Project 5: Outdoor Active Workstation

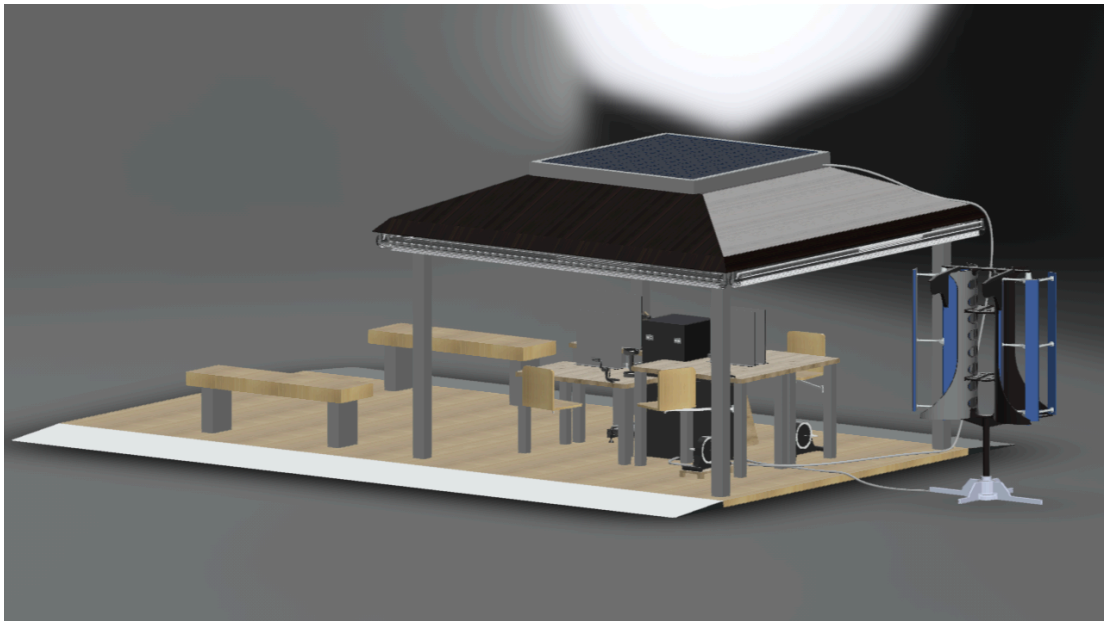
Arnav Bhatt, Nate Cross, Ayush Desai, Adriana Galofaro, Josh Halpert, Gianna Spasevski

Engineering Design Division, Binghamton University

EDD 104: Engineering Communications II Section 57

Prof. Alyssa Leonard

May 7, 2022



Executive Summary

Design Problem

College students sit for long hours at their desks working on assignments, harming their health. Research shows exercises such as walking, cycling, and strength training while working can reduce these risks without hurting productivity. The challenge of this design is to create an outdoor active workstation that allows the user to exercise while doing work, and is also semi-portable.

Design Solution

The proposed outdoor active workstation includes solar panels and a wind turbine to provide renewable energy. It features various exercise machines for movement and desks for completing work. The structure accommodates four users and includes a waiting area. It is designed for easy assembly and disassembly. Additionally, it has a power outlet for charging devices and mirrors for users to view themselves while exercising.

Design Assessment

The final design exceeds expectations because of its ability to be completely self-sustainable and accommodate four users at four different workstations who can partake in low intensity exercises while completing any work that they need to do. This design effectively combines accessibility, portability, and sustainability. The workstation can completely power itself through the use of solar panels, wind turbines, and kinetic energy regeneration with the different workout machines.

Conclusion

This design stands out because of its consideration for users, the environment, and the buyer. It is able to accommodate any user with one of the design's main focus points being inclusivity for all, through accessible locations and adjustable components (machines and seating). The workstation will be made out of recycled metals and sustainably sourced wood, while using three different forms of clean energy to power the workstation. The self sustaining aspect of our design allows for the buyer to take a hands-off approach to maintaining the workstation, and the choice of FSC-certified Accoya wood allows for high durability while being lightweight. In all this design hits all the requirements while appealing to the user and buyer.

Table of Contents

Design Problem (Adriana Galofaro)

Background and Motivation

The outdoor active workstation is an ergonomic design implemented by many establishments to help reduce work-related stress and optimize work quality and output. Outdoor active workstations combine the benefits of working alongside nature and incorporating exercise as opposed to stationary work done from the confinements of indoor settings. This is done by combining various machinery which promotes low-intensity activity as well as areas and tools necessary to complete work. There are many negative effects of indoor work ranging from increased cortisol levels to the development of Sick Building Syndrome (SBS - a condition prominent amongst employees who work within cubicles) (Schuch et al., 2014). While stress levels continue to rapidly increase amongst students and employees delegating most of their time to indoor work, the mental health of these individuals have begun to decrease. Traditional indoor office spaces have concerning levels of work-related stress at around 77% of the population surveyed. Of this 77% nearly 57% reported negative impacts related to “work-burnout”, some symptoms including emotional exhaustion, desires to quit, lower productivity, and irritability (American Psychological Association, 2023). Active and outdoor working environments have proven to combat these negative effects with their own benefits. Outdoor environments improve physiological and psychological benefits in comparison to indoor environments and the exposure to nature allows for increased sensory inputs (Vasconcelos et al., 2023). Active work environments improve circulation, increase energy output and optimize productivity. It is important to manage stress and attend to one's mental health to maintain a good overall wellbeing, which can be done by shifting work from indoors to outdoor active workstations.

Design Statement

Design an outdoor multi-user workstation that encourages healthy work habits and allows individuals to engage in low-intensity, energy-generating physical activity while working.

System Level Requirements

[OAW 1.1] The workstation shall be semi-portable.

[OAW 1.2] The workstation shall accommodate 4 users at once.

[OAW 1.3] The workstation shall allow each user to engage in at least 2 types of low intensity exercises in an hour.

[OAW 1.4] The workstation shall generate electricity to power a laptop and phone for each user.

[OAW 1.5] The workstation shall comply with ADA accessibility standards.

[OAW 1.6] The devices within the workstation shall be adjustable.

[OAW 1.7] The workstation shall be constructed from durable, sustainable materials.

Subsystem Requirements (Adriana Galofaro)

The subsystem requirements were based on the list of system level requirements which were assigned by the Project CEO. There are three subsystem requirements: Environment, Function and Portability (found in Appendix A). These were based on the necessities expressed by the system level requirements and provide further insight to specific aspects of the active workstation. The three subsystems expand on the durability, maintainability and sustainability of the three different aspects. They also provide explanations to the regulations within these subsystems mainly in regards to New York State and the Occupational Safety and Health Administration. The specific regulations closely adhered to for this active workstation ranged from ergonomic necessities in office -like settings, following ADA regulations to accommodate to all clientele, following New York State rules and regulations for outdoor electrical standards and the ease of portability. The Occupational Safety and Health (OSH) Act assures "safe and healthful working conditions for working men and women." The OSH Act proceeded to create the Occupational Safety and Health Administration (OSHA) allowing states to run their own safety and health programs and was enacted to "assure safe and healthful working conditions for working men and women." OSHA also goes into detail about the electrical requirements necessary. The term disability refers to a physical or mental impairment that limits one's life activities and allows individuals to file complaints when these needs are not met. There are specific regulations set in place by the ADA (Americans with Disabilities) which "protect individuals with disabilities from discrimination in services" (New York State Department of Labor (NYSDOL)). Lastly the New York State Department of Labor guidelines were followed closely to classify the weather condition protocols needed to be followed by a proper establishment.

Environment

The environmental impact is important because if the workstation is outdoors then it should not disturb the wildlife in the area. Also if the workstation is being used as a power source, then the environmental impacts for the generation of that electricity should also be monitored.

Function

The workstation must fulfill ergonomical and ADA standards in order to be considered functionable. These are also important considerations in order to ensure the comfortability of the user.

Portability

The workstation is required to be semi-portable such that it can be moved when necessary, but not by a student. This will allow for the workstation to be moved to different locations for a change of scenery.

Please refer to Appendix A for a comprehensive list of System level and Subsystem requirements.

Evaluation of Design Concepts

Evaluation Criteria

The evaluation criteria served as the basis for our group's assessment of our design's efficiency. Essentially, these criteria define the core aspects of our design. Our criteria consisted of Environmental Impact, Maintainability, Durability, Cost, Portability, Safety, and Aesthetic.

Environmental Impact (Ayush Desai)

Environmental impact, in the context of building a portable workstation for a campus, refers to the effects the design, materials, and energy usage have on the surrounding environment. Environmental impact allows our resources to be utilized responsibly, minimizing unnecessary waste and promoting long-term sustainability. It also emphasizes adaptability by incorporating renewable energy sources and recyclable materials, enabling the workstation to align with evolving environmental standards. Therefore, environmental impact is assigned a weight of 0.20 on the evaluation criteria.

Maintainability (Arnav Bhatt)

Maintainability is also essential to achieve long-term operation and reliability of a portable outdoor active workstation. The product must be made of long-lasting, durable materials resistant to wear and tear, corrosion, and the forces of nature with minimal repair and replacement needs. Components must be easy to clean and maintain without much effort in removing dirt, water, or debris acquired when used outdoors. Modular or easily replaceable parts can enhance maintainability by allowing easy replacement of faulty parts without the need for specialized tools. Simple user-friendly instructions and easy access to service should be provided so that minor maintenance and fault-finding can be accomplished quickly, extending the life of the workstation. Therefore, maintainability is assigned a weight of 0.20 on the evaluation criteria.

Durability (Adriana Galofaro)

Durability pertains to the ability to withstand wear and damage, and last a long time. Given the project entails designing a workstation that must be able to bear periodically changing weather

conditions and be easily portable, durability is a key factor when considering design aspects. Not only must the structural integrity of the workstation be able to stand on its own but the individual parts of the workstation must also demonstrate durability in preparation for heavy usage or an increase in the amount of transportation the machinery faces. Therefore, durability is assigned a weight of 0.15 on the evaluation criteria.

Cost (Nate Cross)

Affordability is key to reaching diverse communities, from urban to remote regions, ensuring that people everywhere can benefit from our product. Additionally, a lower price will give us an edge over similar products, making ours the preferred choice for consumers. By balancing cost-effectiveness with quality, we can maximize both usability and profitability, driving widespread success. Therefore, cost is assigned a weight of 0.15 on the evaluation criteria.

Portability (Arnav Bhatt)

Portability is a highly essential aspect of the design of an outdoor active portable workstation, enabling users to be able to carry and install the workstation in varied outdoor environments. The design needs to include an overall weight, dimensions, and foldability of the workstation so that it becomes convenient to transport and store. The best workstation would come with a lightweight yet sturdy frame that is effortlessly collapsible or disassembled without the use of special tools. It should also include ergonomic handle or carrying strap provisions for ease of mobility. Portability entails ease of reassembly as well as ground stability on different grounds such that the workstation remains functional and secure while working. Therefore, portability is assigned a weight of 0.15 on the evaluation criteria.

Safety (Arnav Bhatt)

Safety is a key consideration when designing a portable outdoor active workstation so that the users are not hurt as they work or physically exercise. The workstation should be constructed using sturdy, non-toxic materials that are weather-proof and structurally safe even if exposed to various conditions. Stability features such as anti-slip bottoms and lock-in mechanisms should be incorporated in order to prevent tipping or collapsing. Corners and edges need to be padded or rounded so they will not cause accidents, and if movable parts are present, they should have features to safeguard against accidental pinching or trapping. It also needs to conform to applicable safety standards so that secure and reliable usage can be assured. Therefore, safety is assigned a weight of 0.10 on the evaluation criteria.

Aesthetic (Ayush Desai)

The next criterion is aesthetics, which doubles as user engagement. This criterion ensures that the portable active workstation is visually appealing, modern, and seamlessly integrates into a campus environment. A well-designed aesthetic enhances user experience by making the

workstation inviting and encouraging frequent use. Aesthetics also contribute to functionality by incorporating an ergonomic and intuitive design that balances form and practicality. Additionally, the visual appeal helps establish a sense of professionalism and innovation, reinforcing the workstation's role as a valuable campus resource. Therefore, aesthetics is assigned a weight of 0.05 on the evaluation criteria.

Viable Design Concepts

Design Concept 1: "ADA Accessibility" (Adriana Galofaro and Gianna Spasevski)

Design Concept 1 focuses primarily on the accessibility of the Outdoor Active Workstation. For example, anywhere there could be stairs, ramps are put in place instead. This is to accommodate anyone that uses a wheelchair or has difficulty walking up stairs. This design only includes ramps, since the stairs are not necessary. Another element included in this design is the various machinery included. The design includes benches, treadmills, stairmasters, and cable machines, in order to accommodate all kinds of workouts. All of the workout equipment is spaced out enough in order for people to get around and workout easily without hurting themselves or others. This design also includes a front desk for checking in and out, along with cubbies to store personal items and a seating area for people to wait if the workstation is already at maximum capacity (Gianna Spasevski).

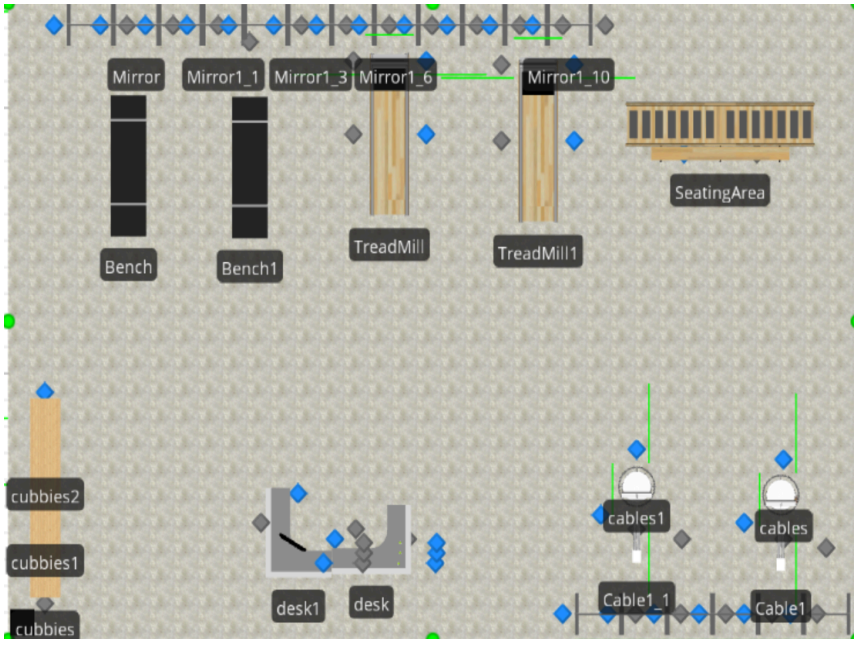


Figure 1 Design Schematic of 'ADA Accessibility'

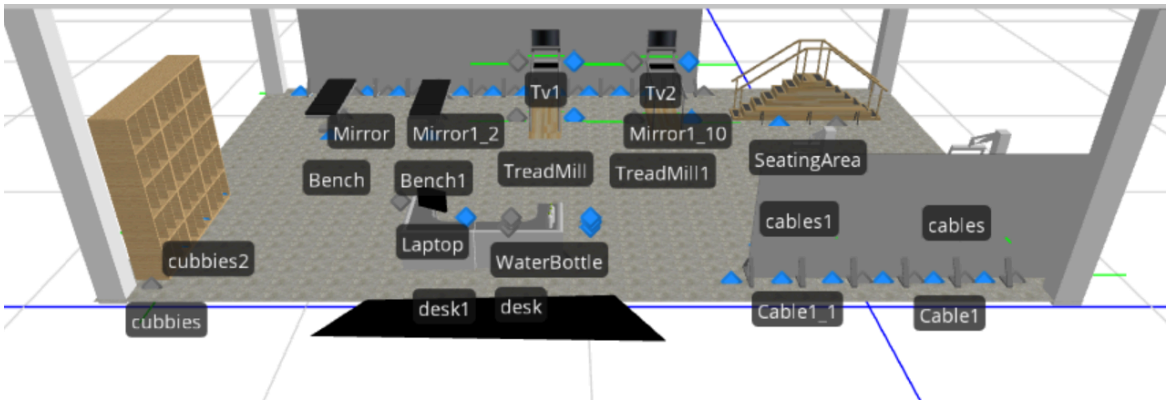


Figure 2: Design Schematic of 'ADA Accessibility' Front View

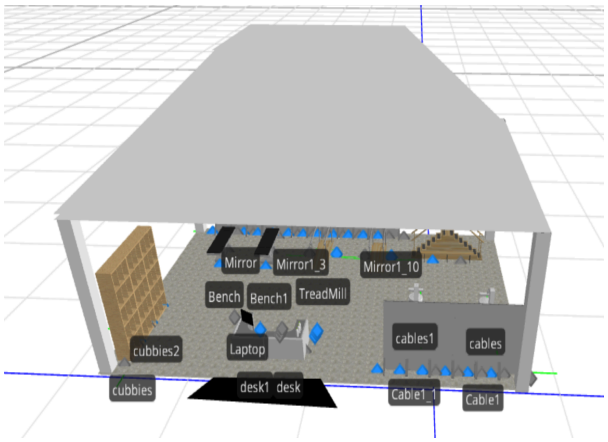


Figure 3: Design Schematic of 'ADA Accessibility' Entire View

Design Concepts Evaluation

Overall, this design concept ranked the worst coming in at 0.88 juxtaposed to the 1.30 Design Concept 2 received and 1.03 Design Concept 3 received (found in Appendix B). Even though the Design Concept did rank the worst, it obtains unique qualities none of the other decisions acquire. However, this low ranking does raise a respectful concern as to what the Design Concept is lacking. Unfortunately, this design focuses so heavily on accessibility that it does not leave much room to be concerned about features such as cost and environmental impact. There are very good design elements from this Design Concept that are going to be utilized in the final design.

