Table of Contents

List of Figures

List of Tables

1 Problem Formulation

1.1 Introduction

Section 1 contains a brief background on the project, the objective statement of the project, and a black box diagram that focuses on how this design will impact the world.

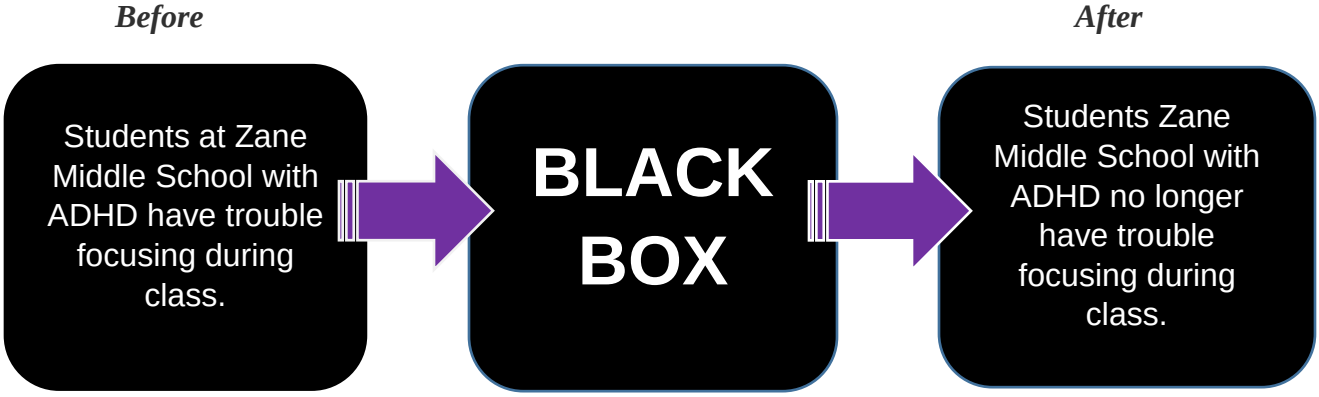
1.2 Background

This project is to design a stand up fidget desk that will allow middle schoolers with the learning disability Attention-deficit/hyperactivity disorder, also known as ADHD, to focus better in class. The stand-up desk will include small fidget devices that the students can play with in class to increase their focusing. The client is Zane Middle School, located in Eureka California, and the teacher in need of this desk is Celia Boomer. We are designing this project as credit for our Engineering 215 design course at Humboldt State University. The team in charge of this project is called the Hardworking Procrastinators and consists of 4 members: Kaden Law, Sarah Parr, Gilberto Sandoval, and Madison Whitlow-Hewett.

1.3 Objective Statement

The objective is to construct a stand-up fidget desk for Zane Middle School; the purpose of this fidget desk is to increase the over-all concentration in students with ADHD during class periods. The fidgeting components of the desk will be used to focus the user's attention during class without detracting from the learning environment of other students in the class.

1.4 Black Box Model



2 Problem Analysis and Literature Review

2.1 Introduction to the Problem Analysis

Section 2, Problem Analysis, is an overview of the problem introduced in the objective statement in Section 1. The proposed project is laid out in this section through specifications, considerations, usage, and production volume. The criteria and constraints given by the client are also introduced in this section.

2.2 Specifications and Considerations

The specifications and considerations will be incorporated into the design process so that upon completion the project meets the client's criteria in the best way possible.

2.2.1 Specifications

The specifications of the project are parameters set by the client that must be incorporated into the overall design of the fidget desk. The specifications are as follows:

- The desk must be adjustable to accommodate students in the height range of 4ft to 6ft.
- Any fidget tools incorporated into the design must be silent as to prevent distractions in the classroom.
- The desk must retain its academic usefulness by having a flat surface on which the kids can write.
- A device to catch pencils must be implemented in the design.

2.2.2 Considerations

Considerations are factors of the project that can be assumed from the specifications, the knowledge the team has acquired about the project, and a desire to produce both a functional and aesthetically pleasing product. The considerations are as follows:

- The structural integrity of the desk
- The desk will promote a better learning experience for its users.
- Color and aesthetics.
- A desk meant for a single student with extra room for the fidget toys (30" by 30")
- The age of students using this desk will range from 11-14

2.3 Criteria and Constraints

Criteria and constraints provide the framework for the building and designing of the fidget desk. The quality of the project depends on meeting the criteria and fulfilling the constraints. The criteria and constraints for the fidget desk are as follows:

Table 2-1: Criteria and Constraints

Criteria	**Constraints**
Fidgetability	More than 2 silent hand fidget tools
Aesthetics	Needs to look similar to other desks in the classroom
Cost	Less than $75 per group member plus $100 dollars from the client
Safety	Safe for kids in middle school/structural integrity is maintained throughout constant use
Durability	Is able to accommodate more than 10 students on a daily basis.

2.4 Usage and Production

The Stand Up Fidget Desk will be utilized by approximately 10 students during a 7-hour school day, 5 days a week. The desk will primarily be in use during the school year from September to June, with the exception of vacations. The desk is expected to function as a typical scholarly desk with the added benefit of silent fidgeting components for both hand and foot use. It is also required to be adjustable in height so that all kids in the class can use it. The fidgeting components of the desk will be used to focus the user's attention during class without detracting from the learning environment of other students in the class.

The production of the desk is to be done using a woodworking shop, and free wood. Many hours will be spent to build this desk. The first stage is to build a sturdy, adjustable desk which will be done in the woodworking shop for free. The second stage is to build the top of the desk with the fidget toys. This will not be free and will be much more fine-tuned and professional looking.

2.5 Introduction to the Literature Review

The purpose of this literature review is to provide a comprehensive source of information to use in the process of conceptualizing, designing, and executing the Silent Fidget Desk. The following section includes a variety of valuable topics including the project parameters suggested by the client, a brief explanation of ADHD, different learning styles of students and how teachers accommodate for those styles in a classroom setting, specific resources available to support proactive fidgeting habits, ergonomic desk design, and a brief overview of the relationship of sound and noise. Source citations are located in the references.

2.5.1 Client Interview

Celia Boomer is the appointed contact for the client, Zane Middle School. The engineering project in question is the design and execution of a stand up fidget desk for her English class. Specific parameters that have been set by the client include: The desk should be adjustable for students ranging in height from 4ft to 6ft, the fidgeting tools incorporated into the desk design must be silent to prevent other students from being distracted, the desk should have a surface for students to do their homework and assignments on, as well as having a place to store or catch pencils. The client also expressed interest in having resistance-based pedal and hand grip appliances incorporated into the desk, but specified that both appliances don't necessarily need to be included in the final design. The estimated age range for the use of the desk is 11-14 years old, the client estimates that 10 students per day will be using the desk, so durability is a necessity. Inspiration for the desk idea came from Antsy Lab's Fidget Cube, and students in the classroom have already been using the cubes in class to promote concentration.

2.5.2 Understanding Attention Deficit Hyperactivity Disorder

ADHD stands for attention-deficit hyperactivity disorder, and is classified by the U.S. Department of Health and Human Services as a brain disorder marked by an ongoing pattern of inattention and/or hyperactivity-impulsivity that interferes with cognitive function or development. ADHD is related to uneven chemical balances in the brain, and is primarily gained through genetics, though it can be developed due to head trauma. The following section delivers a synopsis of subtopics regarding symptoms and diagnosis of ADHD, demographics of the disorder, support and solutions for those living with the imbalance.

2.5.3 Symptoms and Diagnosis

Specific symptoms of ADHD include inattention, hyperactivity and impulsivity. Inattention is exhibited through forgetfulness, being unable to focus on the task at hand, not following through on assignments and experiencing issues with organization and time management. Hyperactivity is showcased through fidgeting constantly, not being able to sit still for extended periods of time, being constantly "on the go" or in a rush. This relates to impulsivity as well, for example, speaking out of turn or at inappropriate times and interrupting often. The Centers for Disease Control and Prevention discuss the issue of people self-diagnosing themselves with ADHD because they have ephemeral experiences with one or more of the previously stated symptoms, however, ADHD is professionally diagnosed when these symptoms occur often enough to interfere with school, work or social settings.

2.5.4 Demographics

For students with ADHD, fewer than one-third of them are being treated with both medication and therapeutic measures. It's estimated that over five percent of middle school students are diagnosed with ADHD, while eleven percent of parents believe that their child has some type of problem with hyperactivity, diagnosed or not. According to the CDC, in California, of students age 4 to 17, approximately 4% have ADHD and of those with it, less than 65% of them take medication for it (Center for Disease Control and Prevention). So middle school teachers in California are often educating students with ADHD that aren't being treated, as well as those that are undiagnosed.

2.5.5 Support and Solutions

There are many different ways to improve focus for people with ADHD, and each works in alternative ways for a variety of people. Medication is typically the first suggested solution for any disorder similar to ADHD. There are stimulant and nonstimulant medications. Stimulants work faster and are more effective than non-stimulants, but have many side effects, including sleep disorders, decreased or increased appetite, migraines and stomach aches. Stimulant medication can also be paired with a non-stimulant for extra effectiveness. Non-stimulants work slower but work to improve focusing and impulsivity.

Other options include Psychotherapy, education and training, and hobbies or exercise. Psychotherapy, or behavioral therapy, helps develops skills for people with ADHD to get organized and make them more aware of their actions in order to make conscious changes. Therapy can also boost self esteem and can teach how to use ADHD to their advantage. This type of therapy also educates and trains the family to live with and help the person with ADHD to succeed in life. Hobbies and other outlets are a good way to exert energy, exercise is highly recommended and works well for kids who have ADHD. Other outlets include art, blogs or vlogs, hands on hobbies like building and videogames (in moderation).

A journal article written by Natalia Turketi outlines that the best ways to help kids with ADHD succeed in school is to improve their organizational skills. These skills can be improved by having a specific routine, with the same daily schedule, and to plan things in advance. Implementing understandable and consistent rules to follow will also benefit the individual, this structure in their life will give them the best chance of success. Praise should be given when deserved because kids with ADHD often receive criticism about their actions. Turketi describes ADHD as an incredible asset in activities that require spontaneous thinkers and a lot of energy, kids with ADHD tend to have more creativity, exuberance, emotional expressiveness, interpersonal intuition and leadership.

2.5.6 Education and Learning Styles

Children spend a significant amount of time in a classroom, and for some, this can prove to be difficult. The focus of this section is to introduce and elaborate on the subjects of kinesthetic learning, teaching styles that have been modified for these learners (and those with ADHD), Montessori and Waldorf schooling techniques, middle school development, and the effect fidgeting has on the learning environment. Figures are included in certain subheadings to provide depictions of different classroom environments.

2.5.7 Kinesthetic Learning

The kinesthetic learner is a hands on learner that benefits from physical activities rather than lectures. Kinesthetic learners work well with their hands, they like to manipulate and touch materials which facilitates their learning process. Incorporating movement in the classroom enhances the ability to focus and learn for students who use a hands on approach to retain and acquire information. The kinesthetic approach to learning has been beneficial to not only the secondary level of education but at the universities level as well, where kinesthetic learning techniques have been implemented and have helped students learn by getting them involved with their surroundings (Mobley, 2017). When students who have ADHD are incorporated into activities that require interaction, movement, and engagement they tend to demonstrate a high level of focused attention (Turketi, 2010). Kinesthetic learning can be beneficial to students who suffer from ADHD and can be a way to convert their need to move into a tool used to teach them.

