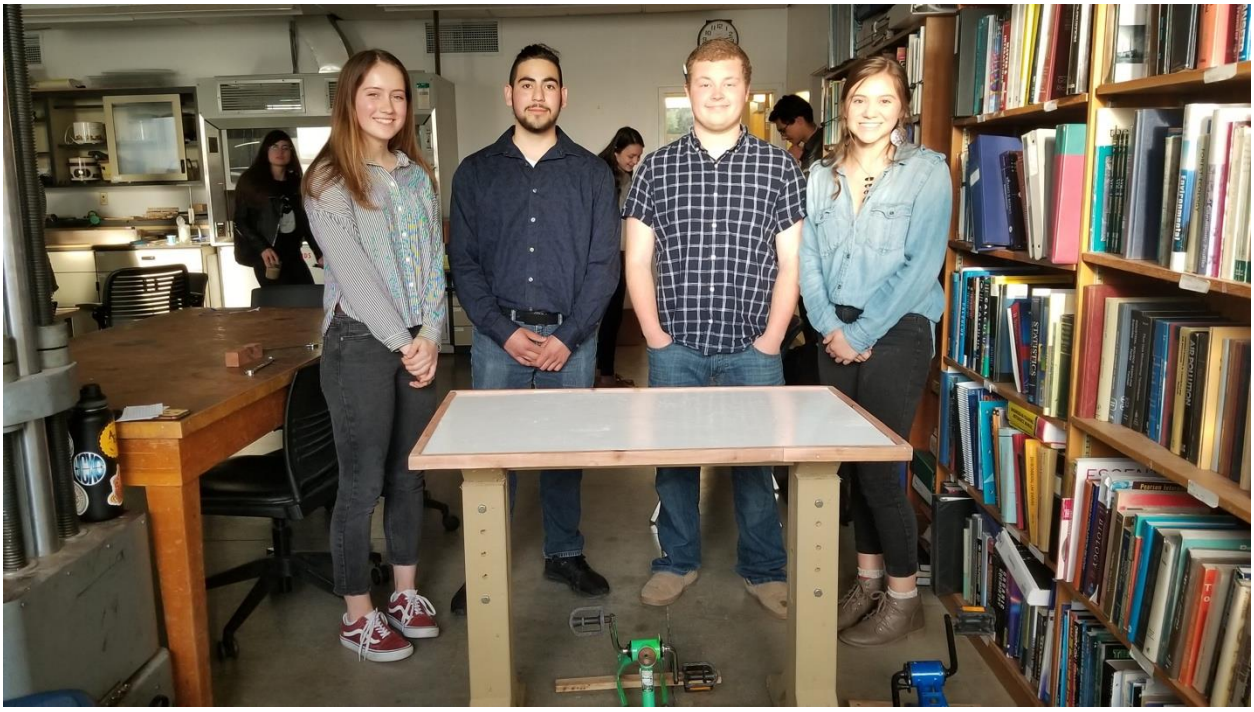
Team Education with Movement

The Pedal Desk



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1 Problem Formulation

1.1 Introduction

Welcome to Team EWM's ENGR 215 Intro to Design Project! This Design Document will be guide you through the thought processes, designs, and explanations that the team worked through to have an efficient project. The following sections will describe our objective statement and the black box model.

1.2 Objective Statement

Team EWM's objective is to construct a student friendly desk that incorporates an attachable movement system and a fidget desk. Our goal is for Zane Middle School students to have a safe and quiet desk area that allows them to focus on curriculum during class time, while also getting movement.

1.3 Black Box Model

The black box model in Figure 1 below is a visual of how the project is going to change the clients class room.

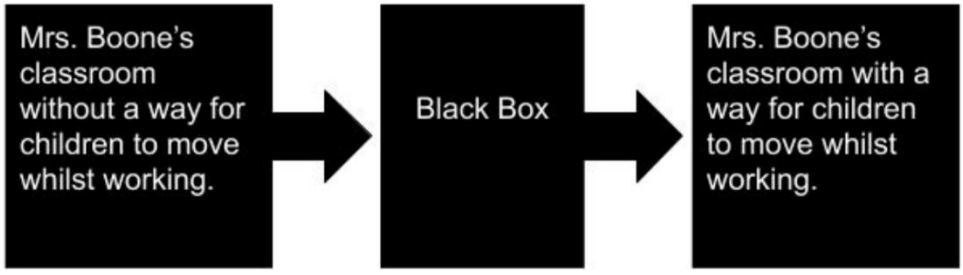

Figure 1: Black Box Model

2 Problem Analysis & Literature Review

2.1 Problem Analysis

Section 2.1 provides information about team EWM's analysis on the pedal desk and guidelines that should be followed in the process. This includes specifications, considerations, criteria, usage and product volume.

2.1.1 Specifications

Specifications cover what needs to be built and what demands need to be fulfilled. The following specifications will be included into our design: must be very quiet, incorporate bicycle pedals, safe for children, and easily transportable.

2.1.2 Considerations

One consideration for this project is that children vary in size. This project will most likely see a decent amount of abuse, so it will need to be designed to last. Team EWM is striving to use environmentally friendly building materials and the table should be able to fit through a standard sized door.

