

The Truffle Maker
Technical Paper
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Team 1708
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<https://youtu.be/OIOQDue6TCA>

I. Abstract

Maddie Leasure is an employee at Cameron's Coffee and Chocolates, a business in Fairfax, Virginia that works with the non-profit organization Every1 Can Work. Maddie has an intellectual disability that restricts her from performing tasks that require fine motor skills. One such task is dipping rolled ganache into freshly melted chocolate to create Cameron's' unique handmade truffles. Using Cameron's' original method with a skewer, Maddie can barely make truffles and those that are made successfully are not of sufficient selling quality. *The Truffle Maker* is an innovative device that will allow Maddie to make quality truffles in less time by reducing the precise control required. Although it assists Maddie, *The Truffle Maker* does not automate the truffle making process but rather helps her further develop her motor skills and coordination. With *the Truffle Maker*, Maddie can make truffles three times faster than before, with 76% of her products of sellable quality. Being able to make truffles simply allows for the creation of new opportunities for employees with disabilities to feel independent and confident in the workplace.

II. Statement of Problem

Cameron's Coffee and Chocolates is a business located in Fairfax, Virginia which is part of Every1 Can Work, a nonprofit organization which provides employment opportunities to people with both physical and mental disabilities. Not only does Cameron's employ workers for the bakery's kitchen, but they also teach their employees everyday skills, such as how to grocery shop and communicate effectively with customers. Due to program policy, Cameron's is not allowed to disclose what specific disabilities their employees battle; however, after working with our Subject Matter Expert, Maddie Leasure, we have developed a strong understanding of what she struggles with in the work environment due to her intellectual disability. Communication and controlling fine motor skills such as precise hand movements are the two most prominent hardships, along with regulating how much pressure is applied while holding materials.

Traditionally, Maddie, like most other Cameron's employees, helps in the kitchen by doing simple tasks, such as feeding toffee into a chocolate tempering machine and filling up chocolate molds. While they are able to roll ganache into balls, Maddie and the other employees tend to stray away from more complex tasks, such as dipping the ganache into melted chocolate to make chocolate truffles.

Currently, the employee who makes truffles - a person without disabilities - is required to stick a short wooden dowel rod into a ball of ganache, dip it into a bowl of melted chocolate, shake off the excess chocolate, and then place the truffle on a wax paper-lined pan. Removing the truffle from the dowel rod is the most arduous part of the truffle making process as there is no concrete method of doing it - since the employees cannot touch the truffle, they have to place the truffle on the wax paper and remove the skewer using small twists, depending on only the adhesion between the chocolate and the wax paper to pull the truffle off. Finally, the worker has to refill the hole made from poking the dowel rod into the truffle. All of this has to be done quickly, since it takes around one minute for the chocolate to begin cooling and thickening. The thickening of the chocolate may also pull the ganache off the dowel rod when dipping it, forcing the employee to fish it out of the melted chocolate with just the rod - something the employees with disabilities cannot do at all.

Altogether, this is an intricate task which is currently unsuitable for the employees with disabilities. Although the employees are willing to take on such a complex task, they are unable

to gauge how much chocolate to use or how far to stick the rod in (based on the consistency of the ganache), and being unable to control their fine motor skills makes twisting the dowel rod out especially impossible for them. Even if the employees attempt to make this sweet, the finished product is not aesthetically pleasing or of sufficient quality to sell.

The restriction that the truffle making process places on employees with disabilities produces several undesirable effects for the bakery. First, the entire truffle making process is dependent on a few employees without disabilities - if one of them is missing from the workplace, truffle making cannot be properly carried out. Furthermore, the employees with disabilities are limited to only a few jobs, meaning they are not allowed to challenge themselves and further bolster their skills. Ultimately, it is important that the employees can engage in jobs that are beneficial to both themselves and bakery's output as a whole; currently, truffle making does not fall into that category.

III. Background Research

In 2015, 74.4% of all people with an intellectual disability in the United States were unemployed (Disability, 2016). An intellectual disability is formally defined as "a disability characterized by significant limitations in both intellectual functioning and in adaptive behavior, which covers many everyday social and practical skills" by the American Association on Intellectual and Developmental Disabilities (Definition). Such disabilities can affect many areas of one's life including cognitive skills (problem solving, memory, etc.), communications skills (use of language, attention span, etc.), motor skills, sensory information processing, and daily life (self care, organization, chores, etc.) (P-J, V., E, V., E, H., & E, S, 2010). Due to these restrictions, people with intellectual disabilities require others to assist them for a majority of their life until they develop these skills to their full potential.

Additionally extensive research has concluded that around 60-70% of people with an intellectual disability have weak dexterity or fine motor skills (Intellectual, 2013). This includes precise, coordinated actions requiring careful control of muscles such as writing and holding small items. Therefore, due to the importance of motor skills, it is critical that people who have intellectual disabilities, like Maddie, practice and reinforce them.