2.6 Teaching Styles

In order to accommodate students with ADHD, and other learning impairments, alternative styles of teaching have been created and implemented through Montessori and Waldorf schools. These alternative methods often include individualized teaching, and sometimes unconventional teaching strategies. The more personalized teaching curriculum can help students not only focus, but also retain more information.

Many of these different teaching styles do not include standardized testing and other measuring sticks for learning (*Association of Waldorf Schools of North America*). Test taking is determined by and fit to the individualistic curriculum, providing a low-stress, personalized testing system for the students. These often test progress of the individual instead of classifying everyone in one group. Incorporating different styles of teaching can help students with specific needs, such as ADHD or any unique learning style, in the classroom.

2.6.1 Montessori

Montessori's are a specific type of educational system that focus on transforming the classroom into a more personalized learning environment typically catering to students that are a variety of ages, as opposed to one specific age group. Often, classes are structured around real life applications--gardening, cooking, etc. (*International Montessori Index*). In the classroom, the students don't have to sit in the same spot, or even sit at all. The schools often follow basic fundamentals of using real materials to make practical solutions, instead of traditional public school learning styles.

Contrary to standard middle school learning, revolved around worksheets and standardized testing, teachers at Montessori teach real life skills through trades and provide integration into the real world through the curriculum.

Figure 2-1 Classroom at Washington Montessori Institute at Loyola University Maryland (Loyola University)

2.6.2 **Waldorf**

The basic concept behind a Waldorf school is extensively incorporating arts into the curriculum. The Waldorf teaching method involves the idea of the world being incredible and how it's experienced, the goal of these methods is that students will learn to be critical thinkers and learners instead of memorizers. The teaching at Waldorf schools intends to focus on understanding and developing learners, through meeting the demands of the specific student.

Some of the curriculum that has been established at Waldorf schools includes dancing, literature, and different arts classes. Teachers also try to guide their students to really enjoy school and have a genuine passion for learning. That growth shown through the enjoyment of learning is used as an alternative to standardized testing and other academic expectations, the teachers choose to focus on the individual cases of their students.

Figure 2-2 Classroom at Minnesota Waldorf School (Minnesota Waldorf)

2.6.3 Middle School Development

Transitioning into middle school, students often undergo changes in their education and in their mental/physical health. Usually, middle school students range from eleven to fourteen years old (6th-8th grades). This is around the time that children are beginning to physically mature through puberty, but they are not necessarily emotionally maturing.

Physical maturing includes height and weight growth. Normally, puberty arises in adolescents from 10-15 years old--right around the age threshold of middle school students. According to a study completed at the University of Wisconsin in 1997, on average, males grow approximately 4-12 inches during puberty and females grow from 2-10 inches. The shortest percent of sixth grade male students are approximately 120 cm tall (3'11") and the tallest percent of eighth grade boys are approximately 175 cm (5'8"). The shortest females in sixth grade are around 115 cm (3'9"), and the tallest eighth grade girls are roughly 165 cm (5'5").

During middle school, the emotional development of students can be altered by numerous things (Eccles). This can be through physical developments, family life, and any other reasons. This is the time that young people begin to develop an identity and build opinions on different aspects of life. This is a crucial time of development for students in the fields of English and Mathematics, and students have the added expectation from teachers that they act a certain way in their learning environment.

2.6.4 How Fidgeting Affects Learning Processes

Students who've been diagnosed with ADHD typically have difficulty focusing in the classroom, so creating a conducive learning environment for these students can be a challenge for many teachers. A study conducted by Sheryl Stalvey and Heather Brasell in the summer of 2006 states that the specific learning style of each student tends to dictate how their attention can be held during classes, kinesthetic learners with ADHD have a particularly hard time focusing because of a strong need for stimulation and movement to be a part of their curriculum. In addition to the kinesthetic learner exhibiting fidgeting behavior, such as clicking a pen or tapping on a surface due to lack of focus, fidgeting can become a distraction for visual and auditory learners who require a quieter learning environment to stay focused. The kinesthetic learner creating distractions during class due to disruptive fidgeting creates the need for a silent more proactive solution to help sustain the focused environment of the classroom. An additional study conducted by Magdalena Majorek, Tobias Tüchelmann, and Peter Heusser focused on using Therapeutic Eurythmy, defined as movement therapy, on students with ADHD. The study concluded that when exposed to movement therapy, the students exhibited increased motor functions, focus, and over-all concentration levels improved.

2.6.5 Types of Fidgeting

Fidgeting includes a range of restless movement by an individual on a daily basis, common forms of fidgeting include: foot tapping, pen clicking, and thumb twiddling. The following section covers information on different mediums being utilized to aide in productive fidgeting behaviors. Specific mediums include: adapted classroom friendly fidgeting apparatuses for hands and feet, commercial fidgeting toys currently being sold on the market, and the connection between fidgeting outlets and video games. Images are included to provide references of functionality and design for specific examples of fidgeting mechanisms.

2.6.6 Adapted Fidgeting Tools

Fidgeting is not something that a student with ADHD generally has control of, to combat fidgeting in the classroom certain tools are being implemented to help those students stay focused while reducing distraction for others. These tools include stress bands which allow the students to engage their feet in a way that reduces noise and keeps their feet occupied thus increases their focus. The bands are placed on the legs of the desk to create resistance as the students move the elastic bands forward with their feet. Balance balls are another tool being used to help students with ADHD. Students who tend to move a lot at their desk are seated on a balance ball, while the student is occupied in trying to sit upright on the ball they are providing themselves with the sensory input they need as well as engaging in physical activity. Stand up desks are also helping kids with ADHD maintain focus in the classroom. The desks provide students the opportunity to stand up while they work. These desks are equipped with a "fidget bar" that allows the students to place their foot on it and move it back and forth while releasing energy. The fidget bar is used as a tool that enhances the student's learning environment. They keep themselves occupied by fidgeting in a way that is not disruptive to themselves or others.

2.6.7 Commercial Fidgeting Tools

There are many commercial options to choose from when it comes to kinesthetic learning devices or 'fidget toys', the following descriptions represent three different fidgeting devices currently on the market (as of 2017). Two of the following fidget toys, the Fidget Cube and Five Dollar Fidget Spinner, are both crowdfunded Kickstarter campaigns that have had a significant impact on the fidget toy industry. The final toy reviewed in this section is the stress ball, one of the most iconic fidgeting toys on the market. Pictures have been included with each description to provide a reference as well as to showcase the design potential of fidget toys.

2.6.8 Fidget Cube

The fidget cube is a crowdfunded project by Mark and Matthew McLachlan for Antsy Labs LLC that launched on kickstarter in August of 2016. The cube is designed with fidgeting components located on each of its six unique sides, in addition to the components the cube offers specific themes to accompany each side: click, glide, breathe, roll, spin. The 'click' side of the cube features five buttons arranged in a dice-like pattern, the three diagonal buttons make a soft clicking sound when pressed, whereas the two buttons on either side of the diagonal make no sound at all. The 'glide' side of the cube features a raised joystick that glides with a smooth motion, complemented by the 'spin' side that offers a dial, outfitted with slight resistance, embedded in the surface of the cube. The 'breathe' side of the cube features a smooth divot that perfectly fits the curvature of a thumb, this side is specifically inspired by worry stones. The final side 'flip' features a switch that can easily be flipped back and forth with slight finger pressure.

Figure 2-3 The Six Sides of the Fidget Cube (Kickstarter)

2.6.9 **Fidget Spinner**

The Five Dollar Fidget Spinner is a crowdfunded project designed by Sean Hodgins, and 3-D printed by Shapeways, that appeared on kickstarter in January of 2017 and reached its funding goal of $4,200 USD in three days. The fidget spinner was originally a selection of 17 different 3-D printed designs, a poll was created that the project backers voted on to select which design would hit the market first. The design that racked up the most votes was the Trama, each spinner design features a skateboard bearing in the center to provide glide and rotation, and weighted ball bearings on the tip of each perpendicular extension to ensure prolonged motion without the input of extra force.

Figure 2-4 Trama Design for Five Dollar Fidget Spinner Kickstarter Campaign (Kickstarter)

Figure 1-4: Trama Design for Five Dollar Fidget Spinner Kickstarter Campaign https://www.kickstarter.com/projects/idlehandsdev/five-dollar-fidget-spinner/description

2.6.10 **Stress Ball**

The stress ball is one of the most popular and iconic fidgeting companions on the market. The celebrity of stress balls has encouraged many variations to appear on the market, ranging from a traditional foam medium to liquid or gel filled spheres. Stress balls are meant to relieve built up stress by allowing the individual to expel tension by manually squeezing or crushing the ball

Figure 2-5 Foam Stress Ball (Google Images)

2.6.11 Video Games

One video game in particular has been linked to ADHD and its help to diminish the disorder's effect, Minecraft. It's very popular amongst kids with ADHD because of its "sandbox" design, the player can go anywhere and build anything. Researchers are finding that it's helping with organization, which is a skill that most people with ADHD lack due to the symptom of impulsivity and inattention to detail. To play the game successfully, the player has to stay organized and remember what they need when they leave their virtual home, as well as being able to memorize patterns to craft needed materials to survive. Dr. Steingard, a child and adolescent psychiatrist at the Child Mind Institute, says that "video games throw stimuli at many different visual points, and to play well you have to be able to pay attention to all of them at the same time. If you're too linear or methodical it won't work." Steingard suggests that that kids who play for longer amounts of time have more severe ADHD symptoms. The American Academy of Pediatrics recommends two hours per day of total media screen time, suggesting that videogames can be beneficial in moderation.

2.7 Ergonomic Desk Design

Ergonomics is the science concerning the optimization of products for human use in their respective work environment. Common problems of current school desk designs include the lack of adjustability, comfort levels, and the inability to accommodate a wide range of the population. As studies have shown these problems in turn reduce the development/attentiveness of students in the classroom (Gimenez, 2016). Key features of a well-designed desk include proper desk chair combination, cushion, backrests and most importantly, adjustability to serve a wider range of the student population based on anthropometric measurements. The following section offers comparisons of different types of existing desks, the difference between standing and sitting in work environments, desk materials, and foot pedal designs. Figures are included as needed to depict different design options.

2.7.1 Standing vs. Sitting

In the work environment neither sitting, nor standing are recommended over the other, but instead a hybrid of standing and sitting is suggested. Sitting in a desk chair for long periods of time can cause a

number of long term lower back injuries, and standing for extensive periods of time can be strenuous. The body gets more of an exercise from standing while working, than sitting, however, both sitting and standing are recommended while working in a stationary setting, due to the resting period it gives different muscles. A study by UCLA, focused on ergonomics and changes in posture found that it's almost a necessity to both sit and stand throughout the work period to increase productivity and promote a healthy lower back.

2.7.2 Standing vs. Sitting (ADHD Specific)

People with ADHD need the freedom of movement in the classroom or workspace, the movement of sitting to standing increases blood flow and helps keep the body active. For students with ADHD, teachers have reported that in some cases that the students who've used the standing desk have been more focused (Bisk, 2017). The desks have provided a better working environment for the students with ADHD and those around them. Some teachers have also noticed that the attention spans of the students are longer with the standing desk. Oftentimes the standing desks, for students with ADHD, coincides with fidgeting.