2.1.3 Criteria

The design and prototypes must meet the representatives' needs described in Table 1 below:

Criteria	Constraints	Weights
Safety	Movable components should be shielded (gears, sharp points), table should have a sturdy base.	10
Durability	Design will be used daily, so it must be sturdy and not break.	9
Sound level	Must be quieter than keyboard typing.	7
Child size	Design should be adjustable to account for all students' sizes. (Table top should be able to move up and down.)	6
Transportability	Must be able to move around with ease. (light weight and movable by one person)	5
Movement	Must provide students with adequate movement to allow for quiet fidgeting. (range of motion)	5
Cost	A maximum budget of $400, but preferably less than $100.	4

Table 1: Criteria and Constraints regarding the design of the project.

2.1.4 Usage

The pedal desk EWM will be building will be used daily by students in the classroom of the client representative, Paige Boon. It will be in a corner available for students who complete work best through movement.

2.1.5 Production Volume

A single desk will be built for the classroom of team EWM's client representative, Paige Boon, at Zane Middle School. If time and materials are available two will be made.

2.2 Literature Review

2.2.1 Introduction

Section 2.2 Literature Review includes background information on numerous topics related to a pedal desk to discover a wide range of ideas for our design.

2.2.2 Children studies

2.2.2.1 Intro to Children with ADHD

In 2016, Centers for Disease Control and Prevention used data collected from The National Survey of Children's Health who surveyed parents and healthcare claims in the United States, to decipher relationships between diagnostics and treatments for children and teenagers with ADHD (CDC 2016). ADHD is an abbreviation for Attention Deficit Hyperactivity Disorder. People with this medical condition have disturbance in brain development and brain activity which result in the deficiency of attention, absence of self-control, and inability to sit still. Often children have trouble with following directions and sitting still, but those with ADHD are unable to, or struggle severely worse with simple tasks involving self-control (The Nemours Foundation 2013).

2.2.2.2 Analysis of ADHD Surveys

Of the parent and healthcare claim survey's the data had shown, in 2016 an approximation of 6.1 million kids ages 2-17 had been diagnosed with ADHD. Of those 6.1 million children, 5.7 million of them were 6-17 years old--middle school through high school kids. In the study the data proved that children who live in rural areas are less likely to have behavioral treatments than children who live in suburban and urban areas (CDC 2016). Further results proved, "The percent of all children 2-17 years of age in the U.S. taking ADHD medication was 5.2%.

2.2.2.2.1 ADHD Treatment Data

Among children with ADHD, 62% were taking ADHD medication

- Ages 2-5: 18%
- Ages 6-11: 69%
- Ages 12-17: 62%

The percent of children 2-17 years of age with ADHD who received behavioral treatment was 47%.

- Ages 2-5: 60%
- Ages 6-11: 51%
- Ages 12-17: 42%

Among children 2-17 years of age with current ADHD, about 77% were receiving treatment. Of these children:

- About 30% were treated with medication alone.
- About 15% received behavioral treatment alone.
- About 32% children with ADHD received both medication treatment and behavioral treatment.
- About 23% children with ADHD were receiving neither medication treatment nor behavioral treatment." (CDC 2016).

The cited data above was taken from the CDC website.

2.2.2.3 ADHD Exercise Behavioral Treatment

According to the article, *How Exercise Works like a Drug for ADHD* on EverydayHealth, Kristen Stewart argues the following statement, "It's no surprise that exercise boasts many health benefits — but it may also help ease or even treat both child and adult ADHD symptoms." The article includes a women's personal experience and professional experiences working with ADHD. She explains, "Exercise not only encourages the production of dopamine, norepinephrine, and serotonin in the brain, but by doing so

has the same effect on the brain as the stimulant methylphenidate." Dopamine increases peoples focus and attention who suffer from ADHD. "Exercise also helps children and adults get rid of restless energy, which is a symptom of ADHD. In fact, the worst thing a teacher can do to an unruly child is to take away their recess time." (Stewart).

In the book, *Teaching Children with Attention Deficit Hyperactivity Disorder: Instructional Strategies and Practices*, written under the U.S. Department of Education partnered with the American Institutes for Research gives useful background information and pointers for those working with students who have ADHD. A majority of the book has useful tips for teaching strategies and ways of making students responsible for their behavior in a positive manner. On page 23, the book states, "The desk and chair used by children with ADHD need to be the right size; if they are not, the child will be more inclined to squirm and fidget. A general rule of thumb is that a child should be able to put his or her elbows on the surface of the desk and have his or her chin fit comfortably in the palm of the hand."

2.2.3 Bikes

The dictionary definition of a bicycle is "a vehicle with two wheels in tandem, usually propelled by pedals connected to the rear wheel by a chain and having handlebars for steering and a saddle bike seat" (Bicycle 2019). A twenty-minute bicycle commute, at a moderate speed, can burn 280 calories round trip (University of California, Santa Barbara). Bicycling is low impact and good for strength and stamina (Better Health Channel 2013). Bicycling, can have moderate or vigorous intensity, depending upon level of effort. Bicycling is great for muscle strengthening but does very little for bone strengthening (CDC 2008).

2.2.3.1 Exercise Bikes

An exercise bike, like shown below in Figure 2, is a stationary bike without wheels that is used simply for exercise and usually found in homes and gyms.

Figure 2: Exercise bike. (Jason and Dave 2017)

2.2.4 Exercise

Physical activity will help maintain adequate weight, but there are many other reasons to stay active. Some benefits to being physically active include living longer, having a "lower risk for heart disease, stroke, type 2 diabetes, depression, and some cancers" (More People Walk to Better Health | VitalSigns | CDC 2013). Simply walking is physical activity adequate enough to improve health without weight loss. "Cardiorespiratory fitness is a modifiable indicator of long-term mortality, and health care professionals should encourage patients to achieve and maintain high levels of fitness," (Mandsager 2018).