Final Design Incorporation

This design concept will be featured in the final design prominently because of the importance of accessibility is the work and potential school campus environment. Everyday different people face different challenges and the active workstation should nor present any additional challenges

for those with disabilities to have to combat. The main components that are implemented from this design into the final design are the spacing between machinery, the ramp to enter in and out of the workstation and the addition of “friction” adhesions on any machine that has a potential risk of slipping.

Design Concept 2: “Energy Generation” (Arnav Bhatt and Josh Halpert)

Design concept two focuses on the energy generation for the Outdoor Active Workstation. This outdoor active workstation is a self-sustaining solution that combines productivity with physical activity while utilizing renewable energy sources. The design integrates solar panels mounted on the roof and a vertical-axis wind turbine (VAWT) to generate electricity. These complementary energy sources ensure continuous power supply, with the wind turbine providing additional energy during cloudy or low-sunlight conditions. The generated electricity is stored in a battery system and distributed through built-in power outlets, including USB ports, making the workstation practical for charging laptops, tablets, and other devices. The workstation also encourages physical engagement through various exercise mechanisms, such as pedal systems and adjustable resistance tools. These features not only promote health and wellness but can potentially contribute to energy generation, enhancing the overall sustainability of the design. The combination of solar and wind energy makes the workstation versatile and suitable for public parks, campuses, and recreational areas. By offering a conducive outdoor workspace while promoting an active lifestyle, this workstation stands out as an innovative, eco-friendly solution.

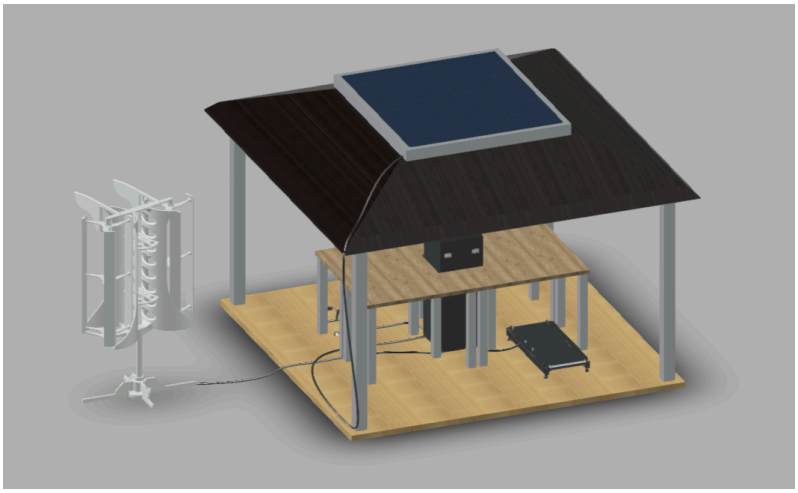


Figure 4: CAD Rendering of Energy Generation

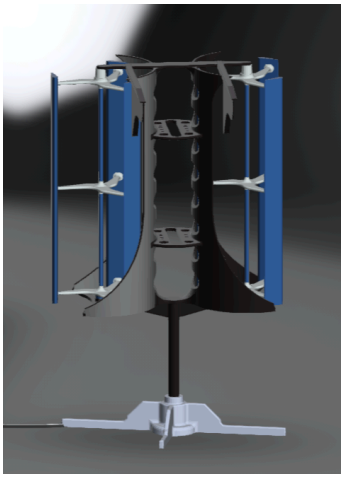


Figure 5: CAD Rendering of VAWT

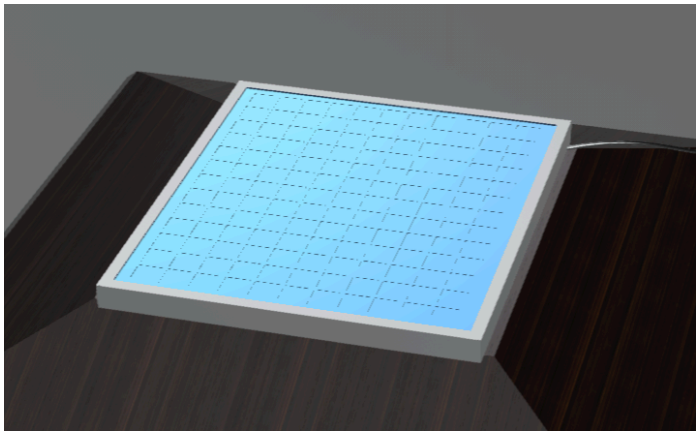


Figure 6: CAD Rendering of the Solar Panel

Design Concepts Evaluation

Overall, this design concept achieved a high assessment score of 1.30, indicating that it is very viable and functional as a solution. The use of renewable energy through both solar panels and wind turbines makes it an innovative, green design. Through the use of multiple sources of energy, the workstation ensures consistent power generation regardless of weather conditions, making it operational for public outdoor spaces. Having a variety of exercises incorporated encourages healthy living and maintains the aim of the concept of having an efficient, productive workplace. The inbuilt power points meet the utility requirements of clients to charge portable devices such as laptops, tablets, and cell phones while outside.

Despite its impressive score, others like cost and environmental impact may be developed even further to meet higher feasibility and affordability. Its possible high materials and installation costs may also hinder its scalability, while the environmental cost of having the parts created and sustained

altogether may be studied further. Also, portability may be an issue due to the summed-up weight and intricacy of the systems, although this can improve with modular design innovations. Nonetheless, the design's ability to balance function, sustainability, and user interaction places it as an outstanding concept with functional potential in public parks, campuses, and recreational areas. With a little adjustment for cost and eco-friendliness, this concept can be the model for futuristic, green outdoor offices.

Final Design Incorporation

This viable design will be highly used in the final design due to its innovative approach to self-sustaining, off-grid energy generation. By incorporating solar panels and a Vertical Axis Wind Turbine(VAWT), there is ensured constant, renewable energy, enabling the workstation to function under the majority of conditions. These sources of energy are a green alternative to powering the in-built power outlets, and consumers can power devices like laptops, tablets, and mobile phones without using mainstream electricity. The in-built battery system is crucial to storing the excess energy, and it enables power to be stored in conditions of low sun or low wind levels.

The use of such elements in the final product is due to their capacity to enhance productivity without wasting resources. The power outlets serve the fundamental use of powering devices in outdoor working areas, making the workstation functional and convertible for use in public parks, campuses, and public recreation. By uniting renewable energy sources and functional usability, this design both responds to sustainability and meets modern demands for outdoor working and learning environments.

Design Concept 3: “Waiting Room Feature/Renewable Energy” (Nate Cross and Ayush Desai)

Design concept three focuses on the waiting room for the Outdoor Active Workstation. The purpose of the design was to add an area for users to complete work while waiting for the Outdoor Active Workstation to become available. It includes 4 private work areas to complete work, as well as tables and chairs for socialization, and a receptionist desk for basic information and waiting lists, as seen in *figure 7*. The design also focused on renewable energy by adding energy storage and solar panels which will power outlets throughout the workstation allowing the workstation to be self-sufficient in terms of energy. Finally, the design focused on privacy by adding separate rooms to do work, separate rooms for the Active Workstations, and restrooms for the users.

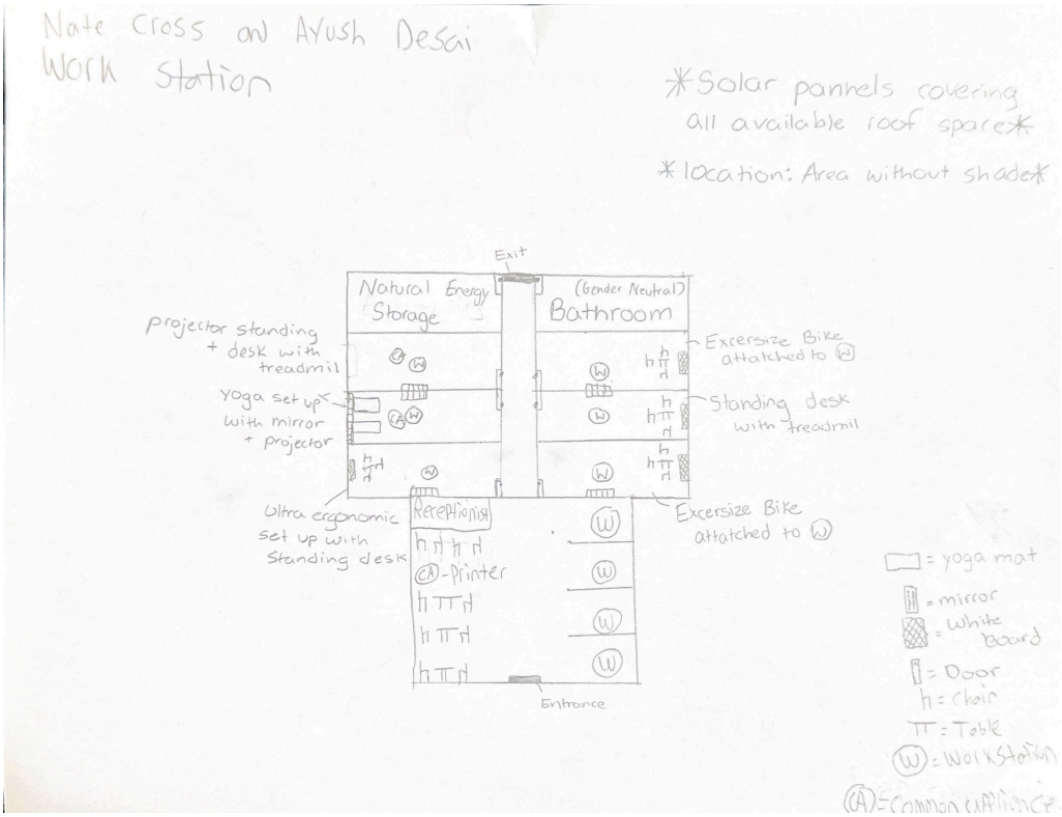


Figure 7: Hand Drawn Model of Design Concept 3

Design Concepts Evaluation

This design ranked at a mediocre 1.03 rating. It was the second best out of the three design components when rated. This proves that there were some effective aspects of the design. The main focus of this design according to the evaluation was a 2.00/3 on maintainability and aesthetics. Aesthetics and maintainability play crucial roles in the design of an outdoor active workstation for. A well-thought-out balance between form and function ensures that the workstation is not only visually appealing but also durable, user-friendly, and easy to maintain over time. Although it excelled in those aspects, it failed in others like safety, cost, and portability. Aspects of other projects will be needed to fulfil these criteria.

Final Design Incorporation

We will incorporate some parts of this design in the final design. Our viable design focused on the waiting room aspect of the requirements, as well as the sustainability aspect. Both aspects will be used in the final design. The waiting room will be essential for anyone waiting to use the active workstation as they will still be able to do work. This is an important productivity booster, and even though there will not be an active aspect to the waiting room, it will allow for the right mindset before users get their turn in the active workstation. Our design also used recyclable, environmentally friendly materials as well as renewable energy sources such as solar panels and

workout equipment generating storable energy. The materials are important as we need to be responsible with how we use the earth's resources, and we need to consider the organisms that share this space. The renewable energy sources allow for the workstation to be self sufficient.

Final Design Concept (Gianna Spasevski)

Overall Concept

The final design concept for the Outdoor Active Workstation was achieved by combining our three previously mentioned design concepts. The main design components primarily focus on accessibility for the user, along with environmentally friendly energy sources. The main design components are: solar panels, a wind turbine, various machinery, workstation tables, a waiting room, the structure, power outlets, and mirrors. The solar panels and the wind turbine will both be used to generate enough electricity to power the entire workstation in an environmentally friendly manner. The various machinery will give users a chance to try different workouts, while also being accessible to anyone, for example having a treadmill and also hand pedals will give everyone the chance to workout. The workstations will provide a surface to do school or office work. The structure will provide shade and protection from weather, it also houses the solar panels on top. The power outlets will allow users to plug in devices while they are working. Finally, the mirrors will prioritize safety by allowing users to view themselves while working out.

1. Solar Panels
2. Wind turbine
3. Various machines
4. Workstation tables
5. Waiting room
6. Structure
7. Power Outlets and Battery
8. Mirrors

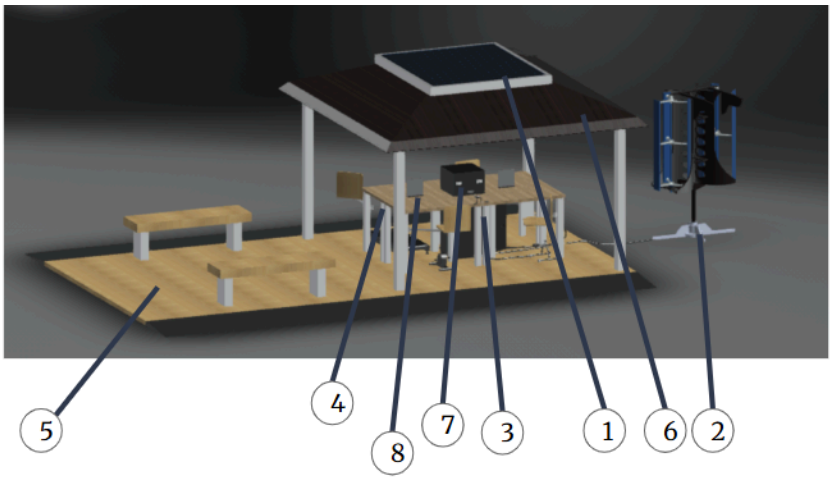


Figure 8: Labeled Schematic of Outdoor Active Workstation

Main Design Components

Solar Panels (Arnav Bhatt)

The solar panel system is a key component of the outdoor active workstation, namely to meet [OAW 1.4], which requires the generation of electricity to charge a laptop and phone for all four

users. For this purpose, high-efficiency monocrystalline solar panels are mounted on the workstation canopy, slightly sloped to maximize sunlight collection throughout the day. These panels are chosen based on their high power-to-space ratio, and hence they suit the semi-portable design as specified in [OAW 1.1]. The solar system also complies with [ENV 2.3], which mandates the use of renewable sources of energy. The energy harvested is routed through a charge controller to a lithium-ion battery system to ensure a constant supply of power in the event of low sunlight, addressing [FUN 2.3]. The entire system will also be weather-resistance compliant under [ENV 2.2] as the wiring components and panels will all be rated at IP65 or higher.