2.7.3 Existing Desk Designs

Desks are an important aspect in the classroom, because it's the place where students spend the majority of their time. Creating a desk that is ergonomic and encompasses the needs of students in regards to body size can result in a user friendly design (Khanam, 2006). Existing desk designs include traditional single pupil desks, separated chair and table, and a few stand up desks that are slowly being introduced into classrooms as an alternative means to traditional desks. It's often the case that existing desks have very little ergonomic design, they tend to be outdated and neglect to acknowledge the physical change the student has undergone as they develop.

Figure 2-6: Current Desk Surface at Zane Middle School (Photo by Madison Whitlow-Hewett)

2.7.4 Traditional Tablet Arm Chair Desk

Tablet arm chair desks are still in constant use in many middle schools, the basic design consists of a chair, usually made out of plastic, with a work surface attached. These types of desks seat a single student and are used due to their low cost, durability, and the ease of cleaning them. These desks are fixed and exhibit no level of adjustability to fit the physical needs of the various students that utilize them on a daily basis. Tablet arm chair desks are practical in an economic sense but not practical in terms of providing the student with the best resource to succeed.

2.7.5 Separated Chair and Table Desk

Desks that incorporate a separated chair and work surface tend to increase the desire and ability of students to work in groups. These desks are usually made up of a single chair or stool placed next to a table top that can seat multiple students. The chair can be adjustable, have arm rests, and allows students the option to shift their posture as needed. The table top is usually in a fixed position but this can vary depending on the size, the chair however may have wheels that allow student to move them without causing classroom disruptions.

2.7.6 Standing Desk

Standing desks provide the user the ability to stand while working on a table surface. The idea of introducing standing desks in the classroom is increasing in popularity due to studies yielding positive results such as increased cognitive functions, health, academic achievement and increased student engagement (Sudholz, 2016). Standing desks allow students that are categorized as having ADHD the opportunity to fidget while maintaining focus on the teacher. Increased productivity is also a benefit of

standing desks due to the fact that students who have tendencies to slouch, fall asleep and fidget while seated at traditional desks are now physically engaged, standing up and paying attention (Chua, 2014).

The design of standing desks allows the user to adjust the height to their liking and provides the option of sitting down when a break from standing is needed. This design also allows for the implementation of tools used to combat fidgeting such as the fidget bar which enables the students to remain engaged in the classroom because they are not constrained to their desks.

2.7.7 Building Materials

Desks are most commonly built from laminate, wood, plastic, or metal due to the fact that these materials are the easiest to manipulate in terms of weight, shape, and price. To minimize cost, and provide a potential learning experience, most components of a desk can be built with reclaimed materials, for example: The Environmental Center at the University of Colorado, Boulder used recycled or reclaimed materials to build an entire desk for their Green Office department. Recycled fibrous agricultural waste material and reclaimed wood were used to build the surface of the desk, recycled post-consumer cardboard was used to create the legs of the desk, and a rubber boot made from recycled tires were placed at the ends of the desk legs to protect them from potential floor damage.

Different building materials can also account for the level of comfort experienced by the students. According to a study done by Chanda Nelofer Khanam, Mahalakshmi V. Reddy and A. Mrunalini for the Department of Resource Management and Consumer Sciences, College of Home Science in Andhra Pradesh, India, students felt more comfortable when sitting at desks made from laminate and wood materials with curved edges as opposed to metal materials with sharper edges. Further recommendations from the students who participated in the study concluded that comfort could be improved by building stronger, more durable classroom furniture.

2.7.8 Foot Pedals

A common mannerism exhibited by students who have trouble focusing is to bounce their leg up and down or tap their feet. This can be a distraction to other students, who find the movement in their peripheral vision disruptive. Foot petals help minimize this annoyance and give fidgeters something to do. The petals should have resistance applied to them, so when stepped on, effort is needed to push them all the way down, causing more energy to be exerted.

Many other inventions already exist to help kids that like to fidget with their legs. One desk design that has been proven effective is the pedal desk, each desk has a set of pedals that are practically noiseless so they don't create distractions. Another under the desk foot fidgeter is the swinging foot rest, it's relaxing and creates a rhythm. Kids with this particular desk can also choose to sit or stand. One creative and inexpensive way to help with foot fidgeters is big rubber bands. To make use of this idea, rubber bands are attached to the sides of the desk so kids can bounce their legs left and right off the rubber bands. A teacher on donorschoose.org is asking for money to build what she calls The Kinesthetic Classroom, which consists of these rubber bands and other ideas for fidgeters.

Figure 2-7 Foot Pedal Desk (Center for Educational Improvement)

2.8 Sound and Noise

Sound and noise are not the same. Sound is a wave that travels and is detected by the human ear. Noise is an excess of sound that can cause disturbances, both mentally and physically. The idea of noise is created through sound. Sound is measured through amplitude, which measures the pressure of the sound, and frequency, which measures the vibration over a certain time period.

Noise can cause hearing loss, and is often a distraction for students. For students with ADHD, the tapping of a pencil, or clicking of a pen can be extremely distracting; however, if they are the one creating this excess of sound, it can be a way to focus. Sound gets turned into noise due to the intensity of the sources of the sound.

2.8.1 Decibel Levels

A decibel (dB)l is equal to 10 Log (acoustic energy/reference energy). The scale of the decibel begins at an absolute zero of human hearing, and the pressure of hearing (Pa) can only be measured if the decibel level if from zero to 140. Whispering in someone's ear is reported as having a decibel level of 34 dB (Indiana State University) and normal conversation is roughly 40-60 dB, depending on the person. The level that's stated to create distraction for the general person is 65 dB--the level in which sound turns into noise.

Source	Pressure rms (*Pa*)	Sound Intensity level SIL (*dB*)	Intensity (W/m^2)
Jet engine at 10 m		150	10^3
Jet engine	200	140	100
Jack hammer	60	130	10
Car horn	20	120 (pain threshold)	1
Rock band	6	110	0.1
Machine shop	2	100	0.01
Train	0.6	90	10^{-3}
Vacuum cleaner	0.2	80	10^{-4}
TV	0.06	70	10^{-5}
Conversation	0.02	60	10^{-6}
Office	0.006	50	10^{-7}
Library	0.002	40	10^{-8}
Hospital	0.0006	30	10^{-9}
Broadcast studio	0.0002	20	10^{-10}
Rustle of leaves	0.00006	10	10^{-11}
Threshold of hearing	0.00002	0	10^{-12}

Figure 2-8 Pressure, Decibel Level, and Intensity (Sound Physics)

3 Alternative Solutions

3.1 Introduction

Section 3 introduces the alternative solutions for the stand-up fidget desk. The methods used to generate the ten alternative solutions are also discussed in this section. Each alternative solution pays careful attention to fulfill certain aspects of the design criteria described in Section 2.

3.2 Brainstorming

Team Hardworking Procrastinators conducted one physical brainstorming session accompanied by the creation of a Google document that was shared amongst the team members. The Google document was used as a supplement to the first brainstorming session. The initial brainstorming session was a discussion that allowed for the creative flow of ideas and discussion about each idea. Each team member's ideas were discussed and if found to be viable were written down on a list. The list was then transferred to the Google document and each team member was instructed to come up with at least two more ideas and introduce them in the document for the other members to see. The team then decided which alternative solutions were best by voting on them. Each team member was assigned two alternative solutions and instructed to write about them and provide the necessary visuals so the reader gets an understanding of each alternative option, which is represented in Appendix-A.

3.3 Alternative Solutions

Alternative solutions are ideas generated through brainstorming that comply with the design criteria of the project noted in Section 2. The alternative solutions are possible desk designs that incorporate the necessary components to achieve the purpose of the project. Sections 3.3.1-3.3.9 describe the following alternative designs: The Footsies-Feetsies Fidgetter, The Fidget

Booth, Twiddle Table, Lego do stuff, Bouncing Back, The Musical Note Desk, The Tracktop Desktop, Magneto, and Le Tour De Class.

3.3.1 Footsies-Feetsies Fidgetter

The Footsies-Feetsies Fidgetter is a desk that only incorporates mechanisms that engage the feet or legs of the user. Figure 3-1 presents the design plan for this contraption. This design incorporates an adjustable four-legged desk, but without any mechanisms for hand fidgeting. The adjustable legs will be made of steel and the top will be a flat, oak surface. The design includes two swings for the lower body; one at knee level and one at a slightly lower position for a foot. The swings are made of elastic bands so it can accommodate both above and below average height students. The swings have a laminate foot platform. This desk is a less safe option because the foot swings can be used as weapons. The desk also has a stationary foot platform for students to have a resting spot for their feet. A foot-pedal mechanism, similar to that in a vehicle is incorporated into this design plan. For functionality, the desktop includes a place to hold pencils, markers, etc. and it also has a storage section for students' supplies.

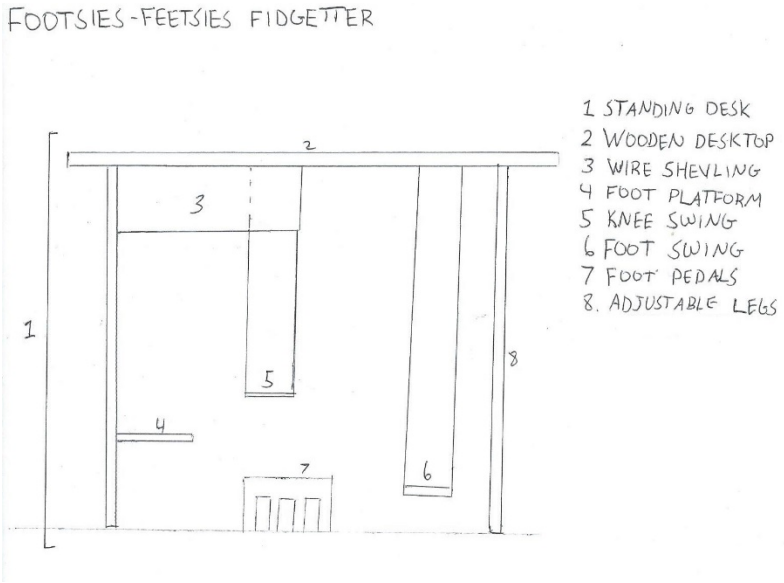


Figure 3-1 Footsies Feetsies Fidgetter (Drawing by Kaden Law)

3.3.2 Fidget Booth

The Fidget Booth acts as a closed-off space for students to escape class distractions for focused study time. At the push of a button, the student can choose between three different fidget themes that are situated on a desk surface in the booth. Each theme occupies one side of a triangular cylinder that rotates based on what button is pressed. The three themes of the booth include: roll, press, and texture. Figure 3-2 illustrates the layout of the desk as well as the booth design.

The desk is made of reclaimed/recycled wood and is larger than a typical classroom desk measuring 3ft x 2ft, to accommodate the rotating components and buttons on each side of the desk. The booth, which houses the desk, is made of recycled plastic material and measure 7ft x 5ft x 4ft, with a door cut 1 ft. from the top and the side of the structure that utilizes a hypo-allergenic cloth as a door cover. The design is the most fidgetable, but is one of the least

aesthetic of the alternative solutions. The fidget components and buttons are fabricated from old/retired arcade game components, providing a personalized feel to each desk design.