Currently, the most common way to coat truffles or other sweets in chocolate is through large machinery such as conveyor belts. However, Cameron's cannot use any machinery for several reasons. The first is space constraints - as a small bakery, there would be nowhere for the shop to place it. Secondly, using machinery to create truffles would almost completely automate the truffle making process, directly contrasting Cameron's goals as a nonprofit focused on bettering the individuals' skills.

Apart from this and Cameron's skewer method, common ways to dip truffles include using a dipping fork or spoon. The dipping fork, although much more consistent than a skewer, will not work for Cameron's' truffles, since their truffles are smaller than the average truffle size. In addition, the problem of gauging how far to stick the fork into the truffle still stands with using the fork as it does with a skewer. For dipping spoons, it is difficult to scoop the spherical truffle onto the spoon, keep it from rolling off the spoon, and shake the excess chocolate off the truffle without ever touching the truffle with one's hands. Therefore, all current methods are unsuitable for employees who have trouble controlling their fine motor skills.

Other than these systems, virtually no other devices exist for dipping truffles, especially those compatible with the unique parameters of handmade truffles or specifically developed for

people with disabilities to use easily. The lack of a simple and innovative truffle maker for employees with disabilities is an obvious problem to solve.

Patent Search

We conducted 12 patent searches on the USPTO Patent Full-Text and Image Database to ensure that a device similar to ours does not already exist. We analyzed the results and found the patents most similar to our product. Searches are listed and relevant patents are described below:

- Searches: Clic AND Eraser (0 results), Truffle AND Maker (2 results), Truffle (126 results), Truffles (169 results), TTL/Chocolate AND Shell (85 results), Dipping AND Fork (632 results), Dipper (1735 results), Chocolate AND Coater (237 results), Chocolate AND Dipping (798 results)
- Clicker AND Eraser (2 results) & Pen AND TTL/Eraser (67 results)
 - Patent 5356232 & Patent 5370471
 - A mechanical pencil like devices with a twist eraser at then end. The eraser portion is composed of an elongated hollow plastic shell with a eraser fitted inside. Upon twisting the shell, the eraser extrudes out of the shell.
- Chocolate AND Dipper (9 results)
 - Patent 4213417
 - Tool for applying liquid coating on food products. This device includes a continuous chain and a compartment, where the food will be places, that can be submerged into a liquid. Additionally squeegees and pressure plates surround the compartment to regulate coating thickness.

IV. Rationale

Chocolate covered truffles are one of Cameron's most popular and unique products. While most other truffles are made by pumping filling into spherical molds, Cameron's' truffles are fully handmade out of a rolled ganache filling, and then dipped into chocolate for a smooth outer shell. In addition, truffle making is by far one of the most desired jobs among the employees at Cameron's. Many employees wish they could participate in the truffle making process; however, this job requires fine motor skills that most of the employees with disabilities at Cameron's do not possess. Even with the few employees who can engage in the chocolate dipping part of the process, their independence and efficiency is highly limited (refer to Section II). Employees with disabilities as well as Cameron's as a whole would benefit greatly if they could discover a easier, faster, and more consistent way to make truffles, allowing them to be included in the truffle making process.

Our solution is to develop a device that could significantly simplify and speed up the truffle making process, primarily by eliminating the hardest part of truffle making: twisting the skewer out after dipping the ganache in chocolate. In addition, our new device is not to completely automate the truffle making process, but instead, will allow the employees at Cameron's to increase participation in making truffles. Finally, the device we created needed to be completely food safe and easy to wash.

With our device, not only will more employees be able to do the job they've always wanted to do, but the employees will also be able to make quality truffles without helpers guiding their every step. Employees will be able to accomplish more in the workplace, gaining more independence in the tasks they take on. Even beyond Cameron's, our device will be able to be used in any bakery or shop that makes dipped foods.

V. Development (Prototyping)

Our team went through two main prototypes and countless other designs before arriving at our final device. Our initial prototype was based off a jumbo pen, with a sharpened wooden dowel rod replacing the ink tube. The user would click once to eject the rod, stick it into the ganache, dip the ganache in chocolate, and then click the pen once more to retract the dowel rod and push the truffle off. We chose this design initially because it seemed straightforward and easy to use. When we asked our SME, Maddie, to try the device for the first time, we noticed that the dowel rod was not long enough to keep the truffle on while dipping it in the cooling, hardening chocolate. Although the device was comfortable for Maddie to use, everytime she tried to lift the truffle out from the chocolate, the truffle would fall back into the bowl. Due to the failure of our device, we were unable to collect any quantitative data and had to rethink our design to make it more consistent for Maddie to use.

