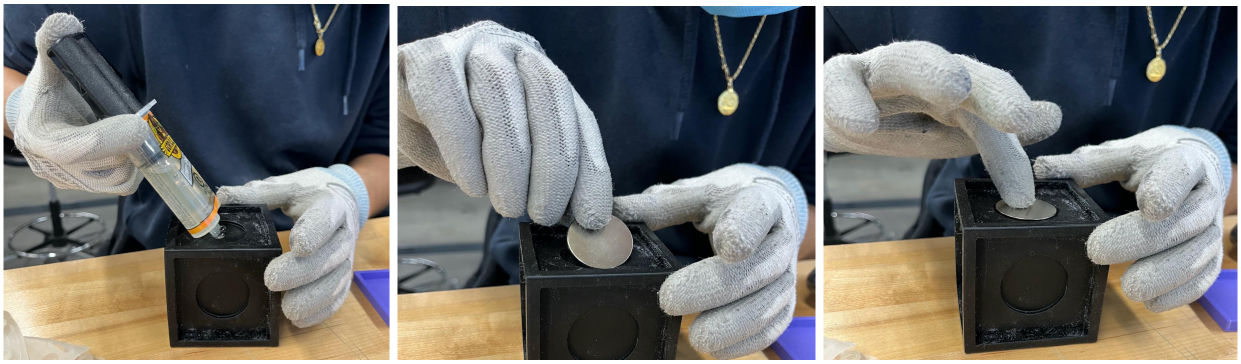

Figure 19: Epoxy Assembly

- Pictures and diagrams encouraged

6.4.1 Testing & Validation

The test conducted on the final product was made to ensure customer satisfaction as a primary goal and the proper performance as a secondary goal.

Satisfaction - In terms of customer satisfaction, three people were chosen as substitutes for the client. Two were diagnosed with ADHD, one with primary impulsive/hyperactive type, one with inattentive and distractible type, and the last was a neurotypical individual.

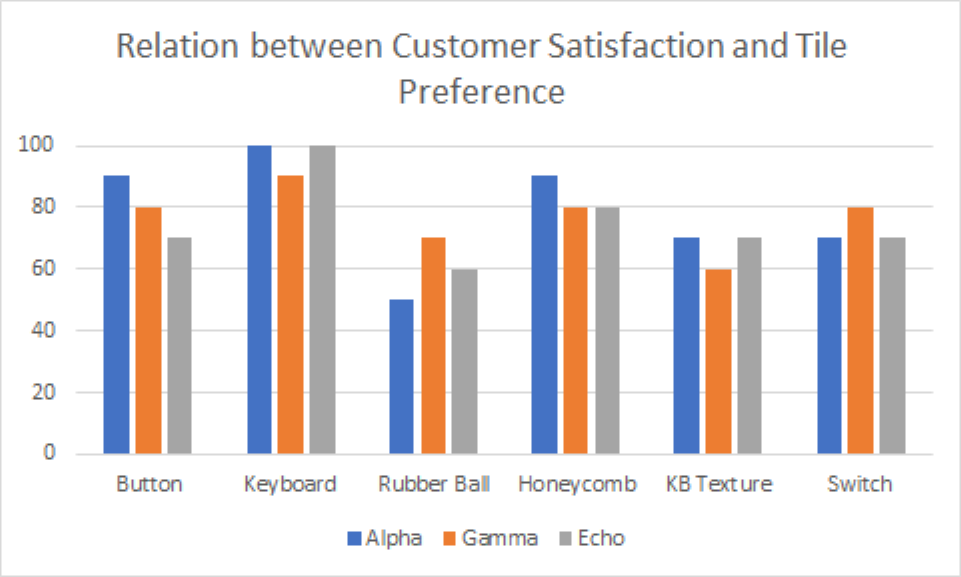

Figure 20. Chart to rate the customer satisfaction with each tile designed

Magnetic Attachment - In terms of performance, the magnetic connection between the base and the tiles were tested rigorously. The test determined that the magnets were strong enough to stay attached to the base.

Tile functionality - In terms of performance, the tiles individually were tested to ensure that they were correctly affixed and functionned. The test determined that the epoxy was properly affixed after 4 hours for each tile minimum. Additionally, it revealed that each tile was properly working after attachment.