2.2.4.1 Children Exercise

Children should exercise moderate to vigorously for at least 1 hour per day. They also need muscle and bone strengthening at least 3 days a week (2008 Physical Activity Guidelines for Americans 2018). One-third of children between the ages 10-17 are overweight in America. Less than 25% of children get less than the daily recommended amount of exercise. Furthermore, teachers may spend more time on academic study than physical activity, to help improve standardized test scores (Klika, A. B. K. C. B. 2017).

2.2.5 Fidget Toys

Fidget toys are mechanicalized tools used to help with stress, anxiety, attention, and student's learning (Ferry 2018). According to Cohen, Bravi, and Minciacchi fidget toys are also known for improving motor control through small movement from the nervous system (Cohen, Bravi, Minciacchi 2018). Fidgets come in different shapes, sizes, textures, and materials. They help students who may have ADHD to focus better and improve their learning performance (Claflin 2017). "John Ratey shows that physical activity — even something as small as fidgeting the hands — increases levels of the neurotransmitters dopamine and norepinephrine in the way ADHD medications do," (Rotz 2018). Fidget tools are also used to improve the nervous systems by producing movement using fidget spinners (Cohen, Bravi, Minciacchi 2018). "Fidget tools provide us with subtle movement and touch inputs that can help calm our bodies and keep our minds attentive, alert and focused," says Claire Heffron.

2.2.5.1 Different types of fidget tools

There are many types of fidget tools that help improve physical movement and mental disorders. The way it works is based on its design, for instance fidget spinners help improve your motor control due to being diffuse and prone to repetitive usage (Cohen, Bravi, Minciacchi 2018).

2.2.5.1.1 Fidget desk

Like the desk shown in Figure 3 below, a fidget desk is a desk that has fidgeting tools or toys that one may play with while sitting in class. Fidget desks are known to help students stay focused while sitting down to prevent them from getting distracted (Zane Middle School standing fidget desk 2017).

Figure 3: Fidget desk at Zane Middle School (Zane Middle School standing fidget desk 2017).

2.2.5.1.2 ONO

The ONO roller is a fidget toy, shown below in Figure 4, which is advertised as a tool that keeps you focused and your hand active. Kickstarter states that the ONO will rotate and roll within your fingers which helps relieve stress and anxiety, improves focus and dexterity, and massages your hands. Based on its design it is capable of releasing inner tension by massaging. This design was based off of rolling

two highlighters in your palm. Therapist's also use sensory toys such as tactile discs, Koosh balls, putties, and clays to soothe kids who have sensory-processing issues (Live Science).

Figure 4: ONO fidget toy (Kickstarter)

2.2.5.2 *Fidget Cube*

The fidget cube, shown below in Figure 5, is a toy that's small in size and has six sides that have different features. The fidget cube was designed for anxiety for instance it clicks, rolls, spins, flips, glides, and says goodbye to stress. According to Matthew and Mark you can get rid of stress and anxiety at the office, in class, while studying, in a meeting, watching tv, and commuting with the fidget cube (Kickstarter).

Figure 5: Fidget Cube fidget toy (Ansty Labs)

2.2.5.3 *Fidget Spinner*

Fidget spinners rotate around a central axis that's formed by two rings. It has three bearings that distribute weight equally from the center which increases the force that results in a rotation that lasts for a few minutes (Cohen, Bravi, Minciacchi 2018). Hobbytron advertises fidget spinners as a tool that helps in stressful situations and helps relieve anxiety (World Tech Toys Blue Elite Fidget Spinner). Fidget spinners are helpful when it comes to entertainment, bad habits, stress, anxiety, and staying focused.

2.2.5.4 *Tangle toy*

The tangle toy, also known as Tangle Jr. shown below in Figure 6, is the original fidget toy that has been a source of creativity for all (Tangle Jr.). The Tangle Jr. has 18 interconnected pieces that can twist in various directions. The Tangle Jr. makes no noise which is great for students to focus without distracting other classmates. National Autism states that, "Tangles are a great manipulative toy that stimulates the brain and can build finger dexterity" (Tangle Jr.)

Figure 6: Tangle Jr. Toy fidget toy (Tangle Creations)

2.2.5.5 *Ball Magnets N35 Fidget Toy*

The ball magnets, shown below in Figure 7, are known for its lifetime of magnetism. These magnets are shaped as a sphere which allows you to make different types of shapes. The purpose of the ball magnet toy is to reduce stress, anxiety, lessen ADHD, and boost focus (Total Element).

Figure 7: Ball Magnets N35 Fidget Toy fidget toy (Total Element)

2.2.6 Materials

2.2.6.1 Wood

Wood is a commonly used material for building and construction that comes from trees. The type of wood used for building is lumber which is "timber sawed or split into planks, boards, etc." (Dictionary.com). Many different varieties of lumber exist, each having different qualities that makes them best for different situations. One main type of lumber is softwood which is acquired from trees such as cedar, spruce, pine, and fir. Softwood is much cheaper than hardwood and can easily be found in a common hardware store, but extra care must be put into its preservation because it absorbs and loses moisture much quicker than most wood (Brett, 2017). The second main type of lumber is hardwood lumber which is acquired from deciduous trees such as maple, oak, hickory, walnut, and mahogany. This lumber is much more expensive because it takes longer for the trees to grow. Finding this type of lumber at common hardware stores will be difficult therefore it is best to go to a lumber yard or specific hardwood store (Brett, 2017).