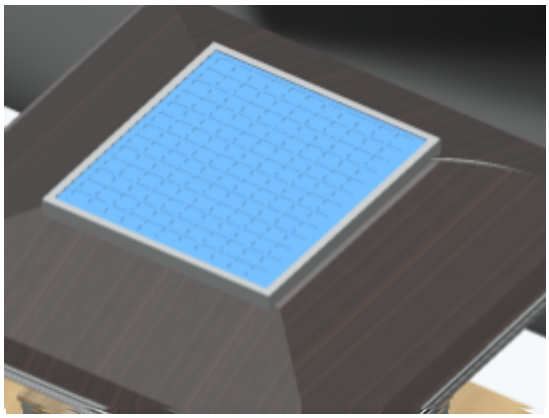


Figure 9: CAD Solar Panel

While the solar panel system does contribute to the upfront cost of the workstation—an estimated $1,200-$1,800 depending on size and storage requirements—the operational costs will be significantly reduced by the elimination of grid power or generators. This accommodation guarantees long-term sustainability and agrees with [OAW 1.7], which demands lasting, sustainable materials. Modular building allows panels to be mounted or removed easily using quick-release mounts, adhering to [POR 2.1] and [POR 2.4] for easy assembly and deployment in under 30 minutes. The use of solar power not only ensures correct device charging but also facilitates the ecological and utilitarian goals of the workstation.

Wind turbine (Nate Cross)

The wind turbine is a vital piece of the outdoor-active-workstation. Its main function is to provide renewable energy to the workstation, and it can be seen in *figure 10*. Wind turbines convert wind energy into electricity. The wind spins the blades, which turn a shaft connected to a generator. The generator then converts the rotational energy into electrical energy(*U.S. Energy Information Administration).* This will help fulfill requirements [OAW 1.4] and [ENV 2.3] which address a need for renewable energy in the workstation. The energy will be used to power exercise machines and chargers for devices within the workstation. This component addresses the environmental impact of the workstation by producing clean electricity without burning fossil fuels. This reduces air pollution and gas emissions, which helps fight climate change. The wind turbine also addresses the cost of the

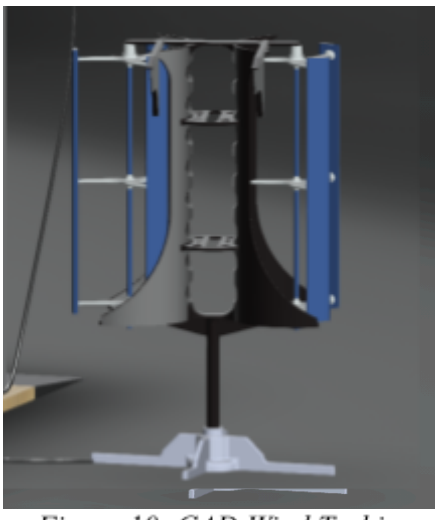


Figure 10: CAD Wind Turbine

workstation. Although it may be somewhat expensive, long-term the absence of electrical bills will pay for itself and even provide profits for the buyer.

Various machines (Adriana Galofaro)

Various machinery is a key aspect of the workstation to allow it to be considered ADA compliant ([OAW 1.5] The workstation shall comply with ADA accessibility standards). Outdoor active workstations, designed to promote physical movement and productivity, should incorporate a range of accessible machinery to fully meet Americans with Disabilities Act (ADA) requirements. The ADA mandates equal access and usability for individuals with disabilities. Standard fitness equipment or active workstation setups often prioritize able-bodied individuals, unintentionally excluding those who use wheelchairs, have limited upper or lower body strength, or live with sensory impairments. By incorporating different types of machinery such as arm-powered exercise bikes, adjustable-seating, foot pedals and treadmills it ensures all users will have at least one option of exercise.

Incorporating diverse machinery also reflects the understanding of disabilities, which views accessibility not as an afterthought but as a necessity. Outdoor active workstations that fail to meet ADA requirements risk not only legal repercussions but also social exclusion, preventing a large portion of the population from experiencing the physical and mental benefits of such spaces. By proactively integrating inclusive machinery, these workstations can become models of universal design, blending function and equity.This requirement also fulfills requirement 1.2 ([OAW 1.2] The workstation shall accommodate 4 users at once) since there will be an abundance of various machinery.

This machinery also serves to provide energy to the active workstation by harnessing the kinetic energy created by the user. The process is done by converting the mechanical motion of the user and turning it into stored energy. Some examples of this concept are generator systems, pneumatic systems or hydraulic systems. This is most commonly seen in active work machinery from the conversion of user work to power outputs such as chargers.

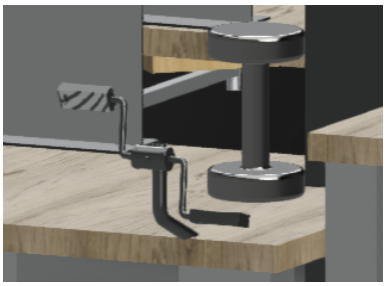


Figure 11: CAD Arm Pedals and Weight

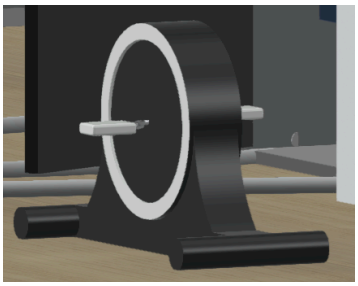


Figure 12: CAD Foot Pedal

Figure 13: CAD Treadmill

Workstation tables (Josh Halpert)

The workstation tables are the central feature of the outdoor active workstation system, designed with multi-functionality and user inclusivity in mind. Each table is engineered to accommodate four users simultaneously, which fulfills the requirement [OAW 1.2]. These tables are constructed primarily from recyclable and biodegradable materials, such as FSC-certified wood and aluminum, aligning with the workstation sustainability requirements [OAW 1.7], [ENV 2.1], [ENV 2.4]. The use of weather-resistant coatings and treatments ensures they meet IP54 environmental protection standards [ENV 2.2], making them suitable for year-round outdoor placement. To integrate with the other system components, one corner of each table is precisely cut to allow seamless placement of the energy cabinet, a requirement to satisfy [FUN 2.3].

Figure 14: CAD Adjustable Desk

Furthermore, each table is designed to stand at a height that enables standing work and physical activity, satisfying [FUN 2.4] and promoting ergonomic activity throughout the work session.

The workstation is also made to be accessible and inclusive. Following that, one of the workstation tables is designed to be ADA-compliant [OAW 1.5], with a lower height and without integrated leg exercise components to support wheelchair users. Each table includes integrated seating with adjustable chairs to comply with [OAW 1.6], allowing all kinds of users to comfortably engage with the workstation. While these custom tables may have higher manufacturing costs due to their unique features and sustainable material requirements, they are too specialized to source commercially. The added cost is counteracted by the long-term durability and environmental alignment of the materials used. While the tables might represent a substantial portion of the system's cost, their critical role in meeting key functionality, accessibility, and sustainability requirements makes them a worthwhile investment.

Waiting room (Gianna Spasevski)

The waiting room was added in order to fulfill the requirement [FUN 2.6], which makes it necessary to include a waiting room for when the workstation is at full capacity. The waiting room is the same size as the flooring of the workstation, but it has ramps built in on two of the

sides to make it accessible to users with disabilities. These ramps partially meet the requirement [OAW 1.5] by meeting ADA accessibility standards for the waiting room portion of the workstation. The waiting room includes two benches that hold 4-6 people, which fulfills the requirement [OAW 1.2] that states the workstation needs to hold at least 4 people. The addition of this waiting room will most likely be costly, considering the area of the hardwood floors are being doubled.

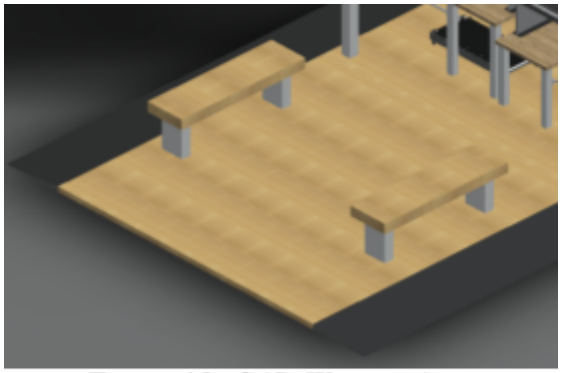


Figure 15: CAD Waiting Area

Structure (Ayush Desai)

The structure of the workstation design is very important for ensuring that requirements are met. This includes [OAW 1.1], [OAW 1.2], [OAW 1.5], [FUN 2.6], [POR 2.4], and [OAW 1.5]. [OAW 1.1] and [POR 2.4] is fulfilled through making the workstation able to come apart into many pieces. This will allow for easy setup and removal of the workstation in different locations by a 5 person team.. [OAW 1.2] is met through ensuring that the structure of the workstation is large enough to comfortably accommodate 4 users and machines for them to exercise on, as well as desks for them to do work on. The structure also includes a designated waiting area, with seating and tables to fulfill requirements [FUN 2.6]. [OAW 1.5] is met through the design of the waiting area which includes ramps to accommodate wheelchair users, as well as grip inducing stickers on the floor to ensure users do not slip or fall. Although some of these structural aspects may be costly to add, they are needed as they play a key role in balancing maintainability, Durability, Portability, and Aesthetics.

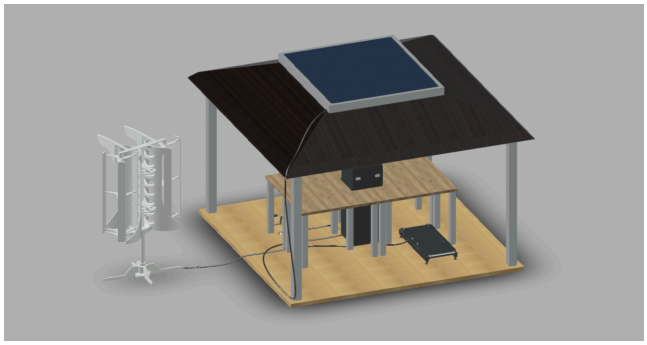


Figure 16: CAD Structure of the Workstation

Power Outlets and Battery (Josh Halpert)

The power outlets and battery are essential components in the outdoor active workstation. Together, they fulfill requirements [OAW 1.4], which ensures that each user can reliably power their devices, and [FUN 2.3], which says the workstation needs a consistent energy output through power storage and regulation. The workstation pulls its energy from solar panels, a wind turbine, and the devices within it, aligning with [ENV 2.3] by using renewable sources.

The energy system includes a high-capacity lithium-ion battery pack that stores power from the energy modules. This battery feeds into standard power outlets, making it easy for users to charge their laptops and phones. While the battery system is one of the more costly parts of the design, it plays a key role in ensuring the workstation can run at all hours, especially when sunlight, wind, or user-generated energy is limited. On the other hand, the workstations' renewable energy sources offer a low-cost energy solution that reduces environmental impact and operating costs. Overall, the design balances cost, sustainability, and usability.

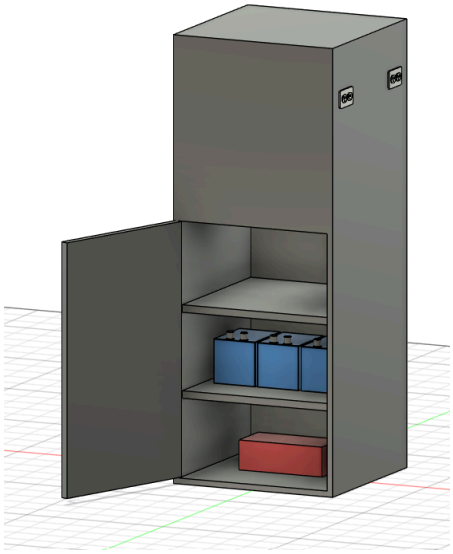


Figure 17: CAD Battery System

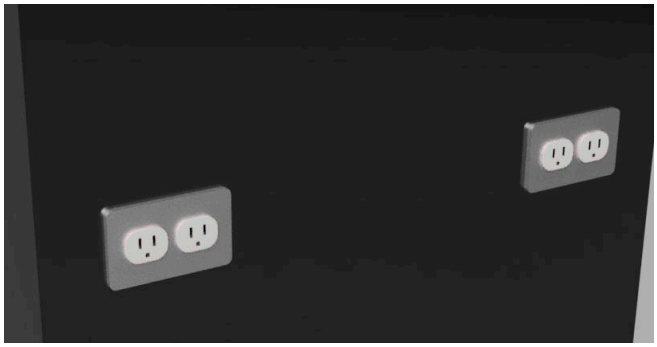


Figure 18: CAD Outlets

Mirrors (Arnav Bhatt)

Mirrors are included in outdoor active workstation design to meet [FUN 2.1], requiring reflective surfaces upon which the users can observe themselves and view their posture throughout exercise. Mirrors are mounted in front of or beside workstation units at a variable angle to enable users to self-correct form and align ergonomically. This feature is especially important to uphold good posture both in the exercise and desk usage, for long-term well-being and health of the user. The mirrors themselves will be constructed of polycarbonate or acrylic shatter-resistant, light material to attain longevity, resistance to weathering ([ENV 2.2]), and safety outdoors.

Adding mirrors has almost no effect on the cost in total. Acrylic mirrors are not expensive and can be mass-produced in standardized sizes, where material costs will be kept at a minimum. They do not require complex installation, which permits the semi-portability of the system according to [OAW 1.1]. Additionally, the mirrors will be fitted with adjustable brackets to accommodate different users of different heights, as required by [OAW 1.6], which insists that all devices on the workstation should be adjustable. Though they are not key cost drivers, mirrors are critical to the level that they affect the functionality of the workstation as well as user experience in conformity with both ergonomics and inclusivity aims.

Figure 19: Mirrors placed in the workstation

Final Design Assessment

The final Outdoor Active Workstation (OAW) design is fully compliant with the system-level and subsystem-level specifications established in the project design statement and Appendix A. This analysis addresses all of the technical and functional aspects of the workstation, demonstrating how our cross-disciplinary approach to design creates a solution that is ecologically sustainable, physically accessible, ergonomically correct, and technologically autonomous.

The semi-portability of the workstation, as described in [OAW 1.1], was achieved through careful weight analysis and modular CAD modeling. Each significant component, from solar panels to workstation tables, was maintained under 200 pounds and equipped with quick-release mechanisms for rapid assembly and disassembly. Appendix D includes exploded assembly diagrams verifying this ability, as well as Fusion weight calculations illustrating that a five-member installation team can safely transport and assemble the entire workstation in less than 30 minutes. This satisfies various portability specifications, including [POR 2.1] through [POR 2.4].

Regarding user capacity and simultaneous functionality, the design accommodates four users simultaneously, satisfying [OAW 1.2]. Each user station includes a desk, chair, electrical outlets, mirrors, and a minimum of two low-intensity exercise forms, e.g., treadmills, hand pedals, or foot generators. This variety enables each user to meet the activity requirement [OAW 1.3] yet

stay productive. We also incorporated the learnings in our evaluation criteria—where safety, maintainability, and durability were of utmost importance—and opted for materials and spatial layout that would reduce equipment failure and repeated use.

Our workstation is completely energy-independent. Through the integration of rooftop solar panels, a vertical-axis wind turbine (VAWT), and user-initiated kinetic energy conversion systems, the OAW generates and stores enough electricity to charge four laptops and four phones simultaneously, as per [OAW 1.4] and [FUN 2.3]. Any surplus power is stored in a lithium-ion battery pack, which delivers stable output even in low-light or low-wind conditions. CAD renderings show where every source is located, and internal calculations (included in the energy analysis section) demonstrate how production comfortably surpasses the 880W/hour level of demand.