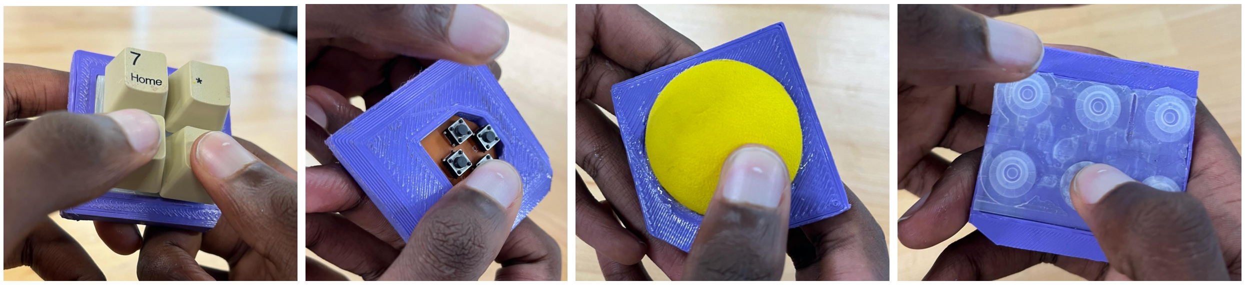

Figure 21. Tile functioning after epoxying features to base design

7. Conclusions and Recommendations for Future Work

Our group learned a lot this semester, and we firmly believe that this product has room to improve with further exploration of materials and manufacturing methods.

7.1 Lessons learned

Throughout the course of the project, our team learned many lessons to take into considerations for future projects. One of the main challenges that occurred was the division of tasks. Initially, for most of the semester, we had planned to split the tasks evenly between those who were working remotely, and those who were able to work in person. This proved to be more difficult than expected when the workload between deliverable and manufacturing shifted over the course of the semester. As Design Day approached, the workload for those at the University increased, while the workload of remote learners stayed the same. Between prototypes II and III, the students studying in person had to learn how to use the 3D printers for the first time. The lesson learnt from that was to prepare for the future and have contingencies in place for those circumstances.

While developing prototypes, we learned that it is important to be consistent with the tools that we are using. During the development of prototype II, our team used two different printers to increase the amount of prints we could produce. Unfortunately, the resulting prints varied more than predicted. For the final prototype, we ensured that all the pieces were printed on printers with the same nozzle size.

7.2 Productive Avenues

If any group were to continue and improve upon our work, our main suggestion would be to create more tiles. Customizability should be the main focus of this tool. Secondly we'd suggest refining the manufacturing methods to produce cleaner prints and potentially lowering the cost of purchasable items without sacrificing on quality. It would be interesting to explore more sustainable materials or potentially look into organic materials such as wood. Using the basic concept we developed and using it to explore different sizes for bases and tiles that might be more ergonomic would be a great way to advance this product. Furthermore, generating an aesthetic or mood board for the product would help it gain a more cohesive and professional look.

7.3 Future work

There are a number of possible avenues we would have liked to undertake in this project to improve and further our design. If the deadline for this project was to be extended, we would have primarily focused on experimenting and developing new tiles for our bases. As versatility is the basis for our project, more specialised tiles focused on other senses such as visual or auditory could be made for a range of different clients. Having tiles centred around rehabilitation is another path which could be explored.

Additionally, customising a base to fit our client would be something that could be implemented in the future. In addition, with rehabilitation in mind, the product would help reach a wider audience as well. Softer and more diverse designs in the base would allow for comfortable grip and traction that could serve as suitable tactile exercise.

Implementing rubberised grip for the base or simply changing the material to a rubberised version would greatly improve the grip and traction of the product overall. Having a consistent material for our product was a choice taken to minimise the ecological impact as well as providing the client with a texture for each tile to use independently. By exploring avenues with different materials that were scrapped in the selection process could help a number of different clients.

Finally, concerning the materials used for the product, having a selection of more neutral plastic colours for our prints is a possible avenue that could have been explored. However, due to the fact that this was mainly an aesthetic concern over a practical one, it was deduced to be a lower priority point. With extended time, each product could be customisable to include a selection of a primary neutral colour with a secondary colour of choice - a comfortable balance between professional and personalised.

7.4 Conclusion

Our group gained a deeper understanding of the need to design products with accessibility in mind. We are proud of our work and believe that it meets all of our client’s needs, but would have appreciated more time to refine and improve our design. Levoton fills a gap in the market by addressing the needs of students and working professionals with ADHD. Design shouldn’t leave anyone out, and the Levoton serves as one more step into an accessible and inclusive future.

8. References

[1] “What is ADHD?,” *Centers for Disease Control and Prevention*, 23-Sep-2021. [Online]. Available: https://www.cdc.gov/ncbddd/adhd/facts.html.

[2] Danielson ML; Bitsko RH; Ghandour RM; et al; “Prevalence of Parent-Reported ADHD Diagnosis and Associated Treatment Among U.S. Children and Adolescents, 2016,” *Journal of clinical child and adolescent psychology : the official journal for the Society of Clinical Child and Adolescent Psychology, American Psychological Association, Division 53*. [Online]. Available: https://pubmed.ncbi.nlm.nih.gov/29363986/.