After much consideration, we recreated the device by replacing the wooden dowel rod with a lengthened sharpened steel rod in hopes that the amount of rod that stuck out when the pen was clicked would be long enough to keep a truffle on through the entire process. Our team brought the new prototype to Cameron's for testing several times, but the original problem was still not resolved. For ganaches that were firmer, the new prototype worked partially, but when used with a softer ganache along with chocolate that thickened after cooling, the steel rod was still not long enough to keep the truffles from slipping off.



The alternate designs we thought of - cages, scoops, claws, etc. - were scrapped before they had a chance to be fully developed and tested. Finally, we decided to modify our design to use a Pentel Clic Eraser instead (Appendix D), which soon advanced as our final design.

VI. Final Design

Our final design consists of a Pentel Clic Eraser, with the eraser part removed and replaced with a sharpened stainless steel rod instead.



As described in the Section II, with Cameron's' original method, depending on the consistency of the ganache, employees stick a skewer in at different lengths in order to dip the truffle successfully. The softer the ganache, the more the dowel should be inserted to ensure the ganache does not slip off when dipped into the cooling chocolate. Compared to our very first design which could only eject the rod at a fixed length of 1 cm, our final product is capable of ejecting the dowel at any length up to 5.6 cm, due to the slider on the Clic Eraser (Appendix C). Additionally, testing has demonstrated that even if Maddie ejects the rod more than necessary, the truffle will still come off easily. Because of this adjustable length, *The Truffle Maker* is also compatible with toffees, caramels, marshmallows, and other sweets that need to be dipped in chocolate, meaning the creation of dipped candies will be revolutionized at Cameron's with our device.

The slider on the device has been increased in size to accommodate Maddie's preferences. To increase the size of the handle, we layered hot glue and hardened it with a layer of varnish to increase the handle length from 0.1 cm to 1 cm. In addition, a 0.7 cm groove was cut out from the hot glue handle to create a place for Maddie to put her thumb in, allowing her to control the slider more easily (Appendix C).

Since this device will be used consistently in the food industry, it must be easy to clean to meet food safety regulations. On the end of the Clic Eraser, a hexagonal nut has been fastened on to scrape excess chocolate off the steel rod before the it retracts into the device (Appendix F). This will prevent chocolate from getting into the inside of the device, making cleaning easier. We implemented a stainless steel rod as it is easy to clean and will not flake (Appendix E). Therefore, pieces will not break off and contaminate the products, unlike the wood used in the first prototype. Finally, we finished off our product with a layer of food safe varnish to keep an aesthetic yet safe to use product.

VII. Cost Analysis

| <i>Material</i> | <i>Unit Price</i> | <i>Quantity</i> | <i>Total Price</i> |
|--------------------------------|-------------------|--------------------|--------------------|
| Pentel Clic Eraser Grip (3) | \$4.79 | 1 | \$1.60 |
| Stainless Steel Rod (30.48 cm) | \$4.56 | ~0.27 (8.10 cm) | \$1.22 |
| Brass Hexagonal Nut (100) | \$12.42 | 0.01 (1) | \$0.12 |
| Clear Gorilla Super Glue (15g) | \$4.39 | ~0.07 (1 g) | \$0.29 |
| Hot Glue (30 sticks) | \$4.97 | ~0.03 (1 stick) | \$0.17 |
| Mod Podge (8 fl. oz.) | \$5.97 | ~0.02 (0.1 fl. oz) | \$0.01 |
| JB Weld (58.8g) | \$4.84 | ~0.02 (1 g) | \$0.09 |

The materials for our final design include one Pentel Clic Eraser, an 8.1 cm stainless steel rod, one hexagonal nut, one gram of Clear Gorilla Super Glue, hot glue, .1 fl. oz. of Mod Podge, and one gram of JB Weld. The total cost for our Truffle Maker is **\$3.50**.

VIII. Testing Procedure

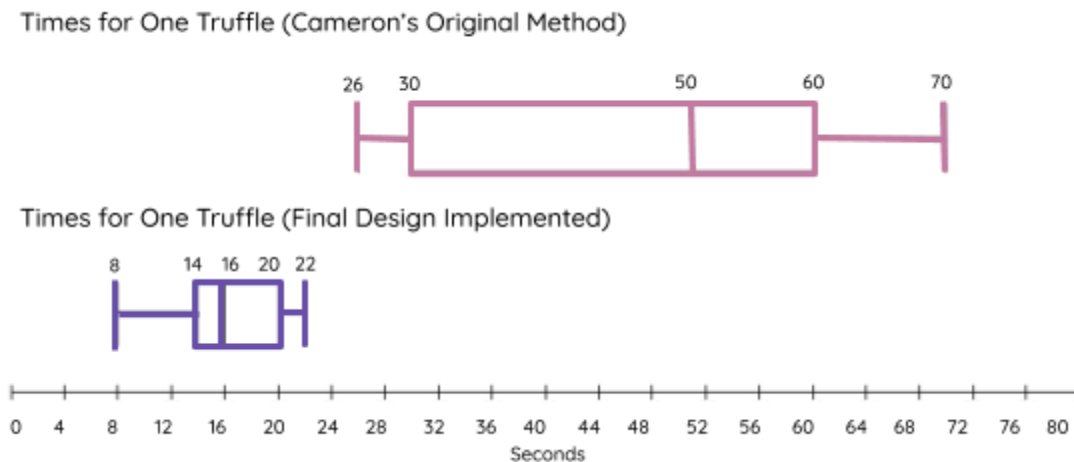
We determined that the most efficient way of collecting data would be to measure the time it takes Maddie to make one truffle from beginning (puncturing the ganache) to end (after covering the hole with chocolate) without assistance from anyone else. Both the original method and the method using *The Truffle Maker* were tested using this procedure to maintain consistency throughout our timing. While doing this, we also kept track of how long each substep took (refer to Appendix A for data for the final device or Appendix B for data for the previous prototypes). The standards for timing are as follows: 'Dipping' is timed starting when Maddie stabs the truffle to when she takes it out of the dipping bowl, 'Taking out' is timed from from when dipping ends to when the truffle is separated from the device, and 'Refilling' is timed from taking out ends to when the truffle is completely finished. We measured these sub-times to help us focus on improving the steps that take Maddie the most time.