2.2.6.1.1 Pros

Several pros when considering wood as a building material include:

- easily bought at stores
- generally inexpensive (Brett, 2017)
- sturdy
- easy to drill into and attach to other pieces of wood
- moderately flexible

2.2.6.1.2 Cons

Several cons when considering wood as a building material include:

- heavy and difficult to transport
- can biodegrade if placed in wrong conditions
- cannot be cleaned easily if spilled on
- expands and contracts with moisture

2.2.6.2 Plastic

Plastic "is a common term that is used for many materials of a synthetic or semi-synthetic nature" that is made up of polymers (An introduction to Plastics, 2014). A big portion of monomers, a molecule bonding to the same molecule to form a polymer, used to make plastics like ethylene or propylene come from fossil hydrocarbons (Greyer, R., Jambeck, J., and Law, K. L., 2017). It is used heavily by

manufacturers all around the globe because it is extremely cheap and can be easily manipulated into different shapes and colors providing an endless amount of uses. There are some plastics that are biodegradable, but most are not so therefore the current modes of disposal are either combustion processes or landfills.

2.2.6.2.1 Pros

Several pros when considering plastic as a building material include:

- corrosive resistant
- inexpensive
- stain resistant
- recyclable

2.2.6.2.2 Cons

Several cons when considering plastic as a building material include:

- Not too stable depending on the type of plastic, but some might not be easy to find
- Will be difficult to find in a common hardware store
- Buying plastic will add to the growing plastic waste problem harming the environment

2.2.6.3 Metal

Metals are essential materials commonly used for construction due to its durability, strength, and weather resistance. The most common metals used in construction include: carbon steel, aluminum, stainless steel, and copper tubing. Carbon steel is an alloy highly praised for its strength and hardness being commonly used as material for bridges, structural framework and highway construction (Continental Steel and Tube Company, 2015). Aluminum is also highly used in construction for things such as automobiles, bicycles, windows, doors, and street lights due to its resistance to corrosion, ductility, and high conductivity (Continental Steel and Tube Company, 2015). Stainless steel is an alloy that can be made into many different grades and is one of the oldest used metals in construction due to its high resistance to stains and corrosion (Continental Steel and Tube Company, 2015). Copper tubing is commonly used for HVAC systems, heat pumps, and water pipes because of its corrosion resistant properties, ease to recycle and good soldering abilities (Continental Steel and Tube Company, 2015).

2.2.6.3.1 Pros

Several pros when considering metal as a building material include:

- highly durable
- corrosive resistant
- stain resistant
- easy to weld if you have the tools to do so

2.2.6.4 Cons

Several cons when considering metal as a building material include:

- expensive
- need specific expensive tools to build/weld
- not all metal is corrosive resistant so some metal will rust easily
- welding mistakes are troublesome to be undone

2.2.6.5 Wood-plastic Composite

Wood-plastic composite is a new eco-friendly composite material that incorporates lumber and recycled wood and plastics as an alternative building material (Kim, 2013). This is manufactured using two steps: compounding and forming. First, in compounding, wood fiber and additional small wood waste is combined with melted thermoplastic. Second, in forming, the molten composite is formed into the preferred shape and/or color using either extrusion, injection molding, or compression molding (Wood-Plastic Composites, 2004). Some frequent uses of wood-plastic composites include outdoor decks, park benches, fences, and indoor furniture (Kim, 2013).

2.2.6.5.1 Pros

Several pros when considering wood-plastic composites as a building material include:

- Not harmful to the environment since it incorporates recycled wood and plastic instead of completely new material
- Not too expensive
- Stain resistant
- Will not decay or change due to certain weather conditions

2.2.6.5.2 Cons

Several cons when considering wood-plastic composites as a building material include:

- Slightly difficult to find a store that sells this type of material
- Difficult to drill into

2.2.7 Desks

Although desks seem simple to build, a lot of thought must go into its design. Things such as dimensions, material, accessibility, and variability in people using it all must be taken into account. Desks themselves are extremely variable because of its large amount of uses, so it may have seats attached or detached, it may have footrests, adjustable heights, and much more (INCYDES). Figuring out what material to use is also an important aspect to building this type of furniture. Frequently used materials for desk tops include, metal, wood, glass and laminate, a type of plastic. The types of wood commonly used for tabletops include: Cherry, Elm, Mahogany, Maple, Rosewood, Teak and Walnut (Crawford). Possibilities for table leg material only include wood and metal which is a much shorter list than table top materials because the material must be sturdy enough to hold the weight on top of the table top.

2.2.7.1 Common Joints

Joints are used to join boards together in wood working. There are many different types of joints in which they each vary in strength and complexity.

2.2.7.1.1 Butt Joints

A butt joint, shown below in Figure 8, is the simplest joint in wood working. It is simply created by butting two board ends together and securing them with glue. This joint is also one of the weakest (Editor 2019).

Figure 8: Butt Joint, example (Editor 2019).

2.2.7.1.2 Mortise and Tenon Joint

This joint, shown below in Figure 9, involves sticking a "tenon", an extra piece of wood protruding out the end of the board, into a "mortise", a hole in the board that will be joined together. This joint is extremely strong and reliable (Editor 2019).

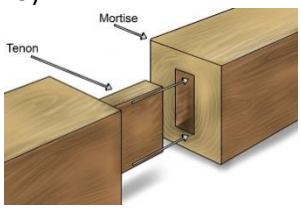

Figure 9: Mortise and Tennon Joint, example (Editor 2019).