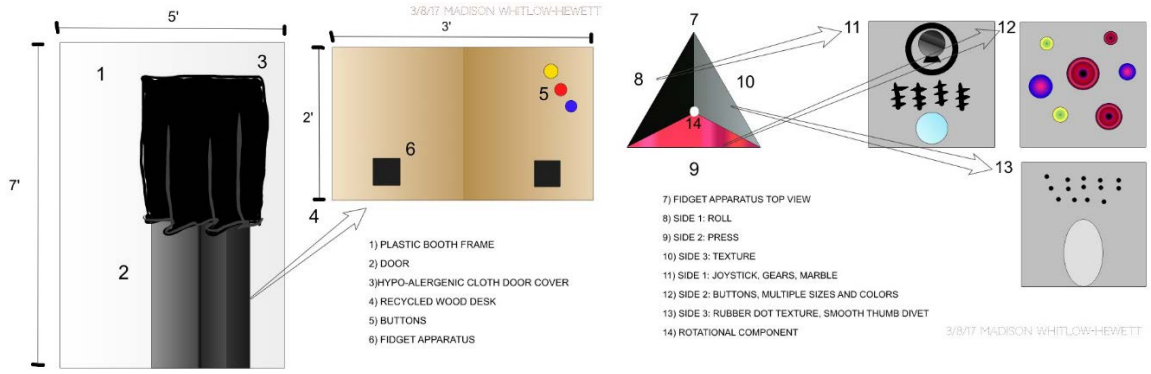


Figure 3-2 Fidget Booth (Drawing by Madison Whitlow-Hewett)

3.3.3 Twiddle Table

The Twiddle Table provides a fidget surface that accommodates more than one student, so brainstorming sessions and group assignments can be executed while the fidgeting components of the table enable a more focused session. Figure 3-3 depicts the table design as well as the fidget control layout. Each circular table sits 4-5 students and provides a fidgeting apparatus at each seat, incorporated into the surface of the table. The apparatus mimics the form of a remote control with different fidgeting components laid out over a 3 inch by 7-inch plastic rectangle, each control will be uniform to avoid student conflict. This design is a fidgetable alternative solution due to the incorporation of fidgeting devices. The center of the table features a lazy susan with a radius of 1.4 ft. Materials can be passed on it--also giving the students an opportunity to group fidget by turning the wheel back and forth. The table surface has a radius of 3.5ft, is crafted from reclaimed/recycled wood, and sits atop a metal frame. The lazy susan is made of the same material as the table, recycled wood, and is attached by and rotates on a 7-bearing unit for durability. The fidget controls are laid out like the fidget cube, but on a flat surface.

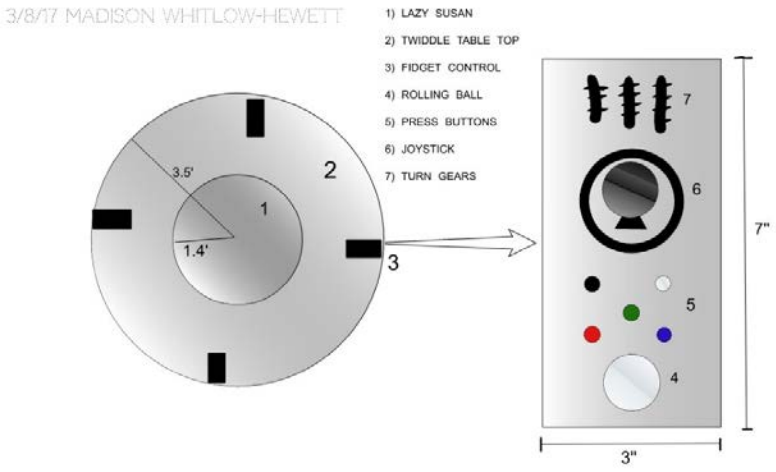


Figure 3-3 Twiddle Table (Drawing by Madison Whitlow-Hewett)

3.3.4 Lego Do Stuff

Lego Do Stuff is a desk or desk top built out of Legos that you can take apart and rebuild in class. The designs consist of Legos integrated into the desk with parts of the desk constructed with Legos. The top of the desk is made of Legos. The design is depicted in Figure 3-4. There is be a smooth, non-Lego part in the center to write on, surrounded by Legos imbedded into the desk. This design is not an aesthetically pleasing alternative solution, but is extremely durable because of the ease of maintenance. It comes with pencil catchers made of Legos on the desk. A magnetic strip on the outside holds tubs of smaller Lego pieces that are not generic bricks, but more complicated pieces.

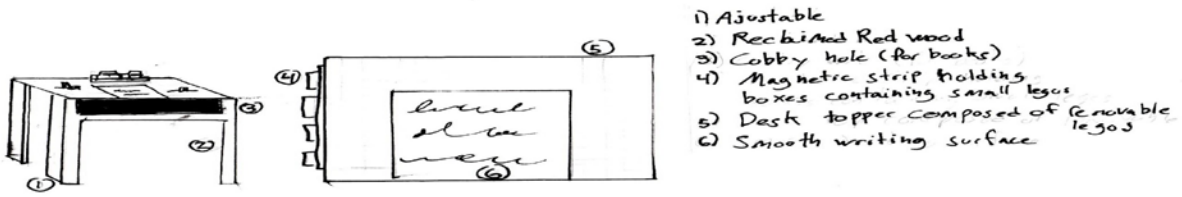


Figure 3-4 Lego Do Stuff (Drawing by Sarah Parr)

3.3.5 Bouncing Back

The Bouncing Back is a chair that utilizes a large exercise/yoga ball as a chair that allows users to bounce up and down. The design for this chair includes a metal frame for the ball. Figure 3-5 shows the design of the Bouncing Back. It would have four regular chair legs and a ring that the ball would rest on. The user is able to bounce up and down, which keeps the body in motion rhythmically. The chair is functional with any desk that the client provides, making it a safe and durable design, but it does lack the criteria of fidgetability.

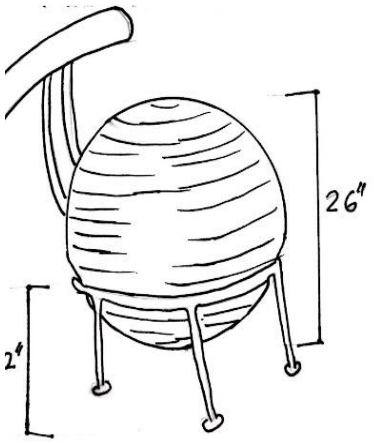


Figure 3-5 Bouncing Back (Drawing by Sarah Parr)

3.3.6 Musical Note Desk

The Musical Note Desk is a fidget desk that has different musical instruments designed and constructed into the table top. Figure 3-6 presents the prototype of the mechanism. The desktop has a central writing space and pencil holder, but does not include a sub-desktop shelf. It has a centralized leg that supports the whole top. This design uses a recycled plastic desktop since its theme is reused materials. This desk includes many different elements from musical instruments for its fidgeting elements. The musical instruments will produce no noise. At the

front of the desk, there's a keyboard built into the desktop. On the right side of the desk, there are mounted wooden drum sticks that can be spun 360° in either direction. The left side has six trumpet buttons on them which press up and down. However, these buttons have strong resistance to them, due to the built-up air pressure beneath them. There are also some guitar string adjusters (knobs) incorporated into the design that slowly twist due to the tension of guitar strings. The top side of the desk includes a slight cutout for students to hold their study materials. It also has rounded corners for safety.

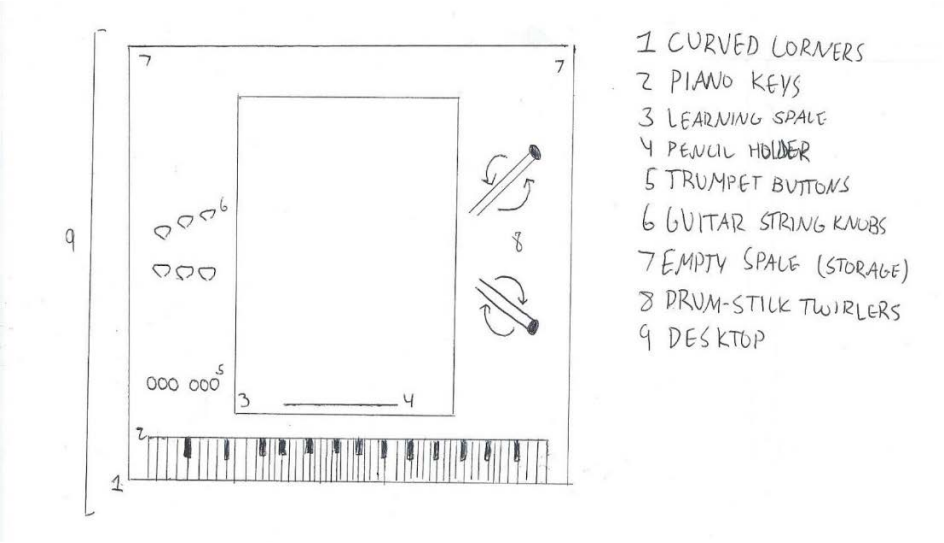


Figure 3-6 Musical Note Desk (Drawing by Kaden Law)

3.3.7 Tracktop Desktop

The Tracktop Desktop is a desk that is designed to only have fidgeting apparati that are on different types of track. A picture of the desk design can be seen in Figure 3-7. The desk will be made from a redwood table top, with four adjustable steel legs. The materials drive up the cost. The desk has curved corners for safety. This design focuses on the idea of containing the fidget tools due to the inability to leave the desktop. That minimizes the overall fidgetability of the design. A reinforced steel-wire, marble track is strung across the whole outside of the desk. The inside area of the desk is reserved for writing space. It's designed with a pencil catching system below the writing space. Beneath the tabletop there is a shelving unit for alternate supplies. The design has aluminum knobs that are mounted into the desk that can slide side to side.

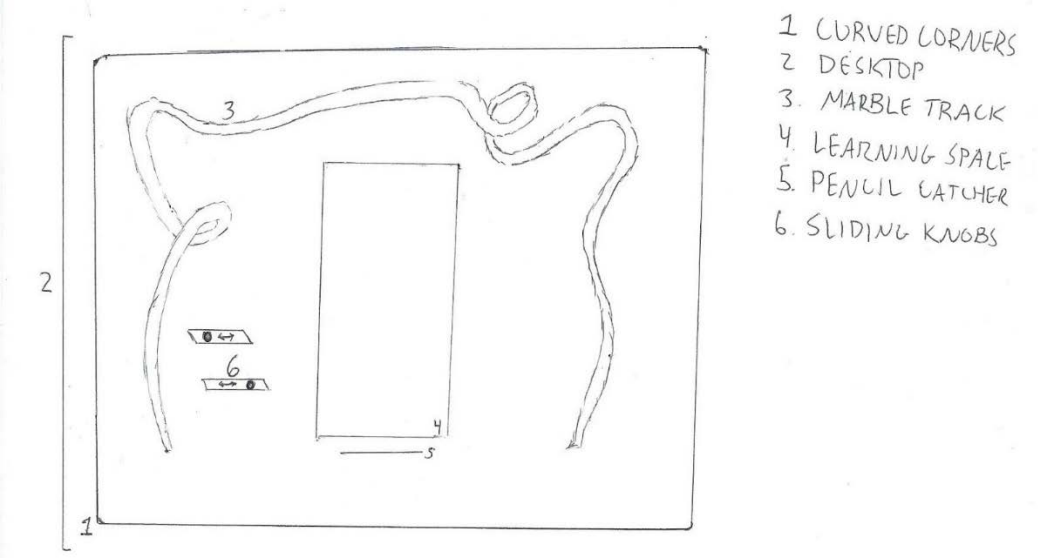


Figure 3-7 Tracktop Desktop (Drawing by Kaden Law)

3.3.8 **Magneto**

Magneto boasts a 3ft by 3ft alternative design including a hand crank that allows students to manually lift and lower the desk to their preferred height. The design can be seen in Figure 3-8. The hand crank is positioned on the right side of the desk for easy access. The surface of this alternative solution includes a magnetized section where the kids can interact with magnets while keeping their focus on the teacher. The legs of the desk support a fidget bar that the students can use to swing their feet back and forth as a means of reducing classroom distractions caused by loud fidgeting. The desk includes both hand and foot fidgeting, which increases the overall fidgetability of the design. To reduce noise, the bottom of the legs is covered with a felt material that also makes it easier to move the desk if needed. The design includes a compartment for books and school supplies. The compartment is integrated into the desk design and can be accessed by lifting the writing surface which is attached with two quadrant hinges located on opposite sides. The hinges allow the surface of the desk to remain open at a 95-degree angle reducing the chance of distractions caused by a sudden slamming of the writing surface against the base of the desk. That element also increases the safety of the design. The desk is complemented by a chair, which features padding in the seat and provides both arm rests and back support. The chair can be adjusted up and down and can move in a 360-degree angle. The chair is not attached to the desk so it can be easily swapped out if another chair is preferred by the students.