Aside from quantitative data, Ms. Pulliam, the store manager, is able to tell us whether or not the truffles are of good enough quality to be sold without further alteration. Both Ms. Pulliam and Maddie provide valuable feedback on how comfortable the device is to use and what features of the device can be improved.

IX. Results and Analysis

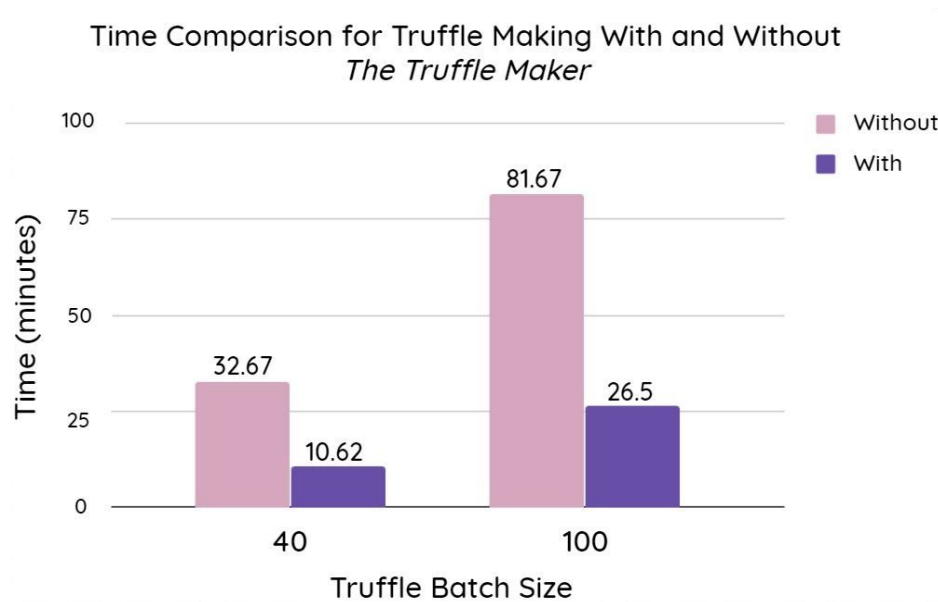
Our goal is to develop a product in order to make the task of truffle making easier for both Maddie and other Cameron's employees. As mentioned in Section VIII, we measured the times it took to completely finish one truffle, along with the times for each subsection. Please refer to Appendix A and B to view the times.

We found that the average time Maddie took to make one truffle using Cameron's original method was 49 seconds, but with our device she was able to reduce her time by 33 seconds or a 68% decrease to a mere 16 seconds. The significance of the improvement in time can be seen in the box plot below. The shortest time Maddie took to make a single truffle using the original method, 26 seconds, is 4 seconds more than the longest Maddie took to make a single truffle using our device, 22 seconds. Additionally our device has made Maddie's performance more consistent. As visible in the box plots, using the original method Maddie took anywhere from 26 to 70 seconds for a truffle, a range of 44 seconds, but with our device she took around 8 to 22 seconds, a range of 14 seconds. As the range stemming from our device is remarkably smaller, our device itself has proven itself to be more consistent in the workplace.



The more prominent impact of our device is visible on the larger scale, however. According to Ms. Pulliam, truffle batches hold either 40 or 100 truffles, depending on consumer demand. From the means of our data, we can estimate that without our device, truffle making would take Maddie anywhere from 32.67 minutes to 81.67 minutes (1 hour, 21.67 minutes) per batch. However, with the implementation of our device, Maddie would be able to make the same number of truffles but with times ranging only from 10.62 minutes to 26.5 minutes. The bar graph on the following page serves as a visual representation for the drastic drop in average time for making two different truffle batch sizes with and without the use of our device.