ADA accessibility was a core design priority. We had great regard for [OAW 1.5] compliance not only through ramps and traction-enhancing surfaces, but also through universally accessible equipment choice. Hand pedals and dumbbells enable individuals with lower-body impairments to utilize the system regardless. One of the four user stations was designed specifically to accommodate a wheelchair user with a lowered desk and generous clearances. Mirrors were mounted at variable angles to help all users assume correct posture and observe exercise form. Every aspect, from the adjustable chairs to the modular tables, was designed with user adaptability in mind, ensuring compliance with [OAW 1.6].

Receptive, durable material forms the workstation's physical infrastructure, in line with [OAW 1.7] and environmental codes [ENV 2.1–2.4]. Accoya wood, FSC certified, chosen for weather resistance and ecologic capabilities, forms most of the structure surfaces, while recycled steel is used in supportive frameworks. These choices are also in line with our cost and environmental evaluation criteria, reducing long-term maintenance needs and allowing the design to be sensible for routine redeployment. Independent research confirms that these materials maintain structural integrity even after prolonged exposure to wind, water, and UV light. Additionally, they pose no toxic risk to indigenous wildlife, confirming state and OSHA compliance. For even greater versatility, the workstation has retractable tarp covers that can be rolled down in adverse weather like rain or snow. These tarps are protective without compromising air circulation, making the system durable in a wider range of outdoor environments.

Other basic features enhance user experience and usability. The workstation desks are carefully angled for ergonomic access, with one corner being used for the energy cabinet and the other for wheelchair users. Waiting space allows usability during peak usage, allowing users to get back to work before it is their turn. Power sources are within easy reach, weather-protected in enclosures. Shatter-resistant acrylic mirrors help posture alignment, as well as offer visual feedback during

exercise. Cumulatively, these enhancements transform the workstation from a bare form into an interconnected, inclusive platform for productivity, mobility, and well-being.

This extensive assessment confirms that every aspect of the Outdoor Active Workstation was designed with integrated system functionality in mind. Each subsystem is complimentary, forming an inclusive solution that exceeds expectations in sustainability, accessibility, power efficiency, and the welfare of users.

Final Recommendation

We strongly recommend the uptake and installation of the Outdoor Active Workstation in campuses, public spaces, and outdoor commercial areas. This is founded on the workstation's ability to satisfy growing needs for ergonomic, sustainable, and accessible working environments in a way that is both technologically innovative and economically beneficial in the long term.

As compared to traditional workplaces, which keep productivity separate from physical health and are grid-dependent, our answer combines both arenas within a wholly self-supplied, cost-effective building. Tri-source power utilizing solar panels, wind turbines, and user-supplied kinetic energy provides full capacity irrespective of the grid. Having a lithium-ion battery system as an integrated unit ensures the workstation operates at the same rate irrespective of ambient conditions. This capability not only preserves long-term energy costs but also transforms the workstation into a climate-resilient infrastructure champion.

The design excels more than most rivals in one aspect: inclusive functionality. From the start, our personnel concentrated on total ADA compliance. All hardware and seating are height-adjustable, mirrors are angled for users of different heights and abilities, and an individual workstation is wheelchair accessible. The hand and foot-powered exercise equipment guarantees all users, regardless of physical capability, have the ability to move healthily while working. These accessible choices make the OAW usable and an attractive, equitable space for all.

Visually, the workstation balances beauty with strength. The materials, FSC-certified wood and recycled steel, were chosen for their clean aesthetic and longevity. The modern, understated design seamlessly fits into outdoor green spaces without disrupting ecosystems. In addition, to enable uninterrupted usage year-round, the workstation also comes equipped with retractable weather-resistant tarps that can instantly be deployed for users' defense against rain, snow, or strong winds. This contributes to the system's usability throughout the seasons, decreasing downtime and proving itself to be a reliable investment for institutions irrespective of the weather. From the built-in roof-mounted solar panels to the clean, minimalist lines of the workstation tables, all details are designed to attract users while also enabling long-term use and easy maintenance. These design choices reflect the prioritizations in our evaluation matrix, particularly in maintainability, aesthetics, and environmental footprint.

From an engagement and user flow standpoint, the workstation is complemented by an integrated waiting room. This feature, unmatched among comparable systems, allows users to remain productive even when workstations are in use. It has seating and a desktop area and is accompanied by ramps, offering unbroken ADA access. This space supports the cognitive and organizational needs of users, making it especially valuable in high-traffic campuses or public park settings where usage may shift.

Outdoor Active Workstation is, at heart, not a design fix but rather a podium for long-term sustainability, learning, wellness, and innovation. It makes hybrid and adaptive workplace transitions possible via the facilitation of movement and outdoor productivity. It can scale based on a modular format, and energy autonomy provides cost effectiveness alongside resilience with regard to growing utility rates or infrastructural bottlenecks.

We call upon Binghamton University and all other institutions to deploy the Outdoor Active Workstation on campus on an immediate pilot basis. The scalability, constructive environmental impact, and wellness benefits of the system far outweigh the moderate up-front cost of deployment. With its harmonious blend of form, function, and sustainability, the Outdoor Active Workstation has the potential to be a model flagship in the move towards healthier, more sustainable outdoor workspaces.

References

American Psychological Association. (2023). *Work in America: Workplace health and well-being*.

Carroll, M. (2023, February). *Health & Fitness Association's*. Retrieved from 2023 Safety & Health Tips for Fitness Businesses:

Engineering Design Division. (2025). *2025 Spring project descriptions: Conceptual design projects*.

Environmental Health & Safety department. (n.d.). *University of Pittsburgh's Office of Public Safety & Emergency Management*.

Forest Stewardship Council. (n.d.). *What the FSC labels mean*. Retrieved February 20, 2025, from

Halpert, J. (2025). *Energy Generation*.

National Fire Protection Association (NFPA). (n.d.). *National Fire Protection Association's*.

New York State Department of Labor (NYSDOL). (2024, August 5). *Protecting outdoor workers from extreme heat (P198)*.

New York State Department of Labor (NYSDOL). (2025). *Protecting outdoor workers from extreme cold (P196)*.

New York State Department of Labor (NYSDOL). (2025). *Protecting outdoor workers from extreme precipitation (P195)*.

Occupational Safety and Health Administration. (n.d.). *U.S. Department of Labor*.

Schuch, F. B., Vasconcelos-Moreno, M. P., Borowsky, C., Zimmermann, A. B., Rocha, N. S., Fleck, M. P., & Rocha, N. S. (2014). Exercise and severe major depression: Effect on symptom severity and quality of life at discharge in an inpatient cohort. *Journal of Psychiatric Research, 55*, 1–6.

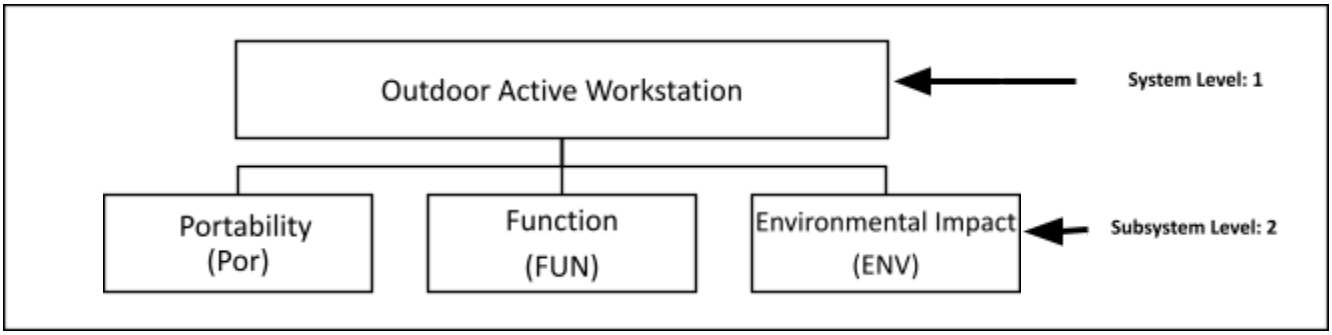
U.S. Energy Information Administration (EIA). (2023, December 27). *Electricity generation from wind*.

Vasconcelos, J. C., Silva, L. G. R., Santana, J. M., Lima, L. H. O., Magalhães, J. P. R., Costa, R. M., & Sousa, C. V. (2023). High-intensity interval training and mental health in adults: A systematic review and meta-analysis. *Journal of Translational Medicine, 21*(1), 453.

Appendices

Appendix A: Requirements

Requirements Structure



Justifications for Evaluation Criteria

Environmental Impact: The environmental impact is important because if the workstation is outdoors, then it should not disturb the wildlife in the area. Also if the workstation is being used as a power source, then the environmental impacts for the generation of that electricity should also be monitored.

Maintainability: The Workstation will need to be easily maintained so we need to consider using long-term materials that are durable and resistant to the elements. We also need to make sure each part of the workstation is easily accessible and replaceable in case of fault or failure.

Durability: The durability of the workstation is very important due to the fact that it must be portable. For all of the parts of the workstation to remain of the utmost quality, they must be made of good enough quality to withstand usage. Also, due to the fact that the workstation is outside it must withstand the weather conditions.

Cost: The cost of the workstation must be low enough to manufacture many products to place them throughout universities. It is expected that the cost will still be somewhat high, as it is a big piece of technology.

Portability: The workstation is required to be semi-portable such that it can be moved when necessary, but not by a student. This will allow for the workstation to be moved to different locations for a change of scenery.

Safety: Engineering ethics require the use to make safe products, therefore, safety is a big factor in designing the workstation.

Project Requirements

Definitions

Electricity: Electrical energy is generated using active and passive methods.

Semi-portable: Does not connect to other structures during use. It can be easily moved and placed around the Binghamton University main campus by staff when desired. Note it should not be movable to students.

User: Adult with belongings typical for a college student who is actively using the workstation.

ADA-compliant: Meets the Americans with Disabilities Act standards for accessibility.

FSC materials: sourced from responsibly managed forests that meet environmental sustainability standards set by the Forest Stewardship Council (FSC).

System Requirements

[OAW 1.1] The workstation shall be semi-portable.

[OAW 1.2] The workstation shall accommodate 4 users at once.

[OAW 1.3] The workstation shall allow each user to engage in at least 2 types of low-intensity exercises in an hour.

[OAW 1.4] The workstation shall generate electricity to power a laptop and a phone for each user.

[OAW 1.5] The workstation shall comply with ADA accessibility standards.

[OAW 1.6] The devices within the workstation shall be adjustable.

[OAW 1.7] The workstation shall be constructed from durable, sustainable materials.

Subsystem Requirements

[ENV 2.1] The workstation shall be made from at least 30% recyclable or FSC-certified materials. {OAW 1.7}

Using at least 30% recyclable or FSC-certified materials in workstation construction ensures environmental sustainability and responsible resource management. Recyclable materials reduce waste and lower the carbon footprint. This approach minimizes environmental impact and supports long-term ecological balance (FSC),n.d.)

[ENV 2.2] The workstation shall be weather-resistant with an IP54 rating or higher. {OAW 1.7}

The durability of the workstation depends on its ability to withstand outdoor weather conditions. (National Fire Protection Association (NFPA), n.d.).

[ENV 2.3] The workstation shall incorporate renewable energy sources such as solar, kinetic, or wind power. {OAW 1.4}

> The active workstation must use clean energy sources to avoid contributing to air pollution and support environmental sustainability. (New York State Department of Labor (NYSDOL), n.d.)

[ENV 2.4] The workstation shall be constructed using materials that do not negatively impact local wildlife.

> All materials must be non-toxic, biodegradable, or recyclable to prevent harm to ecosystems. Outdoor workstation coatings and finishes must be free from pollutants that could leach into soil or waterways. (New York State Department of Labor (NYSDOL), n.d.)

[FUN 2.1] The system shall have reflective surfaces for users to view themselves.{OAW 1.6}

> The outdoor active workstation must allow users to ensure their posture is correct while using the devices. (Carroll, 2023).

[FUN 2.2] The system shall have adjustable surfaces on every machine. {OAW 1.6}

> The surfaces need to be adjustable for users of different heights so they can have reduced strain. (Carroll, 2023).

[FUN 2.3] The workstation shall include an energy storage system to provide consistent power output. {OAW 1.4}

> The active workstation requires a way to store energy generated from renewable sources.

[FUN 2.4] The system shall provide constant ability to exercise while doing work.{OAW 1.3}

> Constant exercise while working promotes brain focus and attention. (Environmental Health & Safety department, n.d.).

[FUN 2.5] The system shall meet New York State's electrical requirements for outdoor establishments. {OAW 1.4}

> Any wiring within the active workstation must comply with the regulations by NYS in regards with the depth they are buried. (Occupational Safety and Health Administration (OSHA), n.d.).

[FUN 2.6] The system shall have a waiting area for people when the workstation is at full capacity. {OAW 1.2}

If there is a queue to use the workstation, then people should have the ability to wait to use the workstation if they would like to use it, compared to working in a regular environment.

[POR 2.1] The machines within the workstation shall be able to be taken apart. {OAW 1.1}

The machines need to be able to be moved around so the workstation can be portable.

[POR 2.2] The frame of the workstation shall be able to be moved by 5 people.{OAW 1.1}

The frame of the workstation should be able to be moved by a group of five people without too much effort.

[POR 2.3] Elements in the workstation shall be at most 200 lbs to be easily transportable. {OAW 1.1}

The machines need to be made out of lightweight materials to make it easy for staff to transport it if needed.

[POR 2.4] The workstation shall allow for setup within half an hour in different outdoor environments. {OAW 1.1}

This ensures users can efficiently deploy the workstation without specialized tools or excessive effort, making it practical for dynamic outdoor use.

[POR 2.5] The workstation shall obtain a various amount of machines to accommodate any individual who needs ADA requirements. {OAW 1.5}

This ensures that people with disabilities can also work in the workstation. This ensures that everyone can use the workstation to some extent.

Appendix B: Evaluation Matrix

		Design Candidate 1		Design Candidate 2		Design Candidate 3	
Criteria	**Weighting Factor** (W)	**Numerical Value** (NV_1)	**Weighted Value** $(W \times NV_1)$	**Numerical Value** (NV_1)	**Weighted Value** $(W \times NV$	**Numerical Value** (NV_3)	**Weighted Value** $(W \times NV_3)$
Environmental Impact	0.20	0.00	0.00	0.00	0.00	0.67	0.13
Maintainability	0.20	1.67	0.33	1.67	0.33	2.00	0.40
Durability	0.15	1.33	0.20	1.33	0.20	1.33	0.20
Cost	0.15	0.00	0.00	0.00	0.00	0.00	0.00
Portability	0.15	0.33	0.05	0.33	0.05	0.33	0.05
Safety	0.10	2.00	0.20	2.00	0.20	1.50	0.15
Aesthetic	0.05	2.00	0.10	2.00	0.10	2.00	0.10
Total	1.0		0.88		1.30		1.03

Table 1: Table with the 3 Design Candidates and their weight as well as the weight value of the Viable design Concepts