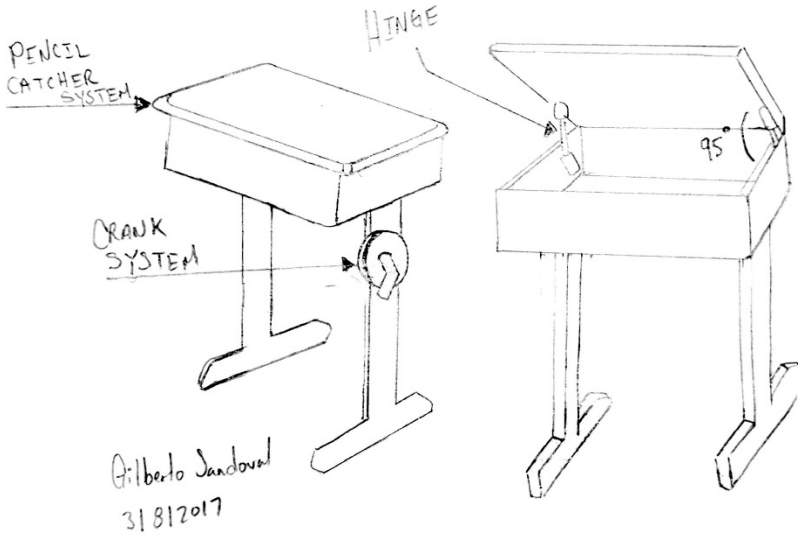


Figure 3-8 Magneto (Drawing by Gilberto Sandoval)

3.3.9 Le Tour de Class

The Le Tour De Class shown in Figure 3-9 is an alternative option built out of upcycled materials. The design consists of a stationary exercise bike that allows the students to adjust the seat of the bike to accommodate for height/comfort. The seat of the bike is redesigned to incorporate a backrest that is lined with foam padding and upholstered with a vinyl fabric that facilitates cleaning. The stationary exercise bike retains its functionality to provide students with a form of fidget relief by allowing them to pedal and control the resistance of the pedals. The handlebar mechanism of the bike is removed and replaced with a flat surface made of repurposed wood. The design is durable, aesthetic, but lacks the overall fidgeting elements. The writing surface is attached at the front of the bike with a system that allows the surface to move up or down and tilt to better fit the needs of each student. The lower part of the writing surface is equipped with a raised border made from piece approximately half an inch tall and ¼ inch wide that spans across the entire surface. The purpose of this border is to keep pencils and or notebooks/books from falling off the desk top.

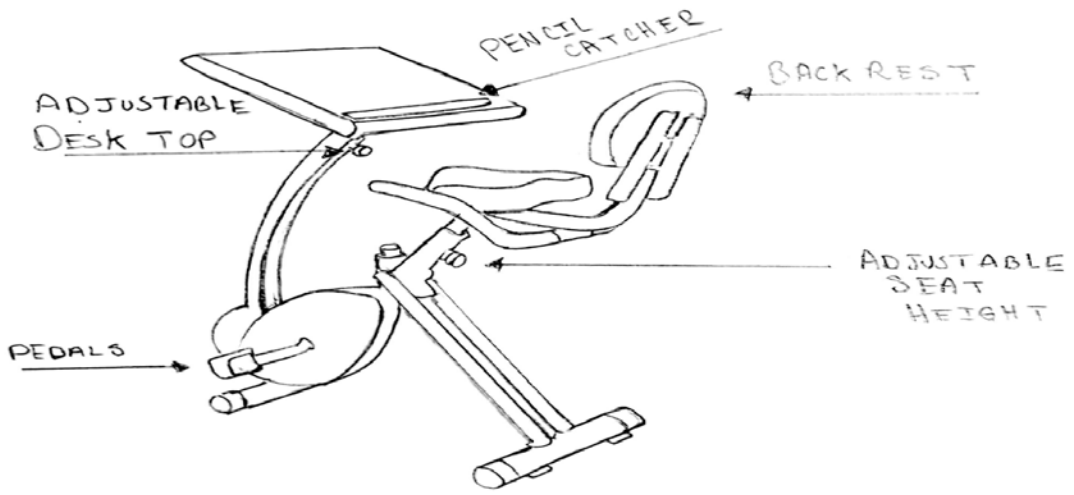


Figure 3-9 Le Tour de Class (Drawing by Gilberto Sandoval)

4 Decision Process

4.1 Introduction

Section 4 is the phase of the project when the Hardworking Procrastinators reviewed the alternative solutions from Section 3 to make a decision on the final desk design. The decision process uses Table 4-2, along with careful consideration of the client criteria to evaluate each alternative design and decide what features of each each alternative solution could be successfully incorporated into the final design.

4.2 Criteria Definition

The following criteria from Section 2 of the document played a pivotal role in the decision process.

Fidgetability: Mechanisms that allow students to fidget silently while maintaining focus must be efficiently incorporated into the desk. The desk must contain multiple fidgeting apparatus that engage the students' hands and feet.

Aesthetics: The desk must be appealing to both faculty and students while retaining a similar aesthetic to the other desks so that it matches the overall design of the classroom. The desk should not stand out and look as if it could fit in a professional workplace. All objects incorporated into the desk must look as if they belong there and function with ease.

Cost: This is the amount of money, time, and effort that will be spent on this project. The financial cost cannot exceed the budget of 400 USD. Time and effort will vary by person.

Safety: All elements of the desk must be intact and must not pose any hazards for the students. The desk's corners must be rounded so that the potential risks involved with sharp corners are minimized. The desk must remain balanced when students exert force on a certain side to

prevent tipping of the desk and possible injuries. The fidget tools incorporated into the desk must not come off with ease as kids can put them in their mouth which then creates a choking hazard.

Durability: This is the overall abuse that this desk will be able to endure. The desk must retain its structural integrity while accommodating over ten students per day over the next school year. The fidgeting tools as well as the mechanism that will enable the desk to be easily adjusted to different heights should be built to withstand constant use and allow for easy repairs if needed.

4.3 Solutions

The following is a list of the alternative solutions introduced in Section 3. Details of these nine alternative solutions are given in Section 3.

- Footsies-Feetsies Fidgetter
- Fidget Booth
- Twiddle Table
- Lego Do Stuff
- Bouncing Back
- Musical Note Desk
- Tracktop Desktop
- Magneto
- Le Tour de Class

4.4 Decision Process

The team used a brainstorming session to produce the alternative solutions which were then analyzed by the Hardworking Procrastinators. The solutions which are created with careful consideration of the client feedback, allows the Hardworking Procrastinators to create a weight system. Each criteria was given a specific weight that incorporates the importance of each criteria. Table 4-1 shows those weights, which are multiplied by individual alternative solution scores and summed to get a total number that depicts how realistic a solution is. Table 4-2 depicts this mechanism. Each alternative solution and its individual components are discussed amongst the group as potentially feasible options. The Delphi Matrix was then used to make the final decision.

Table 4-1: Delphi Matrix Criteria

Criteria	Weight
Fidgetability	10
Durability	8
Safety	6
Aesthetics	5
Cost	3

Table 4-2: The Delphi Matrix

Alternative Solution Scores (0-50)						
Criteria	Weight (1-10)	Footsies-Feetsies Fidgetter	Fidget Booth	Twiddle Table	Lego Do Stuff	Bouncing Back
Fidgetability	10	28 / 280	50 / 500	45 / 450	35 / 350	10 / 100
Durability	8	5 / 40	15 / 120	40 / 320	37 / 296	34 / 272
Safety	6	40 / 240	30 / 180	35 / 210	40 / 240	15 / 90
Aesthetics	5	35 / 175	10 / 50	35 / 175	32 / 160	45 / 225
Cost	3	15 / 45	20 / 60	30 / 90	50 / 150	50 / 150
	Total:	**780**	**910**	**1245**	**1196**	**837**

Table 4-3: The Delphi Matrix (cont.)

Alternative Solution Scores (0-50)					
Criteria	Weight (1-10)	Musical Note Desk	Tracktop Desktop	Magneto	Le Tour De Class
Fidgetability	10	50 / 500	23 / 230	31 / 310	21 / 210
Durability	8	43 / 344	6 / 48	42 / 336	49 / 392
Safety	6	50 / 300	40 / 240	50 / 300	45 / 270
Aesthetics	5	46 / 230	7 / 35	50 / 250	50 / 250
Cost	3	10 / 30	36 / 108	25 / 75	17 / 51
	Total:	**1404**	**661**	**1271**	**1173**

4.5 Final Decision

The Hardworking Procrastinators designing the Adjustable Silent Fidget Desk final design is a hybrid design of the highest rated totals from Table 4-2, based on the criteria from Table 4-1. It includes a foot fidgeter from Figure 3-1, fidget spinners from Figure 2-4 and video game controller elements from Section 2.6.11. It also includes the pencil catcher in Figure 3-9. The design will have high durability and accounts for safety precautions. The Fidget Desk is the most efficient use of resources in order to produce an effective silent fidget desk.

5 Specifications

5.1 Introduction

Section five offers a detailed overview of the Silent Fidget Desk project including cost which involves time and materials invested, as well as instructions for its use. The final solution is described through detailed diagrams and photos of all its components through different points of view. The costs are analyzed through the numerical dollar value of all the materials used on the final design and items used to produce the design, the total project time, and the cost of maintenance for the desk. Section V includes the instructions for usage for the students at Zane Middle School and Celia Boomer the client. The section concludes with the results and a discussion of the results detailing how the desk will be implemented into the classroom.