Along with this substantial increase in productivity, the quality in truffles made with our device is much better than that of truffles made with just the dowel rod. Ms. Pulliam, who oversaw Maddie while she made the truffles, said that none of the truffles that Maddie made with the original method were sellable, whereas with the implementation of The Truffle Maker, approximately 76.2% of the truffles could be sold. Not only does this show a tremendous increase in productivity, but it also shows the creation of new jobs for employees who could never successfully create sellable truffles before.



X. Community Impact

Previously, at Cameron's, participation in the truffle making process by workers with disabilities was severely limited due to the abundance of fine motor skills required by the process. Although many employees wanted to make truffles, Ms. Pulliam and the other helpers could not allow them to. Even for the few employees who could take part in making truffles, they had to be closely monitored and guided by helpers to ensure that the process went smoothly, stripping them of their independence and workplace satisfaction. In addition, the quality of truffles made by employees with the old process was very inconsistent, a negative for a business that needs to sell uniform food products to their clientele.

With *The Truffle Maker*, Maddie can now successfully and rapidly make truffles. Rather than depending on a helper employee to oversee her movements, Maddie - as well as any other employees who will use this device in the future - is now capable of making truffles almost entirely independently. With our device, Maddie can consistently pick up the truffle, dip it in chocolate, and discharge the truffle onto a tray, all while maintaining good quality. Her independence and participation in the truffle making process has spiked since we introduced our device to her, leading to a more satisfying workplace experience and a greater sense of accomplishment. Furthermore, after using our device to successfully create truffles, Maddie exclaimed "Show Mommy. Mommy come quick!," demonstrating her increased self-confidence with her achievements at work. Even Ms. Pulliam mentioned that "you saw on her face when she was dipping that she knew that it turned out really well.....they're going to express themselves if they're happy about something."

Not only does our device have overwhelming positive effects on Maddie, but it also will allow for the many other employees who wanted to make truffles, but couldn't because of the restrictions imposed by their disability, to finally do the job. After viewing the final outcome of our device, Ms. Cindy, one of the Cameron's' employees who has watched our progress throughout this project, mentioned that "all the participants want to be the one that gets to come into [the chocolate room]. They're all a little bit jealous of Maddie [and] are just clamoring to get in here, so if we do get that tool they're all going to want to use it for sure." The owner of the

store, Mrs. Ellen Graham, even asked us if multiple versions of our device were going to be made for use in the entire store.

Because more employees will be able to make truffles, and each employee will be able to do so at a faster rate, Cameron's Coffee and Chocolates will be able to make more truffles more efficiently. This is a plus for the organization, who can now mass produce truffles, sell more, and therefore meet the demands of their truffle hungry customers. By enabling them to get more involved at the bakery, feel more independent, and increase their confidence, our device has an immensely favorable impact on multiple employees with disabilities in the organization's community. Ms. Cindy believes that even outside of Cameron's, our tool "would be a really good tool for any shop that has truffles or something like that which they try to make."

XI. Conclusion

An estimated 20.5 million adults in the United States have reported facing a disability, with over 13.5 million of them being unemployed. While many policies have been implemented to decrease the number of hardships that people with disabilities have to face, tasks that may seem menial to people without disabilities are still difficult for PWD. However, with assistance and constant supervision from others, people with disabilities can reach a similar level of productivity and dexterity. Despite this, it is important that we acknowledge the desires of people with disabilities and strive to help them reach a level of independence so they feel comfortable working on their own in the workplace. By constantly refusing to let people with disabilities do certain tasks, their self-esteem is consequently lowered and they feel less inclined to fully participate in their jobs.

Our ultimate goal for this project was to create a device to change the workplace for an employee with a disability. After running through countless prototypes and repeatedly receiving feedback from Maddie, we can confidently say that we have achieved our goal. Maddie can now participate in a task that she's wanted to but hasn't gotten any opportunities to do due to the limitations from her disability.

As said by Ms. Pulliam, "[Cameron's] is a chance to give [people with disabilities] meaningful employment but it's also a program to help them develop independently so that later on in life they have those skill sets to live more independently than they do now." Keeping this in mind, we designed *the Truffle Maker* to simplify the truffle making process at Cameron's, allow more employees to participate in making truffles, and most importantly, increase the self esteem of employees with disabilities at Cameron's, like Maddie. Through *The Truffle Maker*, Maddie can now complete a new task - truffle making - at a faster rate and with higher quality. Overall, we have successfully realized both ours and Cameron's' goals through the implementation of *the Truffle Maker*, which will hopefully be mass produced to allow multiple employees to use it. We believe that beyond the competition, we have initiated a change in Cameron's' workplace, while also making an everyday job more fun, easier, and ultimately more efficient for Maddie and other employees.