APPENDICES

9. APPENDIX I: Design Files

Table 10. Referenced Documents

Document Name	Document Location/ URL	Issuance Date
Deliverable A - Team Contract	https://docs.google.com/document/d/1_BVoEV07lg3pxMEbvX4NMtvVT1OO71Kq-kZJxEMgfg0/edit	15 September 2021
Deliverable B - Needs,	https://docs.google.com/document/d/	25 September 2021

Problem Statement, Metrics, Benchmarking and Target Specifications	1MXgiCfuYlzLfjXm7AkO8PlSdU8AsIaZPNREXVwrM0d8/edit	
Deliverable C - Conceptual Design, Project Plan, and Feasibility Study	https://docs.google.com/document/d/14reawNmHHxmb2lAr6ieV-aNiKA7wNiNp1KQbe3hqaVk/edit	30 September 2021
Deliverable D- Detailed Design, Prototype 1, BOM, Peer Feedback and Team Dynamics	https://docs.google.com/document/d/1xn8IifGvSFZ8kTEYoIAda8ufNlEaukrYr-e9AbvDo9c/edit	7 October 2021
Deliverable F - Prototype II and Customer Feedback	https://docs.google.com/document/d/1dRYAoaCEqCV931M4VBHmMYUDm_HkjaMA_RhQBYf7WoU/edit#heading=h.2et92p0	4 November 2021
Deliverable G - Business Model and Economics Report	https://docs.google.com/document/d/174rmLejBFBHrTh1H9888aIuOMheZoDjMBqGqtKceqRw/edit	18 November 2021
Maker Repo	https://makerepo.com/srube010/982.gng2101-a14nandos	1 December 2021

10. APPENDIX II: Other Appendices

All of the STL files required to print the bases and tiles for the cube are in our MakerRepo project titled: GNG2101- A14-Nandos. https://makerepo.com/srube010/982.gng2101-a14nandos. A demo video and additional images of the product and design process can be found through that link as well.

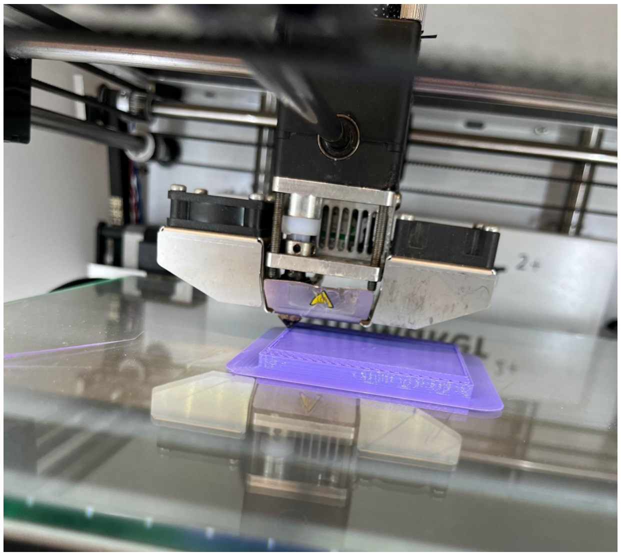

Figure 22. Tile Printing

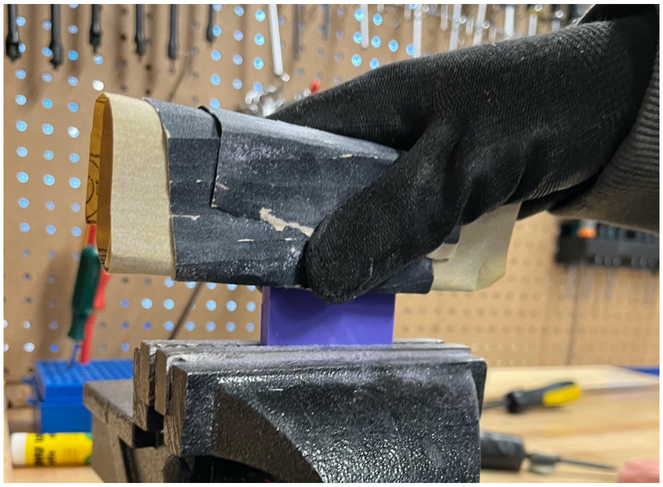

Figure 23. Sanding of a Tile

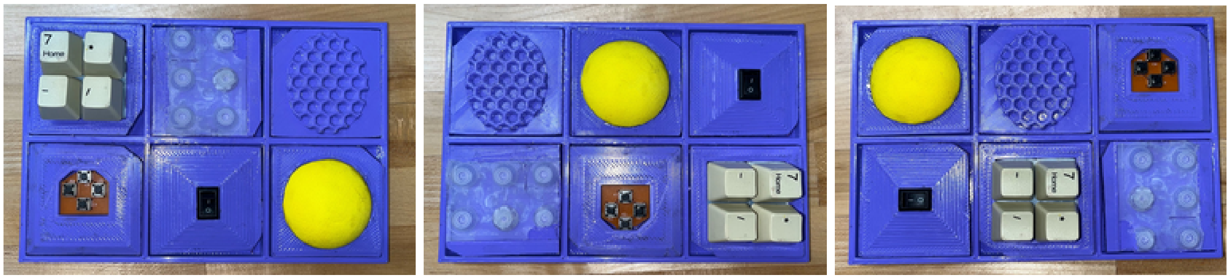

Figure 24. Desktop Base with Different Tile Formats