2.2.7.1.3 Pocket-Hole Joint

The pocket-hole joint, shown below in Figure 10, is very similar except it uses screws along with glue, instead of just glue. A pocket-hole joint is commonly used and allows pilot holes to be drilled at the correct angle and depth. Pilot holes are used to remove wood before screwing into, to prevent blowouts (Editor 2019).

Figure 10: Pocket Joint, example (Editor 2019).

3 Alternative Solutions

3.1 Introduction

Section 3 includes information about our brainstorming process, fidget aspects and alternative solutions. These alternative solutions are each described effectively with corresponding images and will each include fidget aspects from section 3.3 on top of the desk.

3.2 Brainstorming Process

Team EWM masterminded 5 brainstorming sessions to reach the goal of effective alternative solutions. Our first session took place in Paige's classroom, at Zane, where we listened to her ideas and wants, and

also see what our restrictions are physically. This allowed us to have a more structured start to our brainstorming process. The second brainstorming session took place after a phone call with Paige that helped establish further clarity for our client criteria. The third brainstorming session took place in our Engineering 215 lab. We collectively took time individually drawing 3D prototypes of pedal desks. This allowed EWM group members to let their creativity flow and have a visual to describe once we came together to elaborate. The fourth brainstorming session was held in the Science D on Humboldt State University campus. Here we further collected research for pedals and brainstormed different types and styles. We also chose the ones we thought would be most effective. The final brainstorming session allowed us to describe the full potential of our ideas and further improve them. Team EWM 3D drawings and page of notes can be found in the Appendix of this document. Most of the designs we created can be incorporated in with each other for maximum customizability.

3.3 Fidget Aspects

The following designs are alternative solutions team EWM brainstormed for the fidget aspect that our client representative wanted on top of the desk.

3.3.1 Desk Buddy

The desk buddy, shown below in Figure 11, is a quite toy that is in the shape of a ruler and has different textures on top. It is made out of rubber and has different types of ripples. This allows students to fidget quietly by feeling the rubber bristles on the desk buddy.

Figure 11: The desk buddy allows for quiet fidgeting through sensory touch (Home).

3.3.2 Desktop Spinner

The design of this spinner, shown below in Figure 12, is meant to keep you busy without distracting others. It is a simple design that is shaped as a cylinder and spins on any flat surface.

Figure 12: This desktop spinner has several quiet spinning sections (Desktop Spinner Cylinder).

3.3.3 Customizable Fidget Spinner Ring

The customizable fidget spinner ring, shown below in Figure 13, is a ring that has moveable parts on its outside. This ring will allow someone to fidget while remaining discreet about it.

Figure 13: The textured middle of the outside gives your fingers grip to spin it when on the finger (Mensley, 2017).

3.3.4 Trick Bolt Fidget

The trick bolt fidget, shown below in Figure 14, is a fidget toy that attaches to common objects. This bolt and spine gives the consumer endless times of spinning the bolt while being quiet. It is attachable to keychains, backpacks, etc, to take it anywhere to-go.

Figure 14: The nut can be spun up and down the threads (Mensley, 2017).

3.3.5 Truchet Tiles

Truchet Tiles, shown below in Figure 15, is a small, portable puzzle that allows the user to figure out the final pattern, by moving each individual piece to complete the bigger picture.

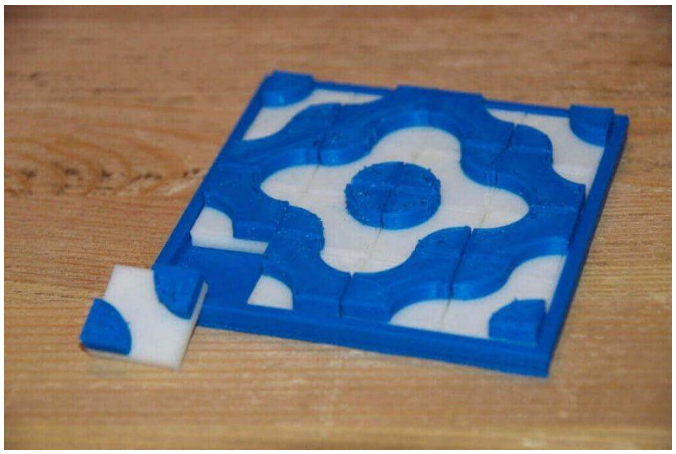

Figure 15: This puzzle makes the children use more than just the sense of sight to finish it (Mensley, 2017).

3.4 Desks

The following designs are alternative solutions team EWM brainstormed for the desk portion that our client representative wanted.

3.4.1 Adjustable Pedal Desk

This desk design, shown below in Figure 16, is meant to be very accommodating by being able to adjust up and down. The pedals would be independent from the desk allowing for personal preference and will accommodate for all student's height and weight. The table top would be on a hinge allowing to rotate the angle and if rotated 180, in which a white board will be present on one side. However, with so many moving parts it is prone to failure. This table will have two legs with runners on the bottom for support in which the table top will hinge onto these two legs. The desk top opposite from the whiteboard will have fidget aspects.