Appendix C: Implementation

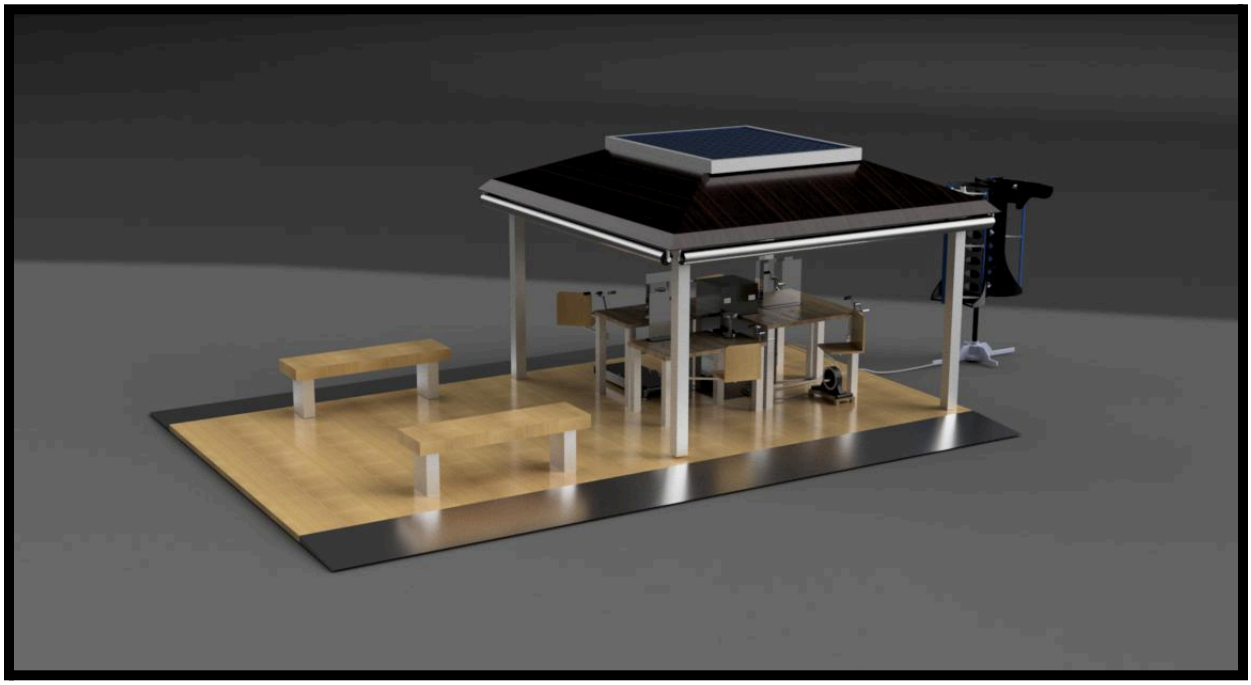


Figure 1: Full model of the Outdoor Workstation, including all of the main design components

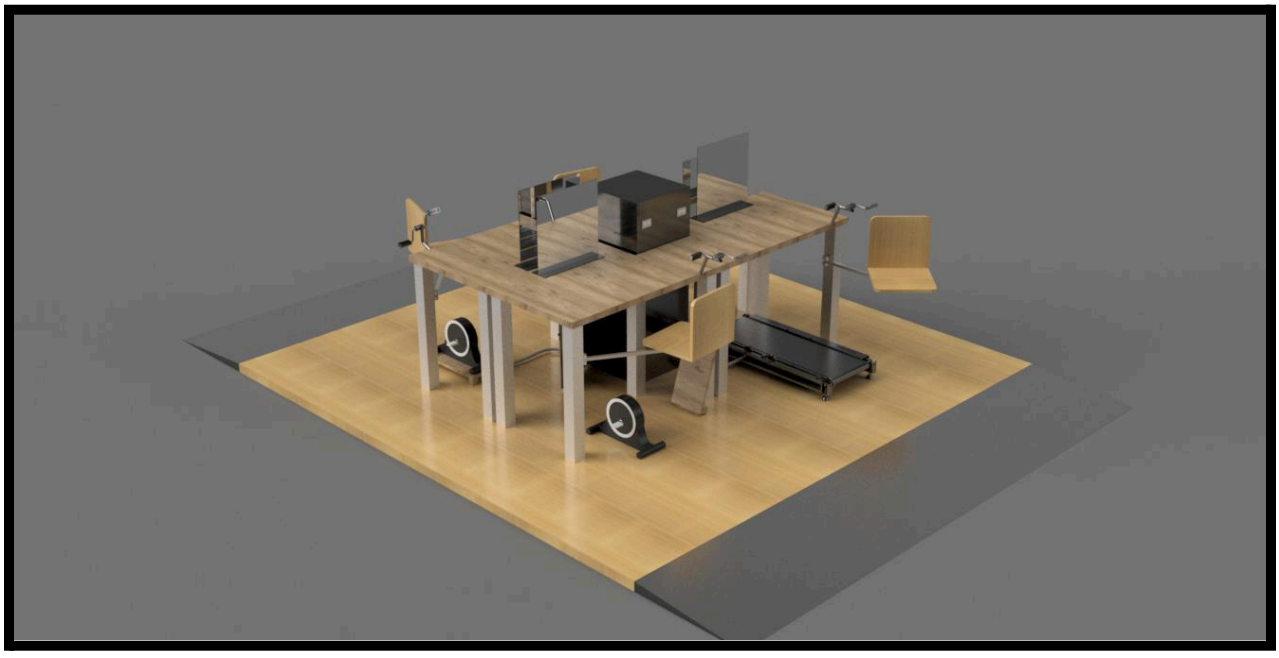


Figure 2: Unobstructed view of the Workstation Tables, Machinery, and Chairs

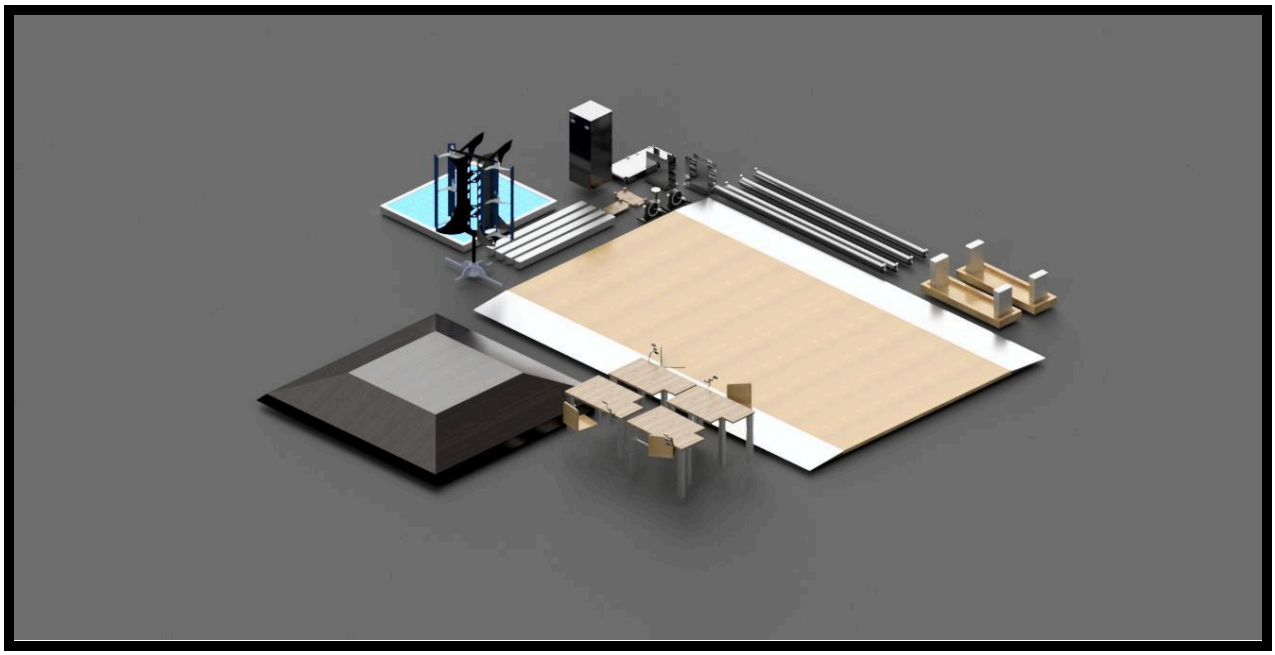


Figure 3: Exploded Assembly of the full Outdoor Active Workstation

Appendix D: Verification of Requirement

System Requirements

Requirement:
[OAW 1.1] The workstation shall be semi-portable.

Verification (Gianna Spasevski):

The exploded assembly shown in *Figure 1* displays how the workstation comes apart completely. Each piece of the assembly can be taken off and transported separately. *Figure 2* and *Figure 3* both show examples of components being weighed in Fusion. These couple of examples prove that every piece can be measured for its weight and make sure that all the components are light enough for the entire Outdoor Workstation to be disassembled by 5 people.

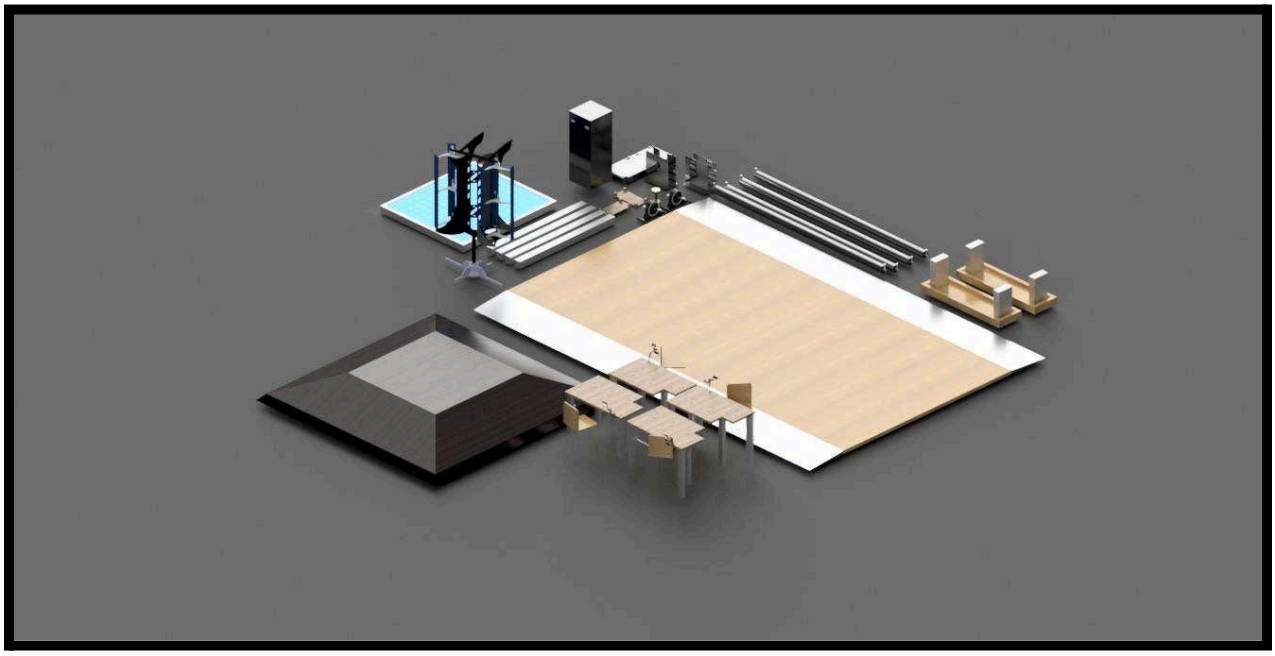


Figure 1: Full Exploded Assembly of the Outdoor Workstation

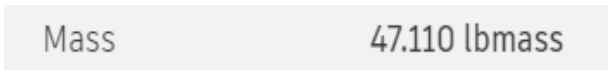


Figure 2: Mass of a Dumbbell

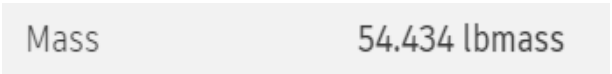


Figure 3: Mass of the Treadmill

Requirement:
[OAW 1.2] The workstation shall accommodate 4 users at once.

Verification (Gianna Spasevski):
This requirement is verified by building our design in CAD. *Figure 4* shows two of the workstations, which contain two desks, two chairs, two mirrors, and two kinds of equipment, one for each workstation. *Figure 5* also contains the same components.

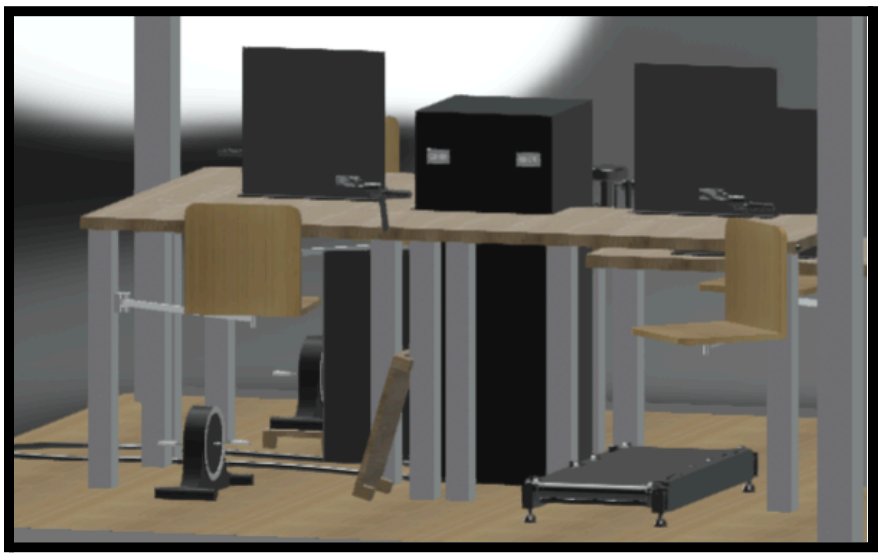


Figure 4: Workstation with Pedals and Workstation with Treadmill

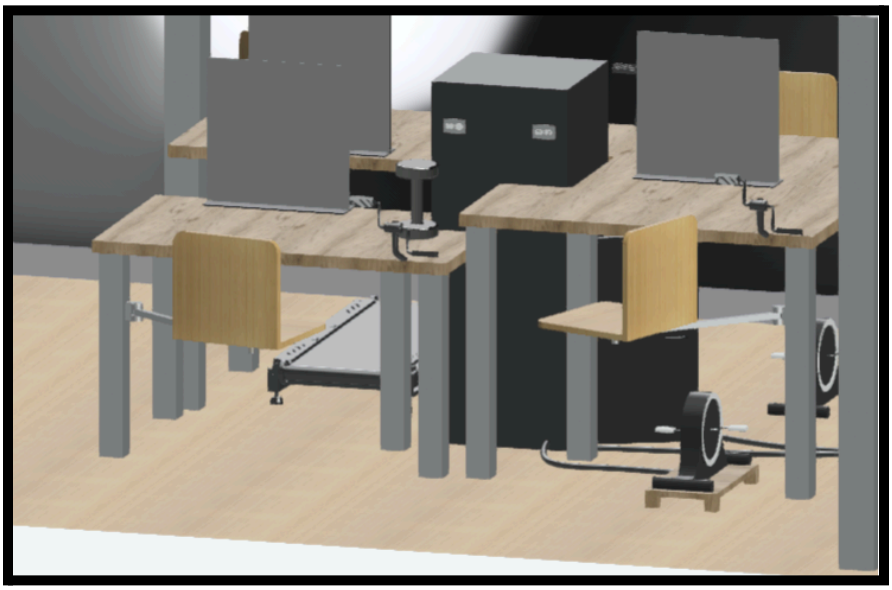


Figure 5: Workstation with Pedals and Workstation with Hand Pedals

Requirement:
[OAW 1.3] The workstation shall allow each user to engage in at least 2 types of low-intensity exercises in an hour.

Verification (Nate Cross):
This requirement is verified by including a minimum of 2 different types of exercise machines within the workstation. *Figure 6* shows an image of a dumbbell located in the workstation. This will allow the user to partake in several forms of strength exercise, such as dumbbell curls, lateral raises, and overhead presses. *Figure 7* shows an image of bike pedals under and on top of a desk. This will allow the user to partake in 2 different forms of aerobic exercise while working. The users always have access to this equipment, allowing them to engage in aerobic exercise and strength exercise at the workstation.