"That's going to be tremendous - everyone's going to want to do it, nobody's going to want to use the stick anymore." - Ms. Cindy

XII. References and Acknowledgments

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Appendix A - Final Data

| Cameron's Original Method | Dipping (s) | Taking out (s) | Refilling (s) | Total (s) |
|---------------------------|-------------|----------------|---------------|-----------|
| | 18 | 8 | 44 | 70 |
| | 18 | 38 | 4 | 60 |
| | 19 | 24 | 7 | 50 |
| | 12 | 9 | 5 | 26 |
| | 17 | 16 | 18 | 51 |
| | 18 | 8 | 4 | 30 |
| | 19 | 17 | 20 | 56 |
| Average | 17.29 | 17.14 | 14.57 | 49 |

| Final Product- Clic Eraser | Dipping (s) | Taking out (s) | Refilling (s) | Total (s) |
|----------------------------|-------------|----------------|---------------|-------------|
| Version 1 | 17 | 2 | 3 | 22 |
| | 10 | Failed | Failed | 10 (Failed) |
| | 9 | 3 | 2 | 14 |
| | 7 | 2 | Not Needed | 9 |
| | 16 | 3 | Not Needed | 18 |
| | 10 | 3 | 6 | 19 |
| | 6 | 2 | Not Needed | 8 |
| | 8 | 2 | 4 | 14 |
| | 12 | 2 | Not Needed | 14 |
| | 10 | 7 | 3 | 20 |
| | 12 | 1 | 3 | 16 |
| | 12 | 5 | 4 | 21 |

| | | | | |
|-------------------|-------|------|-----|--------------|
| Averages** | 10.75 | 2.91 | 2.5 | 15.91 |
|-------------------|-------|------|-----|--------------|

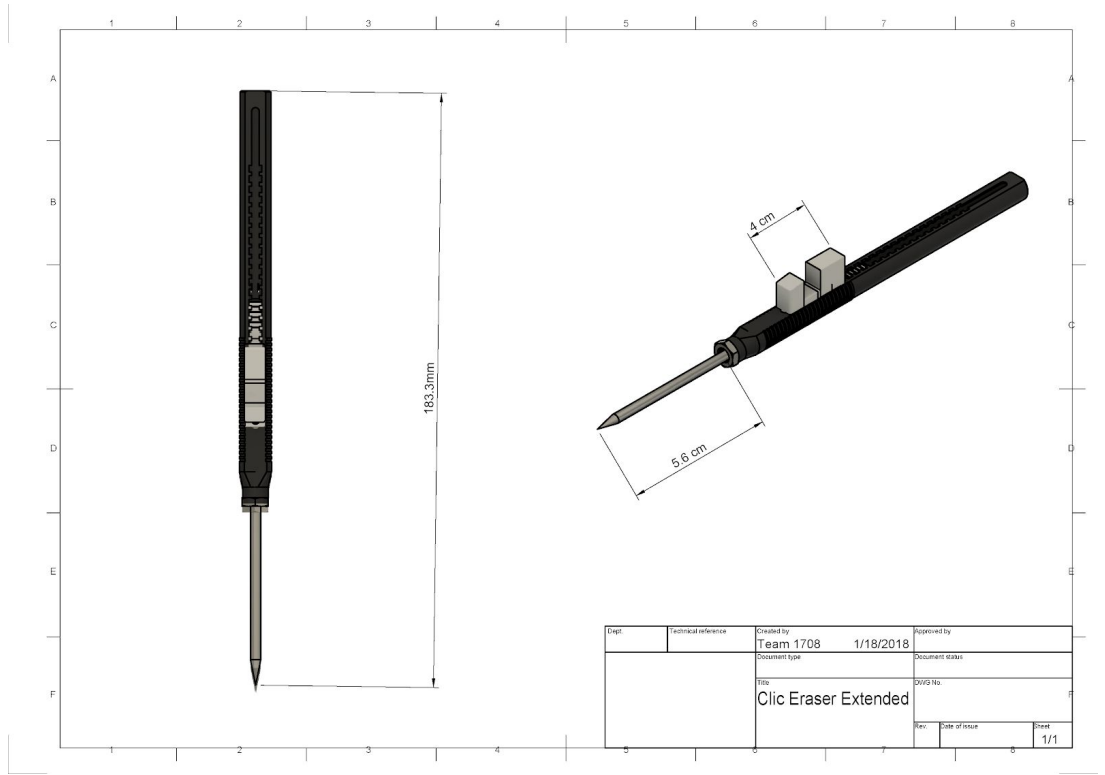
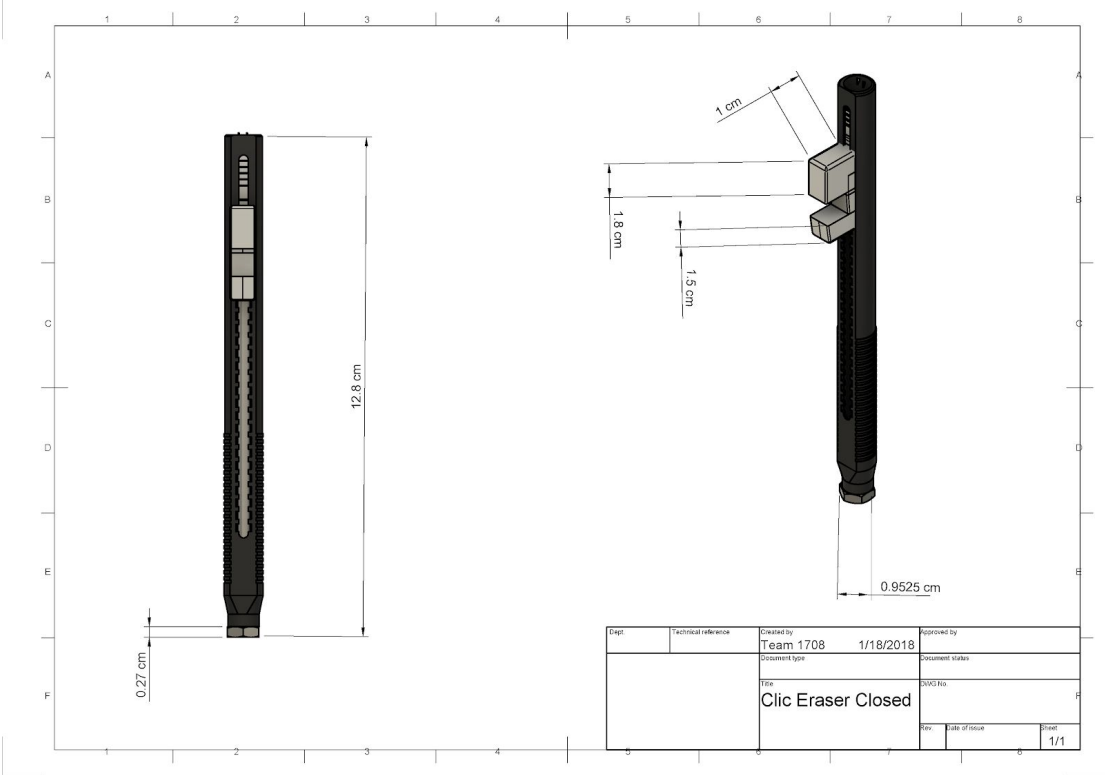
**The averages do not include failed trials