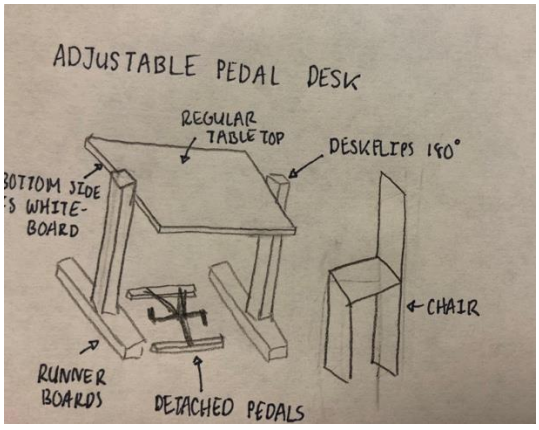

Figure 16: Adjustable pedal desk with detachable pedals and a 180-degree spin table top.

3.4.2 Group Pedal Desk

This round desk, shown below in Figure 17, would be able to accommodate multiple students all at once. It will feature several independent pedal systems along with adjustable chairs attached to a round desk large enough to accommodate multiple students. The desk however would be static and promote group work. This desk is best for students who like to work with others and is beneficial for students leaning environment.

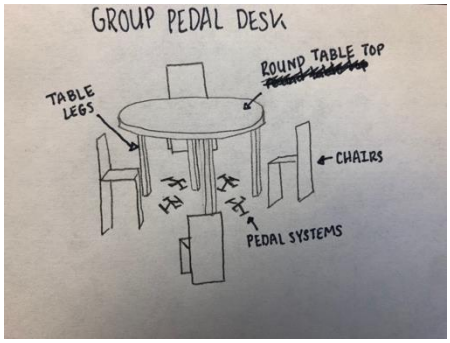

Figure 17: A large round table suitable for four students to pedal and work on classwork.

3.4.3 Basic Pedal Desk

The 4-legged desk, shown below in Figure 18, will be taller to account for taller children. This desk will have an adjustable chair and pedal. The desk itself wouldn't be adjustable due to complexity of adjustments. This will also include a white board that can be attached.

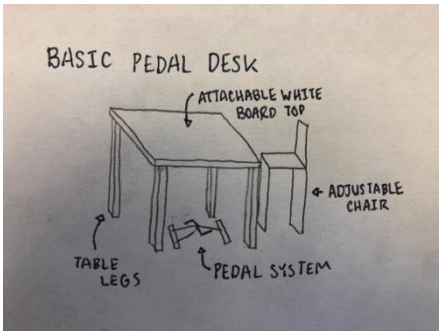

Figure 18: A basic pedal desk with an attachable white board top.

3.4.4 Stand up Walker

Instead of incorporating pedals in a sitting position, this design will have the students pedaling, but in a standing position as shown below in Figure 19. The desk will have an adjustable height mechanism for students with different accommodations. This design will be sufficient for students even without the pedals as well.

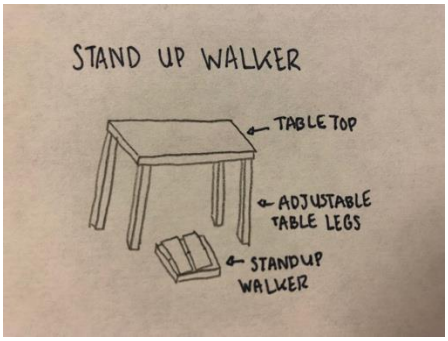

Figure 19: A standup walker desk with adjustable heights on the table legs.

3.5 Movement Aspects

The following designs are alternative solutions team EWM brainstormed for overall general movement aspect that our client representative wanted.

3.5.1 Foot Roller Desk

A four-legged desk similar to design 3 will included a foot roller on parallel tracks attached to the legs of the desk as shown below in Figure 20. The student will be able to roll this roller freely without any interference of the legs. This desk would not be adjustable except for the chair. This idea is based off of the children like the pedal idea.

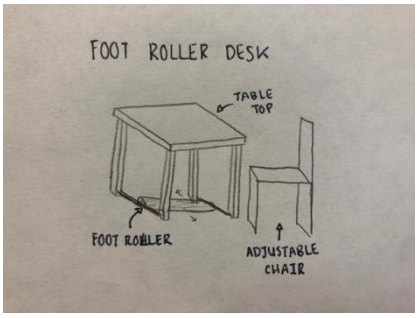

Figure 20: A four-legged desk with a parallel foot roller system on the bottom.

3.5.2 Bubble Chair

This desk will be like the aforementioned desks except the only thing different will be the main fidget aspect. There will be no pedals and instead there will be a stationary yoga ball as a chair, shown below in Figure 21, which will allow the students to move in an up and down motion while completing school work. Since the yoga ball chair will be lower to the ground than most chairs, the table legs will be adjustable so it can be raised or lowered.

Figure 21: A desk with no pedals and instead a bubble chair (Isokinetics…).

3.5.3 Pully System

This pully system is meant for students who dislike the pedal design. This design is meant to have an upward and downward movement with a band that is connected to a pully system on the bottom of the desk as shown in Figure 22. This pully system will help with leg movement and will work as a foot rest.

Figure 22: A pully system that allows student to have a wide range of motion (Total Gym Encompass Leg Pulley System).

3.5.4 Pedal Design 1

This design for the pedal mechanism, shown below in Figure 23, will use a modified triangular prism frame made out of copper as the base. The pedal mechanism will be a standard bike pedals attached to the gear. The top of the triangular prism will run through the gear and act as an axel. The bikes brake system will be incorporated as the main speed resistor.