5.2 Description of Solution

The Silent Fidget Desk is a product that was designed and created by the Hard-Working Procrastinators for the client Celia Boomer teacher at Zane Middle School. The desk was designed to aid students who have difficulty maintaining focus in class. The design can be seen in Figure 5-1, it incorporates elements from a PlayStation 2 controller and other fidget mechanisms. The desk was built out of Sapele mahogany an African wood that is known for its strength and aesthetic presence. The design of the desk includes a base and a top. The base is fixed while the top was designed to move up and down in a way that allows for more than 2 feet of adjustment. The top was fabricated from 2 different types of wood Sapele mahogany and then plywood underneath. The 2 pieces were cut identically and glued with wood glue to get the desired width of the desktop. A border was then made to surround the edge of the desktop so that the plywood was not visible. The final design is adjustable through a simple system of connected members. The desktop has 4 members connected at the bottom, each member has 7 holes strategically placed 2” from each other in a vertical position. The base of the desk has 2 members with 7 holes placed 2” apart from each other. The desk then comes together and can be adjusted by choosing the desired height and placing 4-3” carriage bolts through the top and bottom holes of each leg. The desk features large wingnuts that are easy to tighten and loosen by hand. All fidget components are carefully placed on the desktop so that they are easily accessible and do not interfere with the primary use of the desk which is school work.

Figure 5-1: Final Desk Design (Photo by Kaden Law)

5.2.1 **Desktop**

The desktop is photographed in Figure 5-2 and displays a view of the project from an above point of view, which includes all the desktop elements that were implemented into the final design, each component will be further described in the following sub sections. The desktop includes a rectangular strip of wood approximately 38” in length, ½” wide, and a height of ¼”. This piece of wood was designed to be a pencil catcher and prevent writing utensils from rolling down the desktop and falling onto the floor. The edges of the desktop were rounded off as a safety precaution using a router. The desktop was sanded and waxed using “Howard’s Feed N Wax” for protection as well as aesthetic appeal. The wax will prevent hand prints and smudging from being visible on the desk and it will protect the overall integrity of the wood.

Figure 5-2: Top of Desk (Photo by Kaden Law)

5.2.1.1 *Fidget Spinner*

The fidget spinners, which are displayed in detail in Section 2.6.9 are incorporated into the design as a tool to keep students focused while fidgeting silently. These fidgeting devices have three bearings on the outside, supported by a plastic frame which allows for endless 360-degree rotation. The spinner is attached to the desk with a wood screw directly in the middle of the spinner so that it does not prevent the component from spinning. The fidget spinner can be seen in Figure 5-3. Apart from the one pictured, a second fidget spinner was place on the edge of the desk giving the user the option to interact with the same type of component in a completely different way. A wood screw was also used to mount this fidget spinner to the desk.

Figure 5-3: Fidget Spinner and Roller Ball Bearing (Photo by Kaden Law)

5.2.1.2 *Video Game Directional Key-Pad*

This fidget element of the desk is constructed from a dismantled Playstation 2 controller. The keypad retains its characteristics so that they are engaging to the user and give the sense they are interacting with an actual video game controller. The keypad is fixed on top of another fidget component with crazy glue.

Figure 5-4: Directional Keypad (Photo by Kaden Law)

5.2.1.3 *Roller Bearings*

This fidget component was obtained at a hardware store; it was placed on the desk as a way for the user to interact with the ball bearing. As it spins the user can feel it move and slow it down or speed it up. The bearing housing had 2 holes that allowed the bearing to be attached to the top of the desk with wood screws as can be seen in Figure 5-3. A total of 4 ball bearing were strategically placed throughout the desk to allow the user to interact with them from different angles and increase fidgetability.

5.2.2 **Desk**

Underneath the desktop lie the mounting points for the vertical members of the desk. The mounting points are fabricated from two pieces of wood and the upper section of the legs are

attached to these pieces by a 3” carriage bolt and maintained fixed due to the tightening of a wing nut.

The base of the desk is composed of 5 pieces of wood; four horizontal members are cut so that their length matches the top of the desk. Two pieces are placed side by side and the lower section member of the legs is sandwich in between them directly in the middle. The leg and the horizontal members are joined with brad nails and wood screws. The other part of the base follows the same guidelines and they are both connected with a piece of wood that is attached in the middle. The piece of wood in the middle is placed there to counteract any flex that may occur due to the load being applied by the top of the desk or its user. All desk components can be seen in figure 5-5.

Figure 5-5: Final Desk Without Fidget Components (Photo by Kaden Law)

5.2.2.1 Foot Swing

The foot swing element of the desk is an elastic workout band that has been tailored to function as a foot-swing. The bands are attached with a pair of metal hooks that hold the foam handle above the desk. The band has a resistance of 25 lbs., which allows firm resistance for the lower body. The foot swing is positioned underneath the desk and can easily be accessed by the user. Figure 5-6 showcases the swing and its position on the desk.

Figure 5-6: Footswing (Photo by Kaden Law)

5.2.2.2 ***Desk Legs***

The legs of the desk are the means by which the desk can be adjusted. Each leg has a series of 5/8” diameter holes 2” inches apart from each other in a vertical direction. The lower section of the legs only has one vertical member on each side fixed in a vertical direction at a 90-degree angle from the base. The top section of the desk has 2 vertical members on each side these members are placed a ½” from each other so that the member from the bottom section of the legs can slide in between them. As the members side into the desired position the 4 3” carriage bolts are placed in the holes to maintain the desired height. Components of the legs and the base can be seen in Figure 5-6.

5.3 Costs

The costs of the project and displayed in detail in this section. The costs are broken into four subsections: Design, Research and Development, Implementation, and Maintenance Costs of the Beau Bureau will be analyzed, respectively, in the following sections.

5.3.1 Design Costs in Hours

The design costs are calculated using the sum of all group members time allocated to the completion of the project. The total amount of time is broken into five different sections representing the five phases of this project, which includes research, writing, prototyping, and building. The team completed the full project in 219 hours and can be seen in Table 5-1.

Table 5-1: Total Project Hours

Type of Work.	Hours
Prototyping Hours	20
Assembly Hours	103
Team Meetings	25.7
Client Meetings	3.5
Document Hours	67
Total	219.2

5.3.2 Research and Development Costs

There were no concrete financial costs endured during the research and development stage of the project. All the materials that were used where either free or things we already had.

5.3.3 Implementation Cost

Table 5-2 shows a breakdown of the cost to build the Silent Fidget Desk, which is $121.09.

Table 5-2: Implementation Cost of Final Design

Quantity	Material	Cost ($)
Unknown	Wood	0
4 Each	Miscellaneous nuts and wing nuts	9.53
11	Small wooden circles	1.5
6	3" Carriage bolts	1.25
6	1/2" Washers	0.45
6	1/2" Wing Nuts	1.5
6	Resistance band	11.69
3	Fimo Clay	1.99
2	Play-station controllers	0
2	Fidget Spinners	9.99
2	Dowel 36" 1/8"	0.39
2	Super glue	3.99
1	CD spinner	0
1	Bottle of Feed-N-Wax	10.99
1	Record	0.5
1	White lithium grease	2.99
1	Metallic acrylic paint	1.49
1	Metallic spray paint	6.99
1	Nail polish; clear	2.97
1	Spray paint	0.96
1	Dowel 1/2x36"	1.79
1	1-1/8 wainscoat	8.49
1	Sandpaper	0.49

5.3.4 **Maintenance Cost**

The Silent Fidget Desk does not require large amounts of maintenance. The maintenance that is required is displayed in Table 5-2. Depending on the abuse the top of the desk endures a new coat of wax may be needed just to keep the wood looking good. The hardware of the desk needs t- be tightened and if the thread of a bolt or wingnut strips they must be replaced to ensure the safety of the user and desk.

Table 5-3:Maintenance Costs for Final Design

Task	Frequency	Task Time	Cost
Waxing the surface of the desk.	As needed.	5 min	$6.32
Replace hardware	As needed.	5 min	$0.20-$1.18

5.4 Instructions for Implementation and Use of Mode

The silent Fidget Desk does not require any instructions for implementation seeing as the client will receive the desk assembled and ready to use.

5.4.1 Raising and Lowering the Desk

To raise and lower the desk the user must first remove the two carriage bolts from one side of the desk and lower or lift it to the desired height. The user must then replace and tighten the carriage bolts and proceed to do the same process on the opposite side so that the height of the desk is leveled.

5.5 Results

Results are dependent on the satisfaction of the client and the users. Once the desk is delivered the results will vary depending on the individual's experience while using the desk.

5.6 Discussion

The Stand-Up Fidget Desk will be utilized by approximately 10 students during a 7-hour school day, 5 days a week. The desk will primarily be in use, during the school year from September to June. The desk is expected to function as a typical scholarly desk with the added benefit of having silent fidgeting components for both hand and foot use. The desk has the capability of being adjusted to different height levels to accommodate the user. The fidgeting components of the desk will be used to focus the user's attention during class without causing distractions to other students. The desk was manufactured with donated materials and materials that were bought by each team member. The decisions for what to put on the desk were carefully considered and deliberated upon in a group setting. The final decisions were made with careful consideration for a well use of space as well as ease of fidgeting from each fidgeting component.

6 Appendices

6.1 Group Member Project Hours

Table 6-1: Kaden Law Project Hours

Date	Description	Project Hours
02/10/2017	Client Visit #1	0.5
02/16/2017	Group Trello Pg Design	0.3
02/16/2017	Resource Searching	0.6
02/17/2017	Client Interview	0.5
02/18/2017	Literature Review	2.0
02/19/2017	Literature Review	1.4
02/20/2017	Literature Review	2.2
02/21/2017	PEER Review	2.5
02/21/2017	Edits	0.5
02/23/2017	Formatting LR	2.0
02/24/2017	Group Meeting Section II	1.0
02/27/2017	Section II Memo	0.5
03/03/2017	Section III Assigning	0.3
03/05/2017	Section III Drawings	1.0
03/05/2017	Section III Writing	1.0
03/07/2017	Peer Editing Section III	2.0
03/08/2017	Section III Formatting	1.5
03/09/2017	Section IV Chart/Definitions	1.7
03/12/2017	Section IV Definitions	0.2
03/16/2017	Prototyping	2.5
03/20/2017	Section IV Review	1.0
03/24/2017	Prototyping	1.0
03/26/2017	Section IV Editing	1.0
03/29/2017	Foot Pedal Prototyping	1.7
03/31/2017	ACAD 3	0.0
04/03/2017	Section 5	1.2
04/07/2017	Group Meeting on Fidgetting	1.5
04/09/2017	Section 5 photos	0.2
04/11/2017	Group Meeting-Status Update	1.3
04/15/2017	Section 5 Writing	1.2
04/17/2017	Section 5 Writing	2.5
04/18/2017	Buying Materials/Building	4.0
04/20/2017	Buying Materials/Building	5.0
04/22/2017	Fidget Construction	1.5
04/25/2017	Attachment of Fidget Comp.	5.0
04/27/2017	Last Minute Arrangements	2.0
	Total:	54.0

Table 6-2: Sarah Parr Project Hours

Date	Description	Project Hours
2/9/2017	Team contract	0.3
2/16/2017	Trello/ setting meeting with client	0.5
2/21/2017	Group meeting (lit review)	2.5
2/28/2017	Section 2	0.5
3/7/2017	section 3 group meeting	1.5
3/9/2017	Team Meeting	3.0
3/9/2017	Team Evaluation	0.5
3/23/2017	Group Video design	0.5
3/28/2017	Team Meeting	0.2
3/30/2017	Appropedia page	0.5
4/6/2017	Assembly	3.0
4/9/2017	Appropedia page and Auto Cad #3	4.0
4/11/2017	Team Meeting	1.0
4/18/2017	presentation and poster memo	0.5
4/20/2017	Practice/edit presentation	2.0
4/20/2017	Assembly	4.0
4/22/2017	Assembly	3.0
4/23/2017	Appropedia	3.0
4/25/2017	Group meeting and building	9.0
	Total:	39.5