Appendix B - Prototyping Data

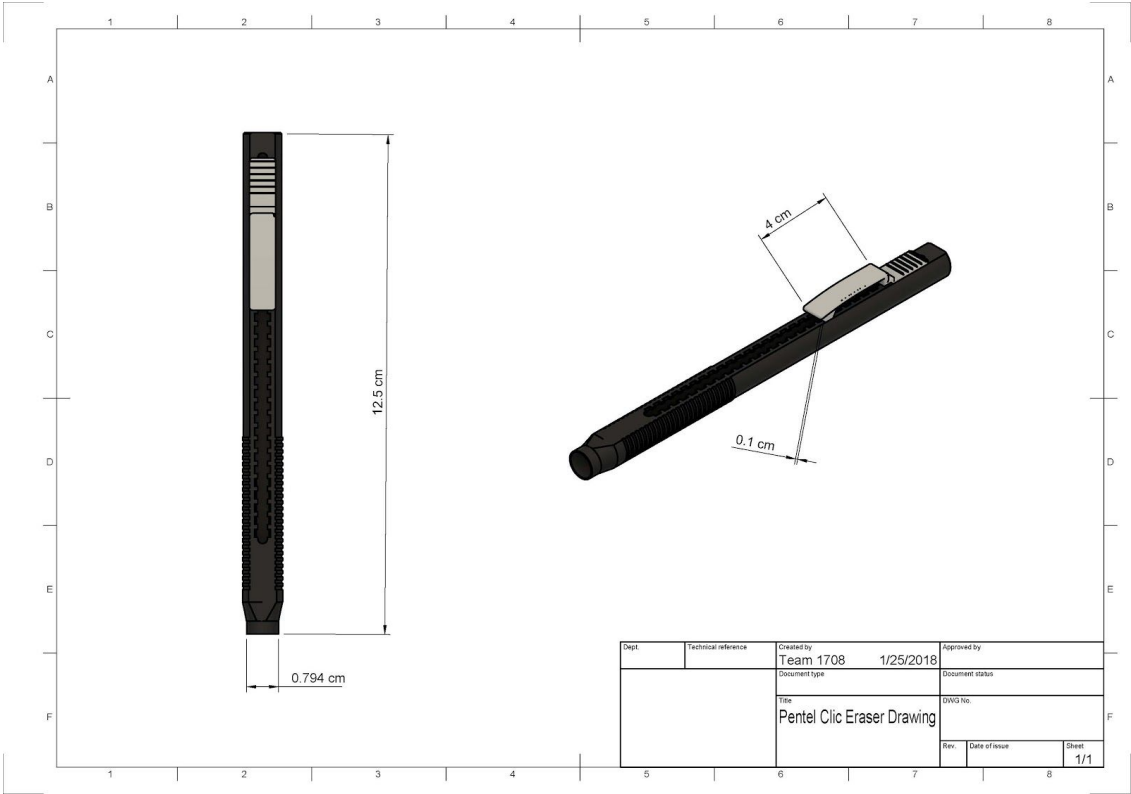
| Blue Pen | Dipping (s) | Taking out (s) | Refilling (s) | Total (s) |
|------------------|-------------|----------------|---------------|--------------|
| V1 (wood) | 8 | Failed | Failed | 8 (Failed) |
| | 11 | 1 | Not needed | 12 |
| V2 (metal) | 21 | 2 | 9 | 32 |
| | 35 | 3 | Not needed | 38 |
| | 12 | 3 | 9 | 24 |
| | 21 | 3 | Not needed | 24 |
| | 25 | Failed | Failed | 25 (Failed) |
| | 12 | Failed | Failed | 12 (Failed) |
| | 9 | Failed | Failed | 9 (Failed) |
| | 10 | 2 | Not needed | 12 |
| | 8 | Failed | Failed | 8 (Failed) |
| | 9 | Failed | Failed | 9 (Failed) |
| | 13 | Failed | Failed | 13 (Failed) |
| | 12 | 6 | Not Needed | 18 |
| Average** | 16.4 | 2.33 | 3 | 23.67 |