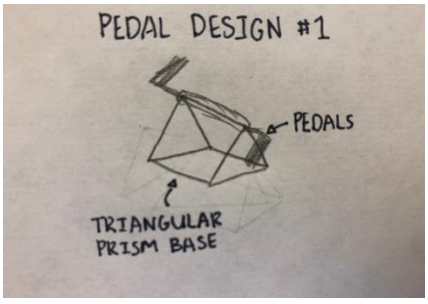

Figure 23: A triangular prism frame for the pedal system

3.5.5 Pedal Design 2

This design, shown below in Figure 24, will have an adjustable pole coming down from the bottom of the desk. The height will easily be adjusted able using a design, like a bike seat. It can be made to move forwards and back if multiple connectors are put on the bottom of the desk. It will incorporate a bicycle brake as the speed resistor.

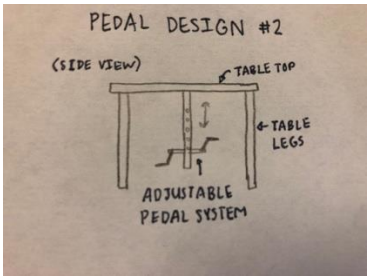

Figure 24: A pedal design with an attached pedal to the bottom side of the desk.

3.5.6 Walker

The walker design, shown below in Figure 25, will use an alternating up and down walking mechanism. It will have a flat base. The actual mechanism will incorporate a curve with foot rests on either side of the curve. As pressure is applied to one side, the other raises up, simulating walking.

Figure 25: Walker with a range of a slight upward and downward motion (Irimia R, Gottschling M. 2016).

4 Decision Phase

4.1 Introduction

Section 4 includes information about the design process and a thorough explanation of our steps and ideas that led to our final decision. The final decision explanation is an analysis of all the parts included in our final decision.

4.2 Criteria

The following table, Table 2, is a list of Criteria needed to be taken into account when designing the desk. All criterion below is weighted on how important each factor is on a scale, with 10 as the max.

Criterion	Description	Weights
Safety	Should not harm the children in any way.	10

Durability	Will be used daily, so it must be sturdy and not breakable.	9
Sound level	Must be quieter than keyboard typing.	7
Child size	Adjustable to account for all students' sizes.	6
Transportability	Must be able to move around with ease.	5
Movement	Must provide students with adequate movement.	5
Cost	A maximum budget of $400, but preferably less than $100.	4

Table 2: A table of this projects criteria.

4.3 Decision Process

Our client gave us specific ideas and criteria (see Table 1) for the project. From there, several other similar designs were created based on that criteria. For this reason, Delphi Matrix was not needed to decide the final decision because all the designs are so similar. Instead, all of the designs will be presented to the client representative and she will decide. In addition, in the prototyping process we came up with a new design that only involves a pedal system. It is a simple design that allows us to create multiple pedal systems quickly and efficiently. This design is easily transportable and will fit under the children's desks, allowing for multiple children to use their own pedals during class. The team took the prototypes to Zane to get feedback from the children. We decided the pedals were the best prototype and we would base our design off of them. Unfortunately, the pedals did not work under their desk because their knees hit the table top. This means that our team also needs to design a desk.

4.4 Final Design

This project final design features an adjustable table with a pedal system. The desk has two main legs with parallel runner boards on the bottom, giving the desk a strong base. It has five present heights that utilize four nuts and bolts, to hold its position. The pedal system is a recycled bike frame and pedals secured to two boards acting as a base. The table top was created with a piece of plywood on the bottom for strength, then a dry erase board was put on top of that. A ¼"x1" piece of trims runs along the perimeter to keep things from rolling off. EWM didn't include any fidgeting aspects besides the peddle system.

5 Specification

5.1 Introduction

This section is based on specifications of the final design including a detailed description of the mechanics and maintenance that will be needed over time. Also, the total amount of hours that were used to build and plan out the design, the total cost of materials used, and a chart that will show total maintenance cost.

5.2 Description of Solution

The final design is a desk that incorporates fidgeting aspects through the pedal system with a whiteboard on top. This design is going to have a detachable pedal, in which two notches are cut on the inside of the two runner boards to allow the pedal system to slip in. The pedal system is easily removeable if students decide to not use the pedal system.

5.2.1 Table

The table, shown below in Figure 26, has two legs that are on opposite sides of the desk. There are two parallel boards on the bottom of the desk that gives the desk support. Down near the legs there are two notches cut in the parallel boards that allow the pedal to be attached while locked in place at the same time. At the top of the legs, there is a pin system using nuts and bolts to adjust the height of the table top. In addition, the table top is a white dry erase board, with a trim around the edges of thin wood.

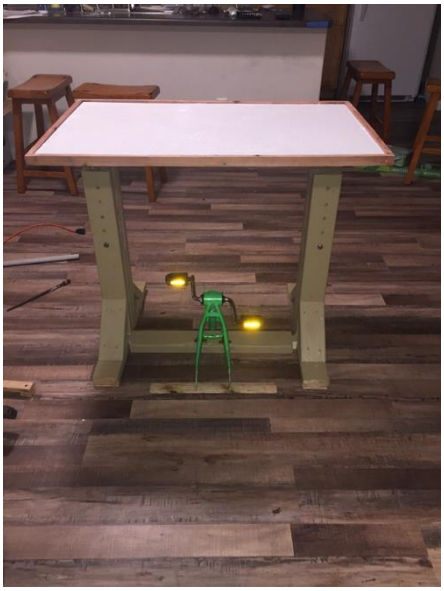

Figure 26: Desk/Table Top

5.2.2 Pedal System

The pedal system is made by modifying a recycled children's bikes. Team EWM found inexpensive bikes at places such as junkyards and craigslist for only a few dollars each. From there team EWM took apart the bike to get to the bearings, which needed to be repacked full of grease to dampen the sounds of the slightly rusty bikes. From there cuts were strategically made in places to cut the frame to provide the pedals a sturdy structure. Wooden supports were then attached to the front and back of the frame so it would not move as much when being pedaled. The pedal system has a simple notch system to strongly secure it to the desk, so it does not move while being pedaled.