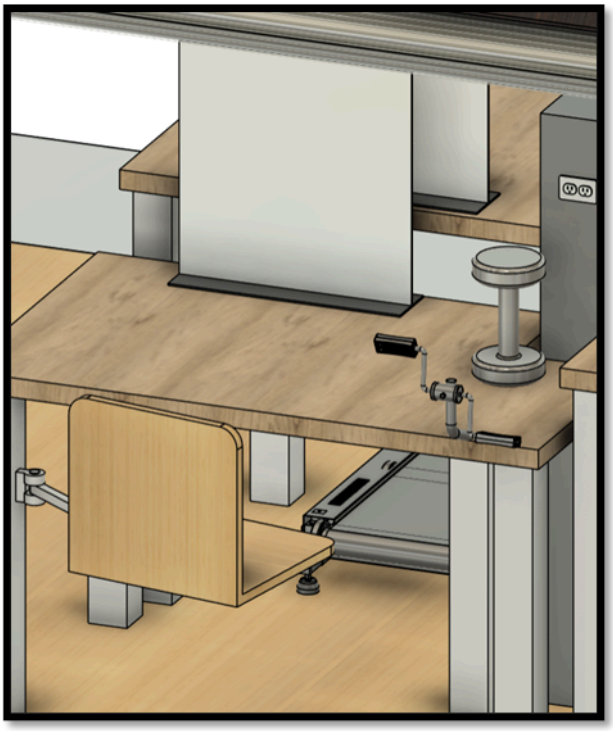


Figure 6: Dumbbell Located in the Workstation

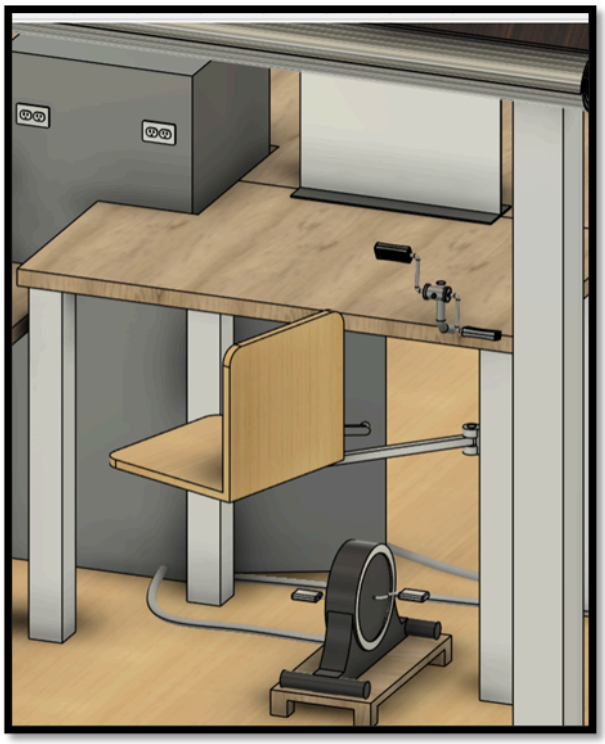


Figure 7: Bike Pedals for Hands and Feet

Requirement:
[OAW 1.4] The workstation shall generate electricity to power a laptop and a phone for each user.

Verification (Josh Halpert):
This requirement is verified by calculating the energy output of multiple energy sources, as described in a study by Joshua Halpert (2/28/25). The study identifies the maximum energy demand to be 880W/hour (four laptops and four phones) and evaluates internal energy sources such as stationary bikes (240W/hour), ellipticals (400W/hour), treadmills (240W/hour), and stepper machines (25.74W/hour), as well as external sources like solar (1.5kWh/day), wind (400W/hour), and outdoor power outlets (1.6–2.4kW). Together, these sources provide more than enough electricity to reliably meet the demand, therefore verifying that the workstation can fulfill the requirement.

Requirement:
[OAW 1.5] The workstation shall comply with ADA accessibility standards.

Verification (Arnav Bhatt):
This requirement is verified by the CAD model which makes sure that people with disabilities are able to access the workstation and use the workstation. The design of the workstation includes ramps at all entrances and exits making sure that people with wheelchairs have access to the workstation, as seen in *Figure 8*. The workstation also has enough room to ensure that people with wheelchairs are able to go around the workstation. Another way that the workstation complies with ADA accessibility standards is with the addition of a workstation that is meant for people with disabilities. As shown in *Figure 9*, there is a workstation that has a shorter desk where people with wheelchairs are able to place their wheelchairs and utilize the workstation. This workstation also has a hand bike which ensures that people with disabilities are also able to partake in low-intensity exercise.

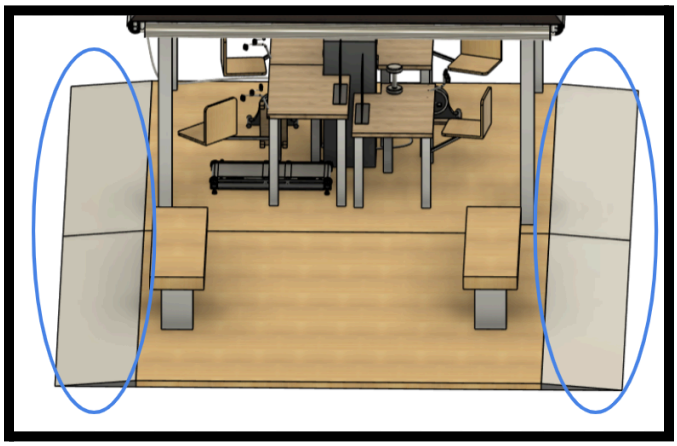


Figure 8: The ramps that lets people with wheelchairs access the workstations

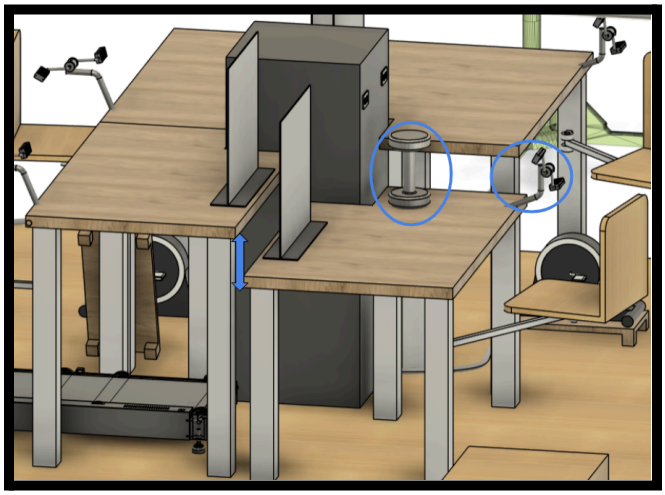


Figure 9: The workstation for people with disabilities, showing the lowered desk, dumbbell, and hand bikes.

Requirements:
[OAW 1.6] The devices within the workstation shall be adjustable.

Verification (Josh Halpert):
This requirement is verified with sub requirement [FUN 2.2] as it provides stricter requirements regarding the devices being adjusted. Since that requirement is verified this one is too.

Requirement:
[OAW 1.7] The workstation shall be constructed from durable, sustainable materials.

Verification (Adriana Galofaro):
This requirement will be met by using sustainable and durable materials on the parts built on CAD Software. An itemized list of every material used in the CAD Assembly is depicted below, in *Figure 10,* in the Bill of Materials. From this list of equipment the materials from each part can be easily compared to similar materials used on the market, if the material is not already stated.

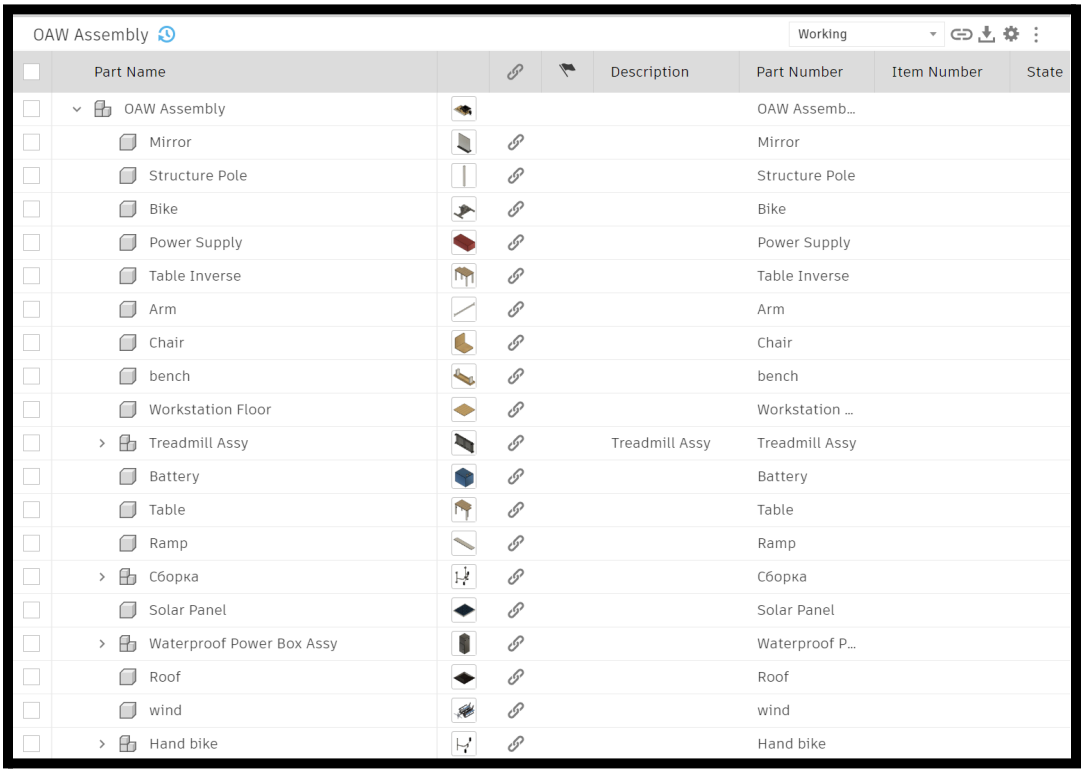
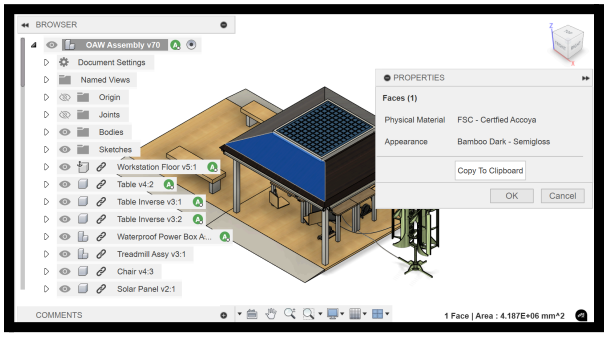


Figure 10: CAD Assembly Bill of Materials

Subsystem Requirements

Requirement:
[ENV 2.1] The workstation shall be made from at least 30% recyclable or FSC-certified materials. {OAW 1.7}

Verification (Ayush Desai):
This requirement is verified by specifically designating building materials for this workstation. A custom material FSC-Certified Accoya wood is used for a majority of the build. This acetylated wood has a density of .005g/mm^3 and is weather resistant. For the non wood components of the build, Recycled steel is used. It is very similar to traditional steel with a density of .008g/mm^3, however is more compliant with Environmental sustainability standards. These parts can be seen in *Figures 11 and 12.*



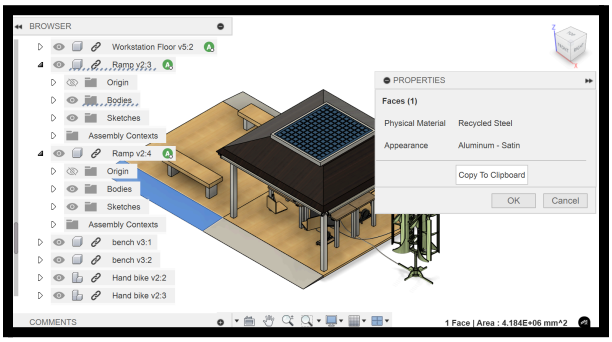


Figure 11 & 12 : Properties of components in the workstation

Requirement:
[ENV 2.2] The workstation shall be weather-resistant with an IP54 rating or higher. {OAW 1.7}

Verification (Ayush Desai) :

This requirement is verified through the analysis of public experiments on the durability and longevity of Accoya wood. A 10-year field study conducted in Karditsa, Greece, evaluated the long-term durability of FSC-certified Accoya wood using ASTM D1758-02 standards for ground stake testing. The study revealed that acetylated pine wood (Pinus radiata) stakes, with a 20% acetyl weight gain, remained completely intact and showed no visual decay (decay rating: 0) after a decade of exposure in ground contact. Despite a reduction in mechanical properties—modulus of elasticity (MOE) and modulus of rupture (MOR) decreased by 32.8% and 29.6%, respectively—there was no evidence of fungal attack, indicating that the material's structural integrity was largely preserved. The acetylation process significantly reduces moisture absorption and pore size, effectively minimizing the ingress of dust, dirt, and water. Over the full test period, the wood remained dimensionally stable with no cracking, swelling, or biological infestation, indicating a level of protection that aligns with or surpasses the criteria defined by an IP54 rating—namely, limited dust ingress without harmful deposits (IP5X) and protection from water splashes from any direction (IPX4). Given these findings, it is reasonable to verify that FSC-certified Accoya wood meets or exceeds the environmental resistance associated with IP54 classification, making it highly suitable for applications requiring sustained exposure to moisture, dust, and fluctuating outdoor conditions.

Sandberg, D., Kutnar, A., & Mantanis, G. (2020). Wood modification technologies – a review. *iScience*, *12*(8), 1638. https://pubmed.ncbi.nlm.nih.gov/32717892/

Requirement:
[ENV 2.3] The workstation shall incorporate renewable energy sources such as solar, kinetic, or wind power. {OAW 1.4}

Verification (Adriana Galofaro):
This requirement will be verified by ensuring that the only machines that will be used in the workstation are equipment that either do not use an energy source or can be powered by renewable energy sources, as seen in *Figures 13 and 14*. This is further proved with the inclusion of the solar panels on top of the workstation, the wind turbine located right outside of the workstation which is responsible for all of the energy input. According to Energy STAR (U.S. Environmental Protection Agency, n.d.), small business can become a partner by saving 30% of energy; on average solar panels are 21% efficient and wind turbines can range anywhere from 20% to 40%, averaging over 30% proving these two additions support environmental sustainability[1].

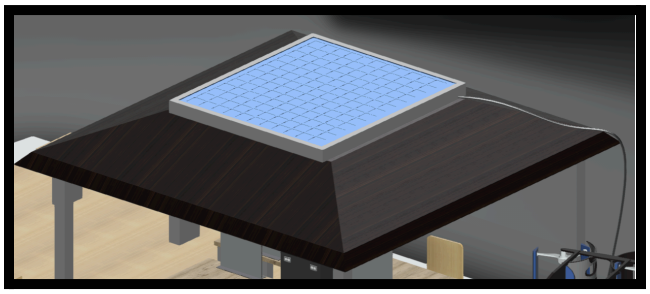


Figure 13: CAD Solar Panel

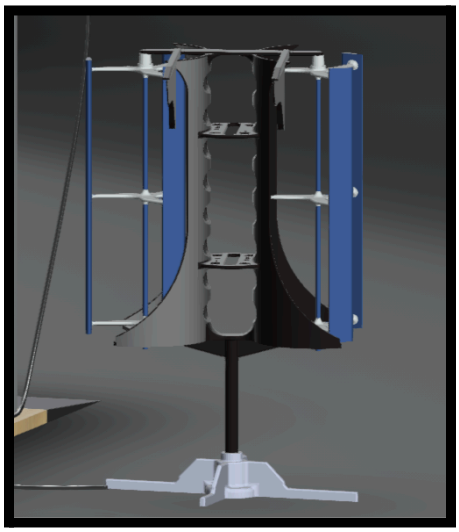


Figure 14: CAD Wind Turbine

[1] U.S. Environmental Protection Agency. (n.d.). *ENERGY STAR for small business*. ENERGY STAR. Retrieved March 30, 2025, from https://www.energystar.gov/buildings/resources-audience/small-biz

Requirement:
[ENV 2.4] The workstation shall be constructed using materials that do not negatively impact local wildlife.