Table 6-3: Gilbert Sandoval Project

Date	Description	Project Hours
2/15/2017	Literature Review	1.0
2/16/2017	Literature Review	1.5
2/17/2017	Literature Review	1.0
2/18/2017	Literature Review	1.0
2/19/2017	Literature Review	2.0
2/20/2017	Literature Review	1.0
2/21/2017	Literature Review	1.0
2/22/2017	Literature Review	3.0
2/24/2017	Section 2	1.0
2/25/2017	Autocad 1	2.0
2/26/2017	Sction 2	1.0
2/27/2017	Section3	2.0
2/28/2017	Section 3	2.5
3/1/2017	Autocad 2	1.0
3/2/2017	Section 3	2.0
3/5/2017	Brainstorming	3.0
3/8/2017	Team Evaluation	1.5
3/12/2017	Brainstorming	2.0
3/13/2017	Section 4	1.0
3/14/2017	Section 4	2.0
3/15/2017	Material Search	1.5
3/16/2017	Prototyping	3.0
3/20/2017	Section 4 Edits	1.0
3/25/2017	Fabrication Ideas	1.0
3/31/2017	Desk Fabrication	2.5
4/1/2017	Desk Fabrication	3.0
4/2/2017	Desk Fabrication	4.0
4/4/2017	Desk Fabrication	5.0
4/5/2017	Desk Fabrication	3.0
4/6/2017	Desk Fabrication	6.0
4/11/2017	Team Meeting	1.0
4/12/2017	Assembly	2.0
4/16/2017	Section 5	2.0
4/20/2017	Assembly	4.0
4/22/2017	Assembly	3.0
4/25/2017	Assembly	7.0
4/26/2017	Client Meeting	0.5
	Total:	82.0

Table 6-4: Madison Whitlow-Hewett Project Hours

Date	Description	Project Hours
2/12/2017	Team Contract	1.0
2/13/2017	Section I	0.5
2/13/2017	Team Contract	0.2
2/15/2017	Schedule team meeting	0.2
2/17/2017	Meeting with Client	1.0
2/18/2017	Lit Review	1.5
2/19/2017	Lit Review	1.5
2/20/2017	Lit Review	6.0
2/21/2017	Peer Review	2.5
2/22/2017	Lit Review Edit	4.0
2/24/2017	Section II	1.0
3/6/2017	Gantt Chart	1.0
3/6/2017	Section III	1.0
3/7/2017	Peer Review	0.5
3/7/2017	Team Meeting	1.5
3/8/2017	Section III	2.0
3/8/2017	Client Meeting	1.0
3/9/2017	Team Meeting	3.0
3/9/2017	Team Evaluation	0.5
3/16/2017	Prototype Assembly	1.5
3/25/2017	Prototype Video	1.0
3/28/2017	Team Meeting	0.2
4/6/2017	Assembly	3.0
4/11/2017	Team Meeting	1.0
4/17/2017	Poster	2.5
4/17/2017	Presentation	1.5
4/18/2017	Assembly	7.0
4/19/2017	Crafting	2.0
4/20/2017	Presentation	1.5
4/20/2017	Assembly	4.0
4/22/2017	Assembly	3.0
4/25/2017	Assembly	7.0
4/25/2017	Client Meeting	0.5
4/26/2017	Presentation	5.0
4/27/2017	Presentation	2.5
	Total:	73.1

Appendix A: Brainstorming Notes

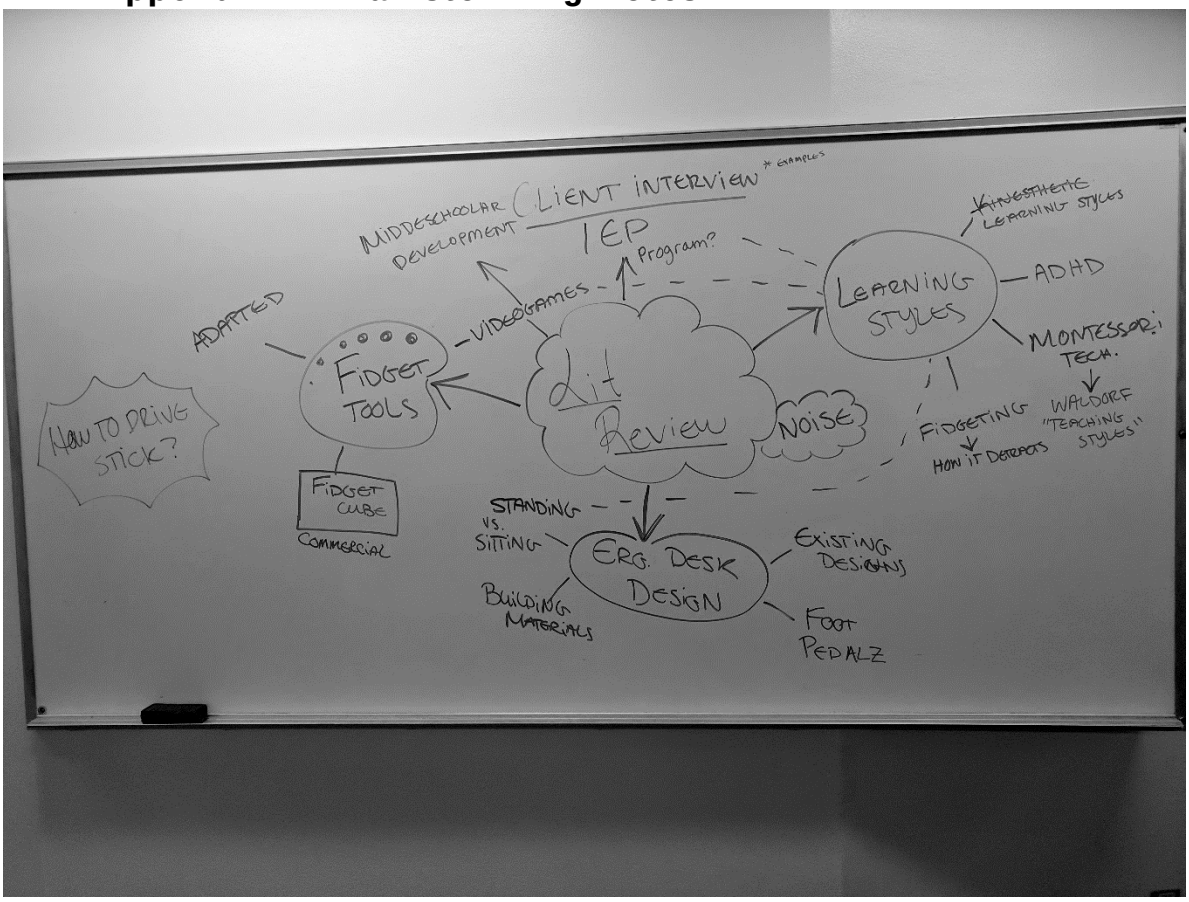


Figure 6-1: Literature Review Brainstorm (Photo by Madison Whitlow Hewett)

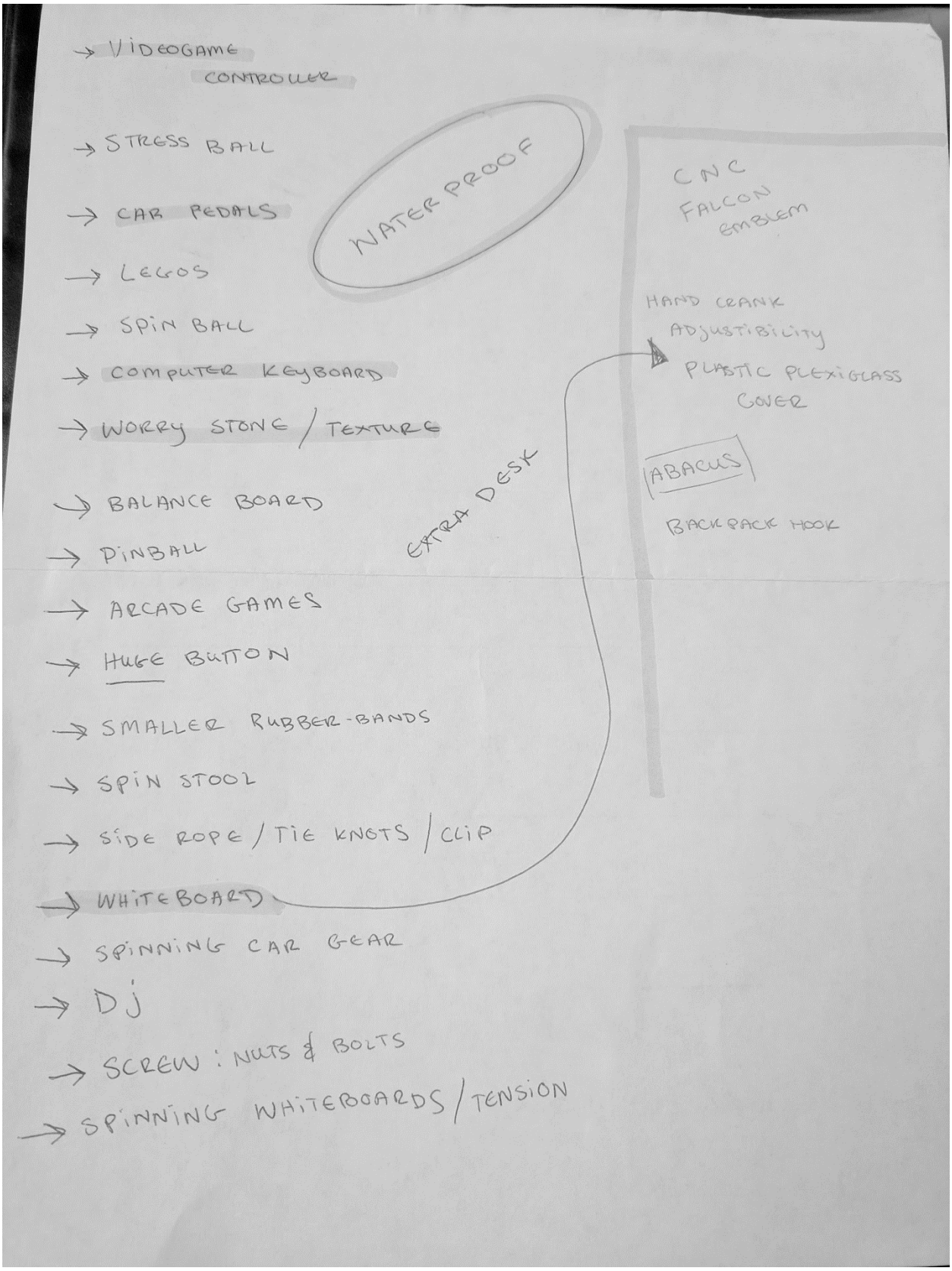


Figure 6-2: Fidget Idea Brainstorm (Photo by Madison Whitlow-Hewett)

Appendix B: How to Construct Desk

How to Do Build a Fidget Desk	
Image	**Step**
	**Step 1 :** Cut 4 pieces of ½” or desired width wood that will function as the legs of the desk. Make end cuts to achieve desired aesthetic preference.The dimensions shown are 18” x 3.5” x 1/2”
	**Step 2 :** Cut 6 pieces of wood into 36” x 3.5” x ½”. These will function as the legs of the desk.
	**Step 3 :** Using a ⅝” forstner bit, drill 6 holes 2 inches apart from each other on every piece of the legs starting from the bottom. Drill a single hole into every member on the opposite side of the previously drilled holes.
	**Step 4 :** Using a palm router, router every edge of all the pieces of wood to get rid of any sharp edges.