**The averages do not include failed trials

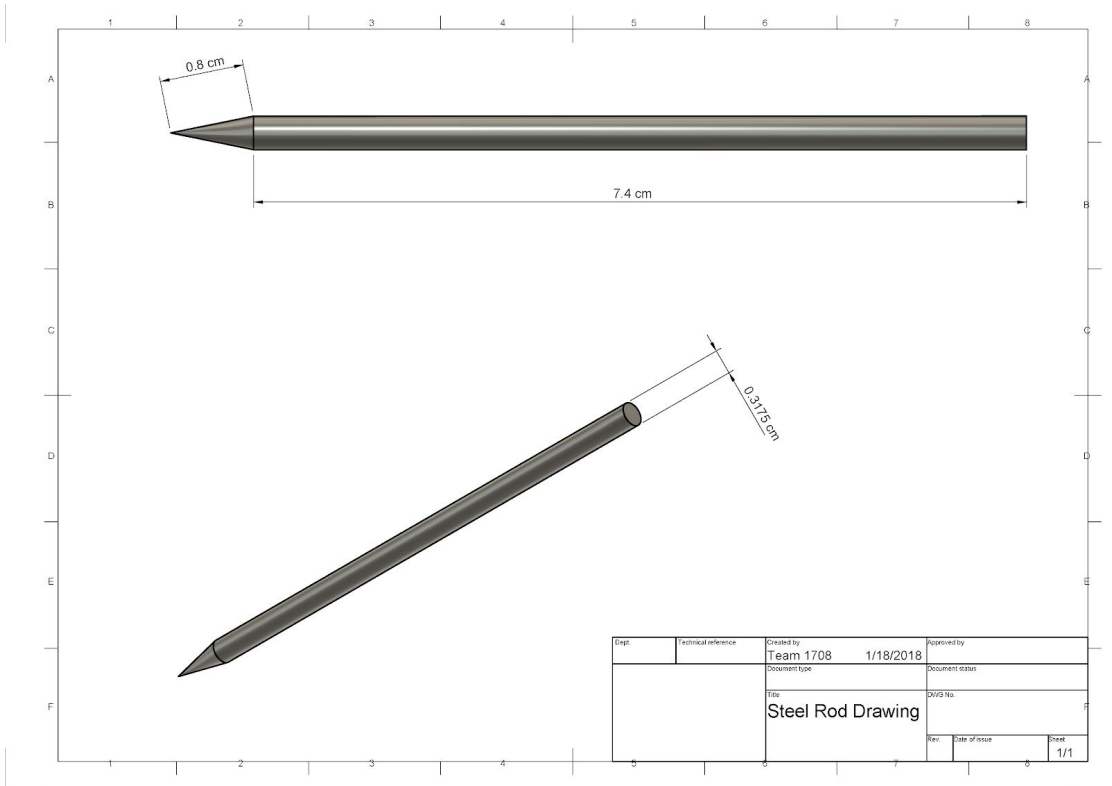
Appendix C - Technical Drawings of *The Truffle Maker* Assembly



Appendix D - Technical Drawing of Pentel Clic Eraser



Appendix E - Technical Drawing of Stainless Steel Rod



Appendix F - Technical Drawing of Nut