Verification (Ayush Desai):
This requirement is verified through designating certain building materials that have no negative effect on the environment. FSC-certified Accoya wood and recycled structural steel are environmentally responsible materials that align with the New York State Department of Labor (NYSDOL) standards for sustainable construction and wildlife safety. Accoya, produced through a non-toxic acetylation process using sustainably sourced radiata pine, is certified by the Forest Stewardship Council (FSC), ensuring responsible forest management that supports biodiversity and prevents habitat loss (FSC, 2023). Its manufacturing emits no harmful VOCs, heavy metals, or leachates, making it inert and safe for use in environments near sensitive ecosystems (Accoya Technical Brochure, 2022). Similarly, recycled steel, which conserves natural resources and significantly reduces the carbon footprint compared to virgin steel, is chemically stable and does not introduce pollutants or toxins that could harm terrestrial or aquatic wildlife (World Steel Association, 2021). Both materials meet NYSDOL's Environmental Health and Safety guidelines, which emphasize the use of non-toxic, non-leaching, and recyclable materials in construction to minimize adverse ecological impact (NYSDOL Green Construction Guidelines, 2020). Therefore, FSC-certified Accoya wood and recycled steel are verified to be compliant and non-detrimental to wildlife according to NYSDOL regulatory standards.

Forest Stewardship Council. (2023). *FSC and biodiversity*. Retrieved from https://fsc.org/en/page/fsc-and-biodiversity

Accoya. (2022). *Accoya wood technical brochure*. Retrieved from https://www.accoya.com

World Steel Association. (2021). *Steel: The sustainable material for a better world* [Fact sheet]. Retrieved from https://worldsteel.org/publications/fact-sheets/steel-sustainable-material/

New York State Department of Labor. (2020). *Green construction standards and guidelines*. Retrieved from https://dol.ny.gov/green-construction-standards

Requirement:
[FUN 2.1] The system shall have reflective surfaces for users to view themselves.{OAW 1.6}

Verification (Arnav Bhatt):
As seen in *Figure 15* for the CAD rendering of the Outdoor Active Workstation, there is a mirror placed on the desk of the station. This mirror is positioned directly in front of the user at each of the four distinct workstations, as shown in *Figure 16*. This ensures that every individual has access to their own reflective surface while using the station. Each mirror is also an adjustable component of the workstation unit, freely able to be moved on the desk.

Figure 15:Image of a mirror used at each workstation

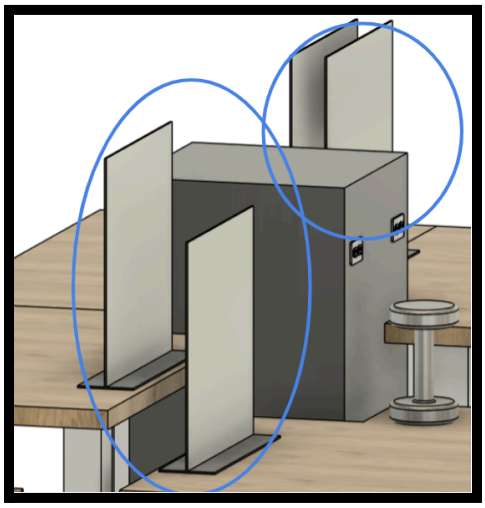


Figure 16:Image of the mirrors at each of the workstation

Requirement:
[FUN 2.2] The system shall have adjustable surfaces on every machine. {OAW 1.6}

Verification (Josh Halpert):
This requirement is verified by designing the devices in a CAD program and showing their adjustable capabilities. This can be done by showing images of the part at different adjustable heights. There are two methods to adjust the devices within the workstation. The first method of adjusting is either changing their position physically or adjusting the chairs by swivelling and moving them to comfortable positions. The chairs can move, as shown in *Figure 17*.

The second way the devices can be adjusted is with the device-adjusting stool. This stool can be placed below a device to raise its height for users who are unable to reach it. It can also be easily removed and placed to the side for later use. The stool can be seen in *Figure 18* and *Figure 19*.

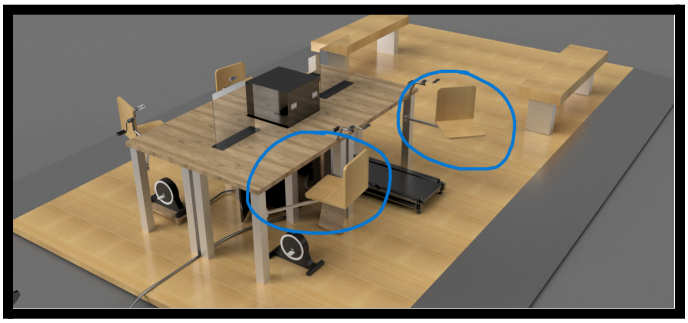


Figure 17: Image of the chairs in the workstation

Figure 18: One of the devices on the stool

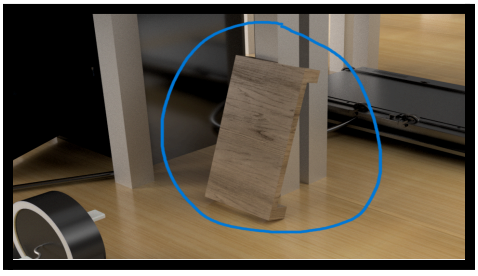


Figure 19: Image of the adjustable stools in the workstation

Requirement:
[FUN 2.3] The workstation shall include an energy storage system to provide consistent power output. {OAW 1.4}

Verification (Josh Halpert):
This requirement will be verified by adding an energy storage system with a power regulation system to the project CAD model. The consistent power output can be verified by ensuring the specifications of the portable power station meet the needs of the workstation. The energy storage system and power regulation module is shown below in *Figure 20*.

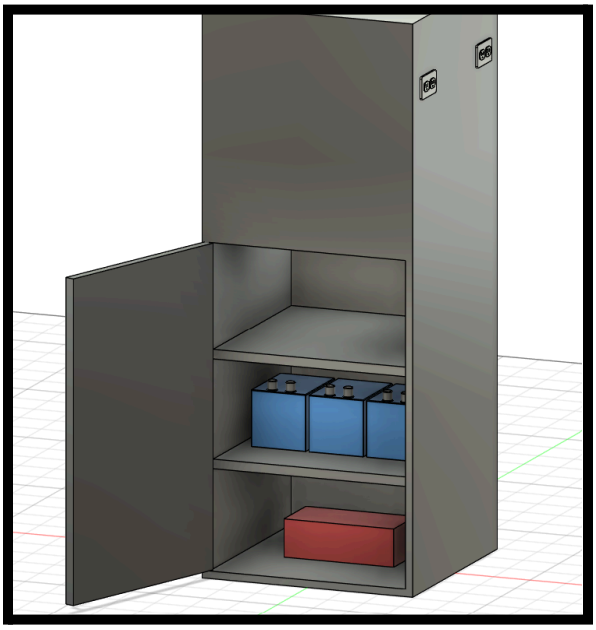


Figure 20: CAD Batteries and Power Supply in Electrical Cabinet

Requirement:

[FUN 2.4] The system shall provide constant ability to exercise while doing work.{OAW 1.3}

Verification (Nate Cross):

This requirement is verified by providing the ability to engage in several different types of exercise and also having access to desks to complete work. *Figure 21* shows a desk with a chair, hand bike, and treadmill. This provides the user with the ability to do several different forms of exercise while also completing work at the desk. *Figure 22* also shows a desk including a chair, with a hand bike and foot pedals.

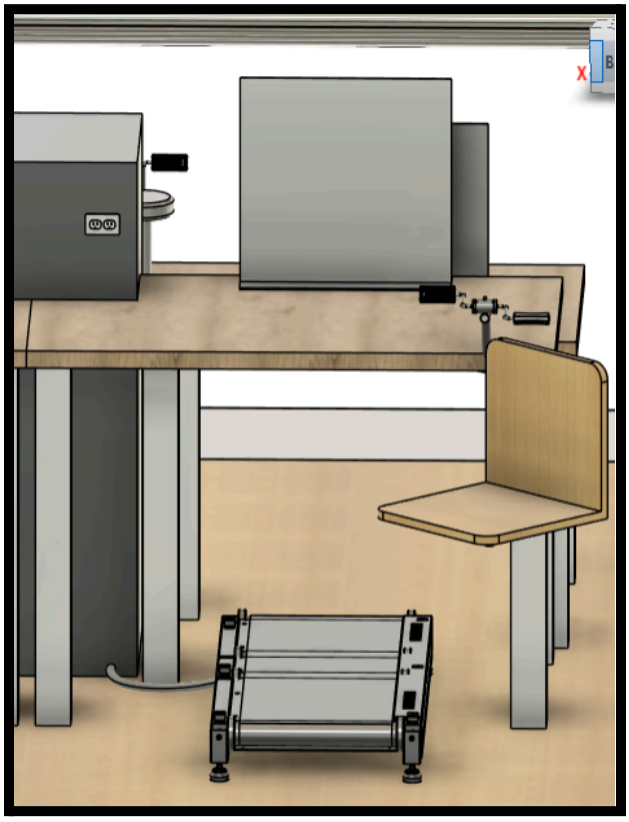


Figure 21: Treadmill located in workstation

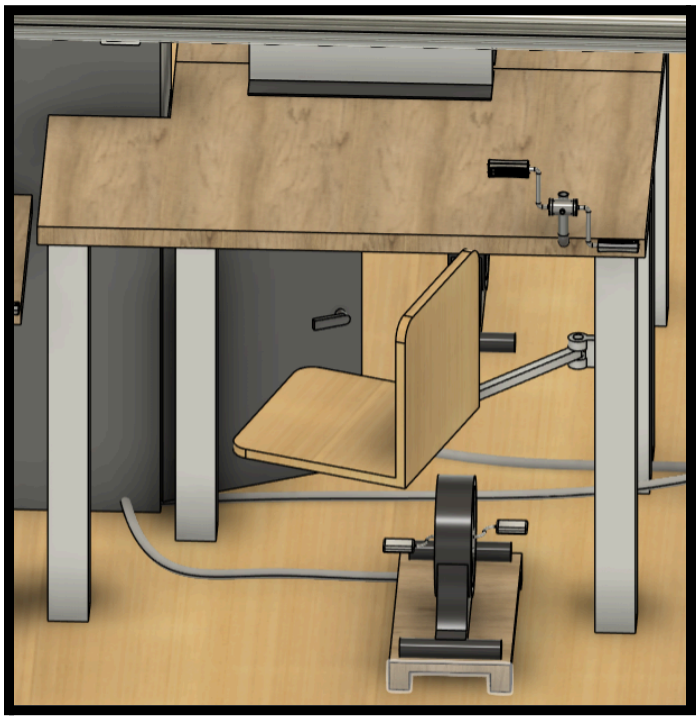


Figure 22: Bicycle foot and hand pedals

Requirement:

[FUN 2.5] The system shall meet New York State's electrical requirements for outdoor establishments. {OAW 1.4}

Verification (Adriana Galofaro):

These verifications will be met by ensuring that all of New York's states laws are followed regarding the depth of wires being buried. Since the workstation is portable, the wiring would not concern any new installations but rather the wiring that is already within the campus of Binghamton University. This will be ensured by including the Binghamton University Assessment of conditions (Binghamton University Facilities Management, 2011)[2] entailing underground requirements that are proven to be met. Section 2.9 focuses specifically on the technology usage of Binghamton, covering the Campus Data System and the Technology System Capacity. Pictures of this specific section are included down below in *Figure 23*.

Figure 23: Binghamton University Facilities Management PDF

[2] Binghamton University Facilities Management. (2011, June 6). *Phase 2 assessment of conditions: Final report*. https://www.binghamton.edu/facilities-management/img/general/FMP%20Phase_2_Assessment_of_Conditions_2011-06-06_FINAL.pdf

Requirement:
[FUN 2.6] The system shall have a waiting area for people when the workstation is at full capacity. {OAW 1.2}

Verification (Adriana Galofaro):
This requirement will be met by creating a designated area that has seating and tables so that clients have a place to wait prior to working out. This will be ensured by creating a space on CAD with a seating area outside of the workstation area. A picture of this waiting area is included below in *Figure 24*.

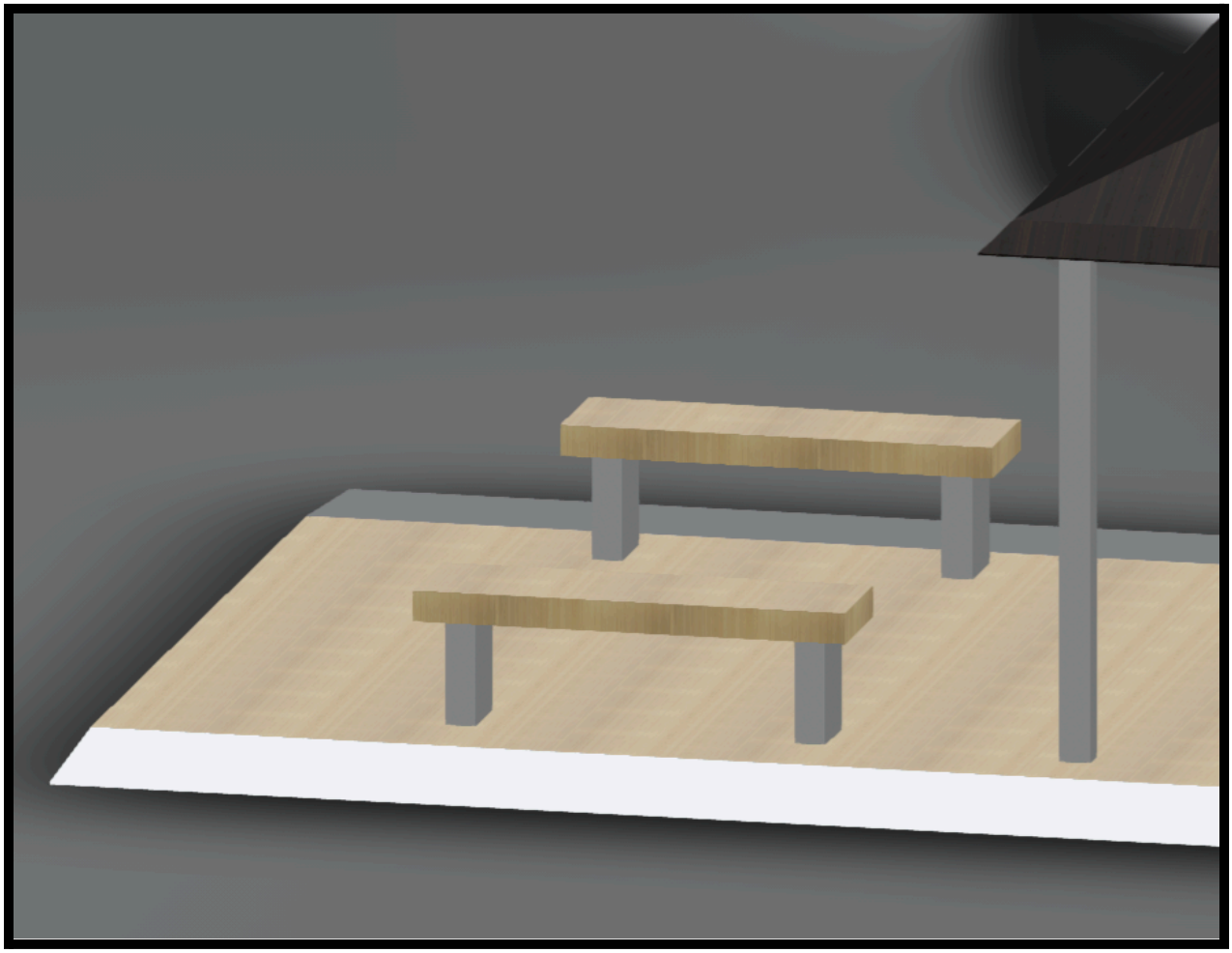


Figure 24: CAD Assembly Waiting Room

Requirement:

[POR 2.1] The machines within the workstation shall be able to be taken apart. {OAW 1.1}

The machines need to be able to be moved around so the workstation can be portable.

Verification (Adriana Galofaro):

The equipment will be built on CAD software and will have an exploded assembly view demonstrating that it can be taken apart and put back together. The parts for the equipment will be made individually and assembled together. The exploded CAD Assembly will prove that each item can be individually moved and prove its portability. A picture of this exploded CAD Assembly is included below in *Figure 25*.