	**Step 5 :** Sand all pieces of wood with an orbital sander or preferred sanding method to achieve the same smoothness, color, and to get rid of any burn marks that may have occurred from routing on all pieces
	**Step 6 :** Generously apply “Howard’s Feed-N- Wax” to every piece of wood making sure to evenly spread so that there is no color deviation in the final result. Once applied use a clean rag and wipe every piece of wood to remove excess wax.
	**Step 7 :** Allow pieces to dry and reapply wax as needed.

	**Step 8 :** Begin assembly of the base using a pneumatic brad gun. Align 2 pieces of the base and place small blocks in between them on opposite ends. Nail the pieces together then use wood screws for extra support.
	**Step 9 :** Place a single piece of the legs into the base making sure it is directly aligned in the center. Using the nail gun attach the piece and then proceed to run wood screws through it so that it does not move under load. Repeat steps 8-9 to create the second part of the base
	**Step 10 :** Attach both sections of the base with a single cross brace in the middle.

	**Step 11 :** Nail a 2” long piece of wood with a 35 degree cut on both ends to act as a support inside the legs and prevent flexing when under load.
	**Step 12 :** Cut a section for the top of the desk 42” x 30” then proceed to sand, route, and wax as needed.
	**Step 13:** Final assembly can now be started by attaching the 4 remaining members of the legs onto the bottom of the desk. Make sure to attach the members of the legs running a 3” carriage bolt through the single hole at the top of the legs onto the the hole at the bottom of the desk top.
	**Step 14 :** Assemble the base and top of the desk by placing 4 3” carriage bolts through the holes and tightening the wingnuts to keep everything in place. Adjustability can now be changed moving the carriage bolts from hole to hole depending on desired height.

Appendix C: Attached Fidget Components

Image	Step
	Fig 3: There were two fidget spinners (red) placed on the desk, one flat on the surface (shown) and one on the side of the desk (fig 8), making it easier to grip. The small rolling wheel is another device to play with that can be rolled in every direction.
	Fig 4: The abacus is for both work and play; the beads can be moved to solve math problems or just for fun.
	Fig 5: This is a functional turn table that can be turned on and off and played with by placing a finger on the surface to slow the spinning disk down.

	Fig 6: These wooden circles are just about a fingers length apart and spin when fingers are weaved through them.
	Fig 7: This metal bar contains nuts and wingnuts that can be twisted the entire span of the metal rod. There is alos bottons taken from a video game controller on top of one of the wooden blocks
	Fig 8: This box contains a small foam pad similar to the idea of a worry stone, and is meant to be rubbed and pressed on to relieve stress.
	Fig 9: The foot swing is good a way to get more than just hand fidgeting

Appendix D: References

"Attention Deficit Hyperactivity Disorder." National Institutes of Health. U.S. Department of Health and Human Services, n.d. Web. (22 Feb. 2017).

Bisk "Standing Desks May Help Engage Students in the Classroom." *The University of Scranton*. Bisk <http://educationonline.scranton.edu/resources/teaching-tips/standing-desks-may-help-engage-students-in-the-classroom/#.WKz6M1UrLIX> (16 Feb. 2017)

Breysse, Patrick N., and Peter S.J. Lees. (2006) "Noise and Sound." Johns Hopkins Bloomberg School of Public Health <http://ocw.jhsph.edu/courses/PrinciplesIndustrialHygiene/PDFs/Lecture6.pdf> (16 Feb. 2017)

Bright, Rebecca. "Kids Who Can't Sit Still." NEA. N.p., n.d. Web. (22 Feb. 2017).

CHUA, KRISTIE. "Standing Desks May Be the Next Classroom Trend." Education Week, vol. 34, no. 3, 10 Sept. 2014, p. 10. EBSCOhost,ezproxy.humboldt.edu/login?url=http://search.ebscohost.com.ezproxy.humboldt.edu/login.aspx?direct=true&db=aph&AN=98224116&site=ehost-live.(20,Feb. 2017).

"Data & Statistics." (2017) *Centers for Disease Control and Prevention*. Centers for Disease Control and Prevention <https://www.cdc.gov/ncbddd/adhd/data.html> (17 Feb. 2017).

Doyle, Benjamin (2012) "Standing vs. Sitting at Work" *UCLA Ergonomics* <https://ergonomics.ucla.edu/backsafety/standing-vs-sitting-at-work.html> (16 Feb. 2017).

Dumbleton, Trevor. "Reduce Your Stress With Stress Balls." Reduce Your Stress With Stress Balls. N.p., n.d. Web. (23 Feb. 2017).

Eccles, Jacquelynne S. (1999) "The Development of Children Ages 6 to 14." *The Future of Children*, p. 30-44 <https://www.princeton.edu/futureofchildren/publications/docs/09_02_02.pdf> (17 Feb. 2017).

"EC Green Office." EC Green Office | Environmental Center | University of Colorado Boulder. N.p., n.d. Web. (23 Feb. 2017).

"Fidget Cube: A Vinyl Desk Toy." Kickstarter. N.p., n.d. Web. (23 Feb. 2017).

Forinash, Dr. K. "An Interactive EBook on the Physics of Sound." *SOUND*. Indiana University Southeast <https://soundphysics.ius.edu/?page_id=912> (16 Feb. 2017).

Ganster, Kathleen. "Under-desk Pedals Help Students Learn Better." Community Health. N.p., 19 Apr. 2016. Web. (22 Feb. 2017).

Gimenez, Roberto, Rafael Do Nacimiento Soares, Victor Vedovelli Ojeda, Cristiane Makida Dionisio, and Edison De J. Manoel. "The Role of School Desk on the Learning of Graphic Skills in Early Childhood Education in Brazil." <https://www.SpringerPlus.edu> Springer International Publishing, 19 July 2016. Web. (22 Feb. 2017).

Guyer, Barbara P. ADHD: Achieving Success in School and in Life. Boston: Allyn and Bacon, 2000. Print.

Hartanto, T.A. et al. “A Trial by Trial Analysis Reveals More Intense Physical Activity Is Associated with Better Cognitive Control Performance in Attention-Deficit/Hyperactivity Disorder.” Child neuropsychology : a journal on normal and abnormal development in childhood and adolescence 22.5 (2016): 618–626. PMC. Web. (23 Feb. 2017).

Julia. "New 3D Printed Spinning Fidgets Cost Only $5 for All Your Fidgeting Needs." www.3ders.org N.p., 29 Jan. 2017. Web. (23 Feb. 2017).

Khanam, Chanda Nelofer, Mahalakshmi V. Reddy, and A. Mrunalini. "Designing student’s seating furniture for classroom environment." *Journal of Human Ecology* 20.4 (2006): 241-248.(19 Feb. 2017).

Kuhn, Dana, and Sarah Lewis. "The Effect of Dynamic Seating on Classroom Behavior and School Performance For Students in a General Education Classroom." Sound Ideas. N.p., May 2013. Web. (20 Feb. 2017).

Lai, Hui-Chuan, et al. (1997) "Growth Status in Middle Children." *University of Wisconsin Department of Biostatistics*: p. 1-26. University of Wisconsin <https://www.biostat.wisc.edu/sites/default/files/tr_117.pdf> (19 Feb. 2017).

Maxwell, Lorraine E. "Noise in the Workplace." *Facility Planning Management Notes* 1.11: p. 1-4 <http://www.human.cornell.edu/dea/outreach/upload/FPM-Notes_Vol1_Number11.pdf> (18 Feb. 2017).

McDermott, Molly. "Minnesota Waldorf School." *CIS Portfolio* <http://pages.stolaf.edu/cis-mmcdermott/minnesota-waldorf-school/> (21 Feb. 2017).

Majorek, Magdalena, Tobias Tüchelmann, and Peter Heusser. "Therapeutic Eurythmy—movement therapy for children with attention deficit hyperactivity disorder (ADHD): a pilot study." Complementary therapies in nursing and midwifery 10.1 (2004): 46-53.(19 Feb. 2017).

Miller, Caroline. "Video Games and ADHD | ADHD and Attention Disorders in Children." Child Mind Institute. N.p., n.d. Web. (22 Feb. 2017).

"MONTESSORI." *The International Montessori Index* <http://www.montessori.edu/> (21 Feb. 2017).

Nyguyen, Toan. "The Desk Toy That Can Help You Focus." Veritas News. N.p., 15 Nov. 2016. Web. (23 Feb. 2017).

Ogoe, Richard. "The Kinetic Classroom: The Pedal-Desk, ADHD, and the Mind-Body Connection." Center for Educational Improvement. N.p., 21 July 2015. (Web. 22 Feb. 2017).

Oyewole, Samuel A., Joel M. Haight, and Andris Freivalds. "The ergonomic design of classroom furniture/computer workstation for first graders in the elementary school." *International Journal of Industrial Ergonomics* 40.4 (2010): 437-447.(18 Feb. 2017).

Rosen, Larry D., and Michelle M. Weil. "Are Computer, Video and Arcade Games Affecting Children's Behavior? An Empirical Study." Http://www.csudh.edu. N.p., n.d. Web. (22 Feb. 2017).

Schweitzer, Julie (2015) "Fidgeting in ADHD May Help Children Think, Perform in School" *UC Davis Health* <https://www.ucdmc.ucdavis.edu/publish/news/newsroom/10069> (16 Feb. 2017).

Stone, Zara. "How The Fidget Cube Raised $6.4 Million And Entered Kickstarter's Top 10 Most Funded Projects." Forbes. Forbes Magazine, 04 Nov. 2016. Web. (23 Feb. 2017).

Stalvey, Sheryl, and Heather Brasell. "Using Stress Balls to Focus the Attention of Sixth-Grade Learners." Journal of At-Risk Issues 12.2 (2006): 7-16.(19 Feb. 2107).

Story, Mary, Jamie Stang (2005) "Chapter 1." *Guidelines For Adolescent Nutrition Services*, p. 1-8. <http://www.epi.umn.edu/let/pubs/img/adol_ch1.pdf> (20 Feb. 2017)

Sudholz, Bronwyn, et al. "The impact and feasibility of introducing height-adjustable desks on adolescents' sitting in a secondary school classroom." *AIMS Public Health* 3 (2016): 274-287. (17 Feb. 2017).

Taifa, Ismail Wilson, and Darshak A. Desai. "Anthropometric measurements for ergonomic design of students' furniture in India." *Engineering Science and Technology, an International Journal* (2016). (19 Feb. 2017).

"The Kinetic Classroom: The Pedal-Desk, ADHD, and the Mind-Body Connection." *Center for Educational Improvement*. Admin, 21 July 2015. Web. 23 Feb. 2017

"The Washington Montessori Institute (WMI)." *Washington Montessori Institute*. <http://www.loyola.edu/academics/washington-montessori-institute/about/location-facilities> (18 Feb. 2017).

Turketi, Natalia, "Teaching English To Children With ADHD" (2010). MA TESOL Collection. 483. http://digitalcollections.sit.edu/ipp_collection/483. (2010).Web. (20 Feb. 2017).

"Waldorf Education." Association of Waldorf Schools of North America <https://waldorfeducation.org/waldorf_education> (20 Feb. 2017).