Figure 27: Bike Pedal System

5.3 Cost Analysis

This section describes the total cost of the project. Different types of cost that were taken into consideration were cost in hours of the design project, cost of construction and cost of maintenance.

5.3.1 Design Cost

The design cost of the Pedal Desk is the total hours all group members spent working on this project. Included in the pie chart below are the total hours spent on each section of the document and the amount of time spent building. In total, the design cost resulted in 286.5 hours.

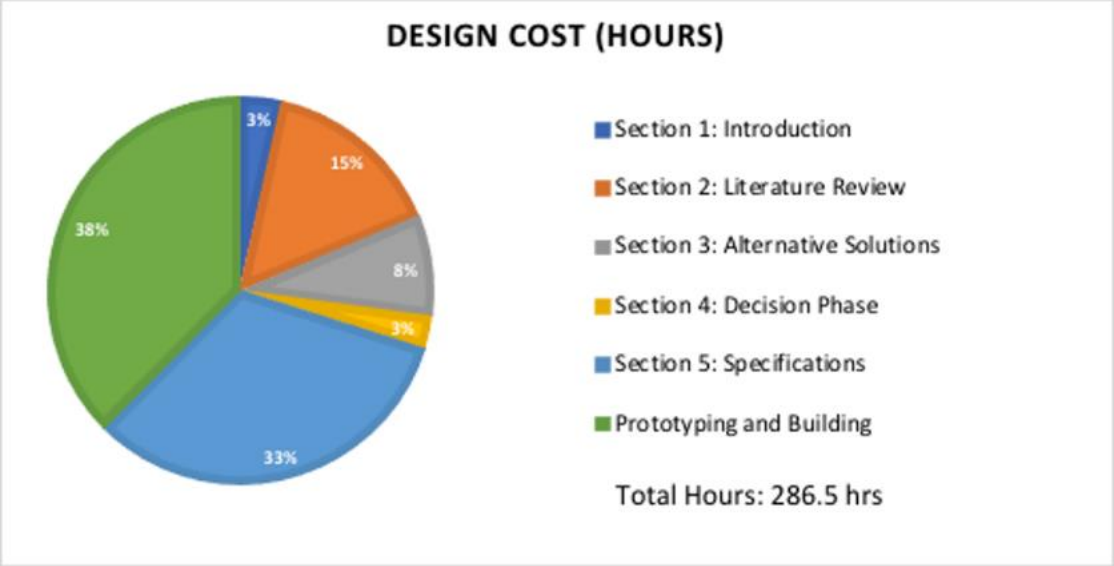

Table 3: This pie chart explains the team's design hours.

5.3.2 Implementation Cost

The total cost of construction for the pedal desk includes the monetary value of all materials bought and used. The total cost for construction resulted in $75.12. If materials were not donated, the estimated total cost would have been $100.00.

Implementation Costs		
Items	**Quantity**	**Cost**
2x4 wood	4	$12.69
Box of screws	1	$6.49
Washers	4	$0.92
Bolts	4	$6.00
Nuts	4	$0.92
Drill bit	1	$7.04
Blue bicycle	1	$5.00
Green bicycle	1	$2.00
Wrench	2	$8.03
Whiteboard paint	1	$26.03
Plywood	1	Donated
Miscellaneous hand tools, power tools, and paint brushes		Donated
Total Cost:		$75.12

Table 4: This table explains the implementation cost.

5.3.3 Maintenance Cost

The maintenance cost of the pedal desk is the estimated amount of money spent on maintaining the pedal desk if something breaks. The only real maintenance that will come up is cleaning the desk top with cleaner and fixing the squeakiness of pedals over time. This can be solved quickly my spraying WD-40 inside the pedal system. However, a more long-term fix would be to take it completely apart and re-pack the bearings with grease. WD-40 and grease is cheap and only costs a few dollars, these are things that are regularly found in a maintenance room and should be readily available whenever. Things can still break with abuse, but it is hard to tell what is most probable and the solution will be more up to the judgment of the school's maintenance staff. Bolts should be checked about every two months or if there is clearly something loose on the desk.

Operation and Maintenance	**Cost**
WD-40	$3.88*
Grease	$4.29*
Cleaning supplies	$4.48*
Tools: wrenches and rubber mallet	Donated

Table 5: This table explains the maintenance cost.

5.4 Results/Performance

Once EWM had a few prototypes finished, the group decided to get feedback from students by bringing the prototypes into the classroom. The team brought in two different models of bike pedal foundations that allowed students to feel which would be sturdier and more durable. The feedback from the students' interaction with the prototypes, lead the team to make the adjustable desk with detachable pedals. Some students still enjoyed the foot rolling system, which fortunately works with their existing desk. Both models were successful in terms of being able to use the pedals properly and glide their feed along the roller. Simultaneously, the students were able to give feedback on how they would utilize the project. The students had the capacity to learn while staying more focused due to the ability of movement. This will be accomplished safely by students who feel the urge of being disruptive during class.

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