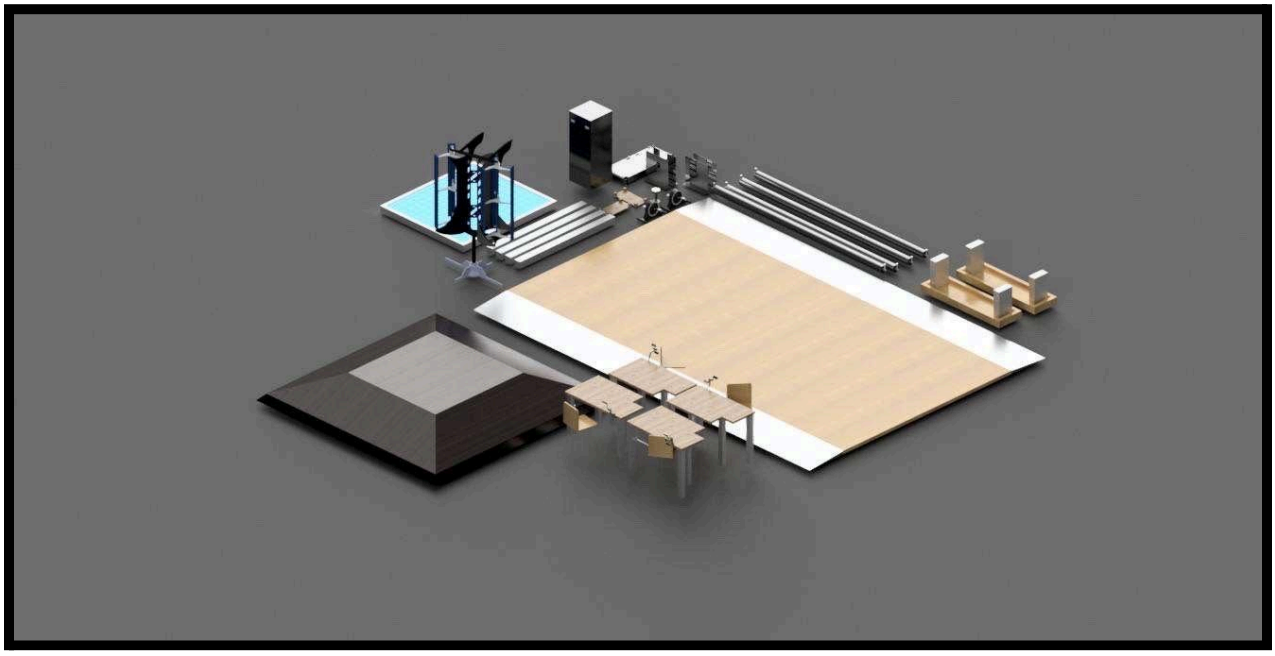


Figure 25: An exploded assembly of the workstation

Requirement:
[POR 2.2] The frame of the workstation shall be able to be moved by 5 people.{OAW 1.1}

Verification (Arnav Bhatt):
This requirement will be verified with the requirement [POR 2.2]. Since all of the elements in the workstation are under 200 lbs it will be able to be moved by five people. Also the heaviest components of the workstation, the floor and the roof, are split up into nine and sixteen equally weighted parts, respectively. This means that each of those parts fall under 200 lbs which means that they are able to be lifted and moved by five people. This is according to guidelines set by moving companies that one person is able to lift 50 lbs. Since there are five people moving the parts of the workstation 200 lbs falls under the threshold for max weight carried by five people. It can be seen in *Figures 26 and 27* that the roof and the floor of the workstation is split up into numerous parts

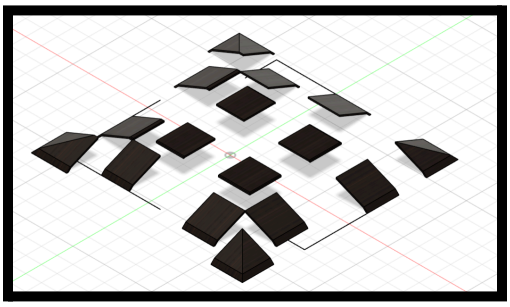


Figure 26:Image of the roof off the workstation split up into 16 parts

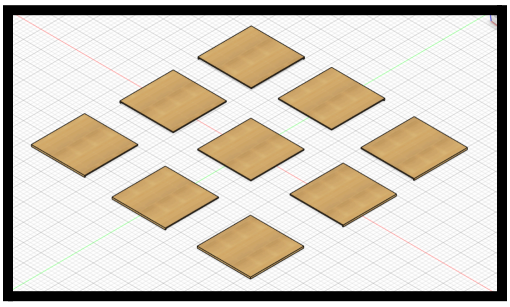


Figure 27: Image of the floor of the workstation split up into 9 parts.

Requirement:
[POR 2.3] Elements in the workstation shall be at most 200 lbs in order to be easily transportable. {OAW 1.1}

Verification (Gianna Spasevski):
This requirement is verified by designing the equipment in a CAD software and using the statistics in order to see the estimated weight of the drawing, according to Fusion. In *Figure* - below, it lists all of the masses of each separate part of the workstation. As shown in *Figure 28*, each piece is verified to weigh under 200 lbs.

Mass	9.711 lbmass
Mass	144.109 lbmass
Mass	28.236 lbmass
Mass	16.550 lbmass
Mass	47.110 lbmass
Mass	11.265 lbmass
Mass	28.093 lbmass
Mass	151.400 lbmass
Mass	123.217 lbmass
Mass	88.885 lbmass
Mass	178.332 lbmass
Mass	178.332 lbmass
Mass	113.492 lbmass
Mass	178.332 lbmass
Mass	89.044 lbmass

Figure 28: List of Masses of each part of the Workstation

Requirement:

[POR 2.4] The workstation shall allow for setup within a half an hour in different outdoor environments. {OAW 1.1}

Verification (Nate Cross):

This requirement is verified by including an exploded CAD model of the workstation, showing the workstation taken apart into lightweight components that will be easy to place on a trailer and move around as needed as seen in *Figure 30*. The workstation also includes a roof and drop down walls to provide safety from the rain, allowing users to work in different outdoor environments as seen in *Figure 31*. *Figure 32* also shows a complete list of the mass of every deconstructed component, which is no more than 200 lbs per component. This weight can easily be lifted and placed on a trailer by several people and driven to a new location within 30 minutes.

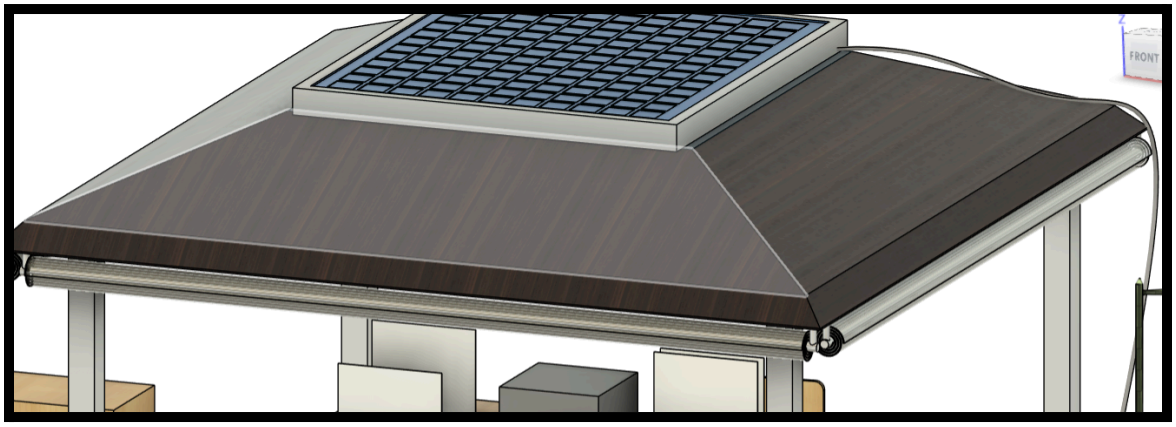


Figure 30 : Roof with drop down walls

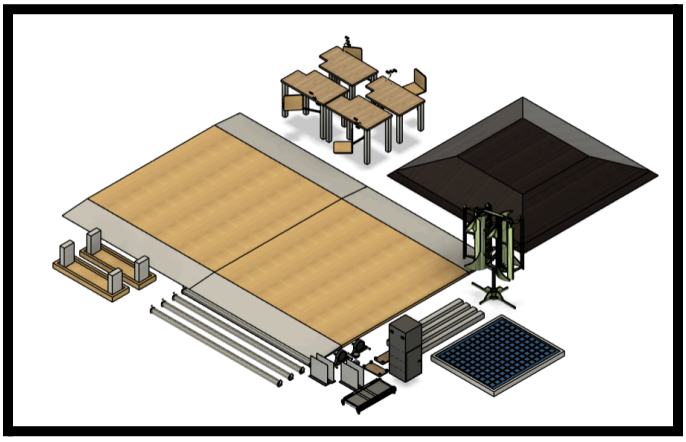


Figure 31: Exploded CAD view

Mass	9.711 lbmass
Mass	144.109 lbmass
Mass	28.236 lbmass
Mass	16.550 lbmass
Mass	47.110 lbmass
Mass	11.265 lbmass
Mass	28.093 lbmass
Mass	151.400 lbmass
Mass	123.217 lbmass
Mass	88.885 lbmass
Mass	178.332 lbmass
Mass	178.332 lbmass
Mass	113.492 lbmass
Mass	178.332 lbmass
Mass	89.044 lbmass

Figure 32: List of masses

Requirement:
[POR 2.5] The workstation shall obtain a various amount of machines to accommodate any individual who needs ADA requirements. {OAW 1.5}

Verification (Adriana Galofaro):

The workstation will include a variety of equipment considering individuals who can only use their arms or only use their legs. This accommodation will be met by using CAD to create equipment that is only upper body and lower body focused. This equipment entails foot pedals, arm pedals and treadmills and pictures of these items are included down below in *Figures: 33, 34, and 35*.

Figure 33: CAD Assembly Arm Pedal

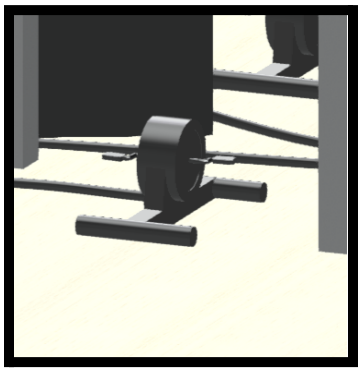
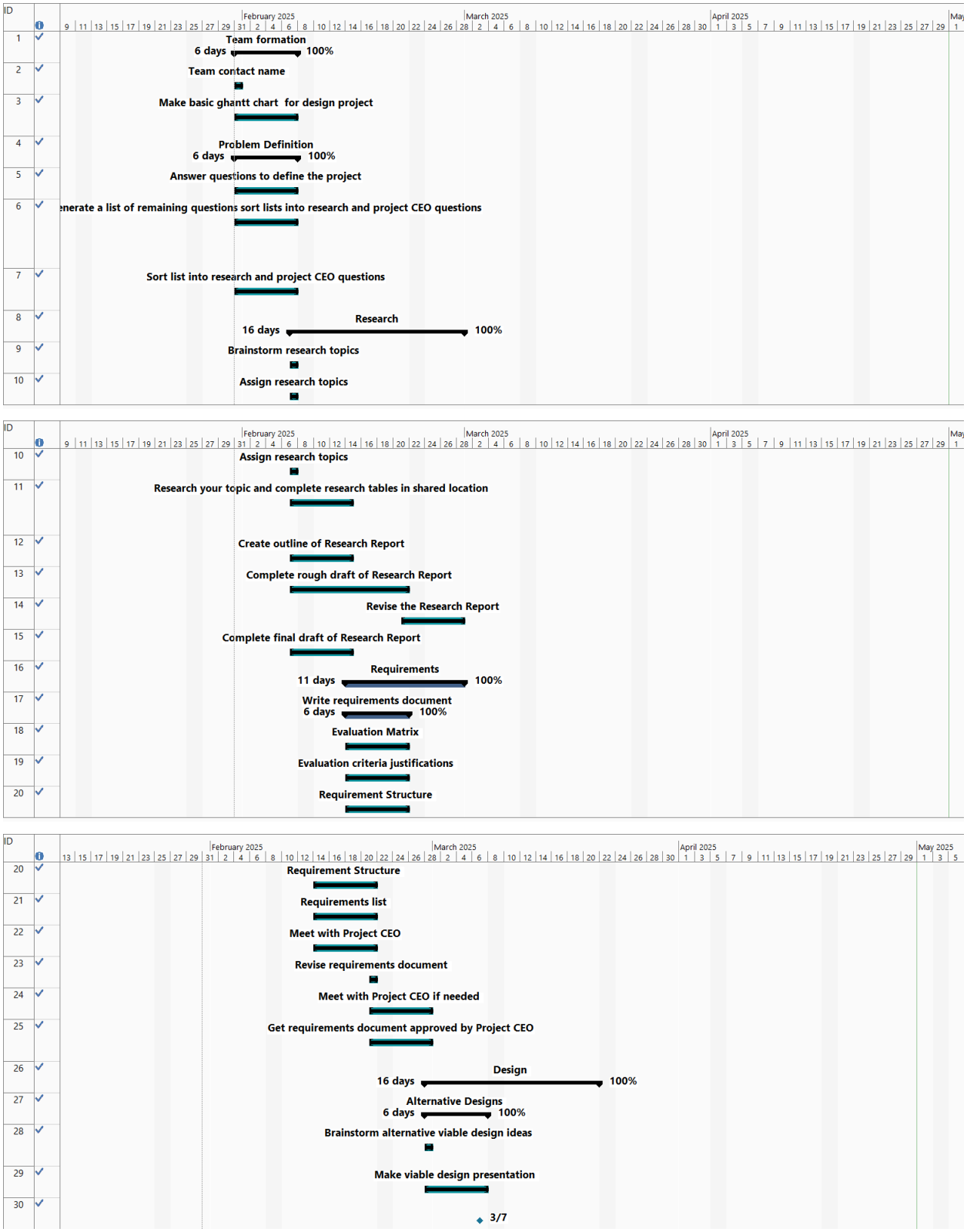
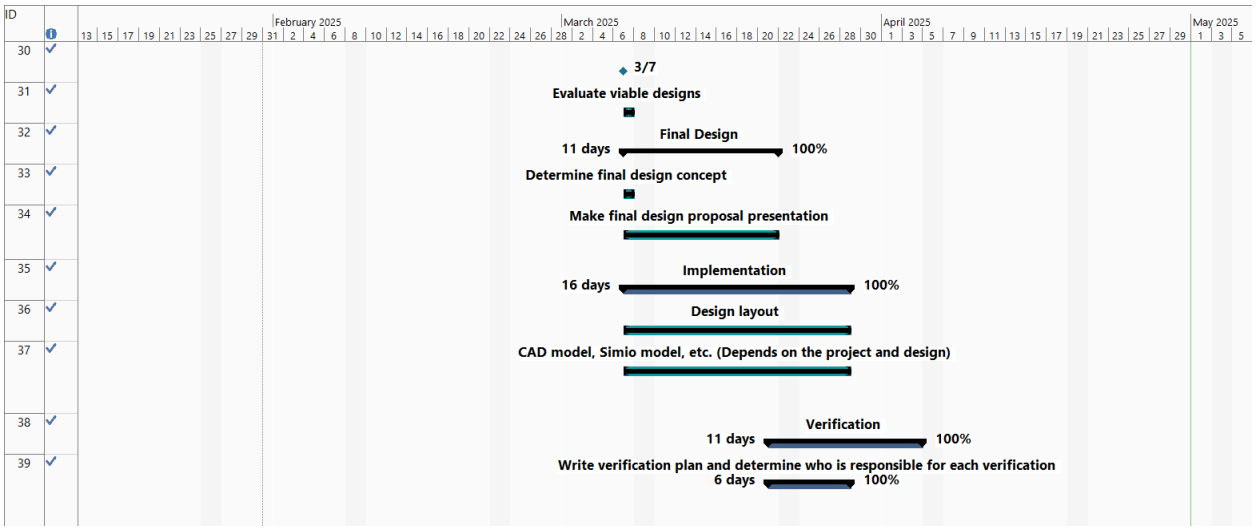


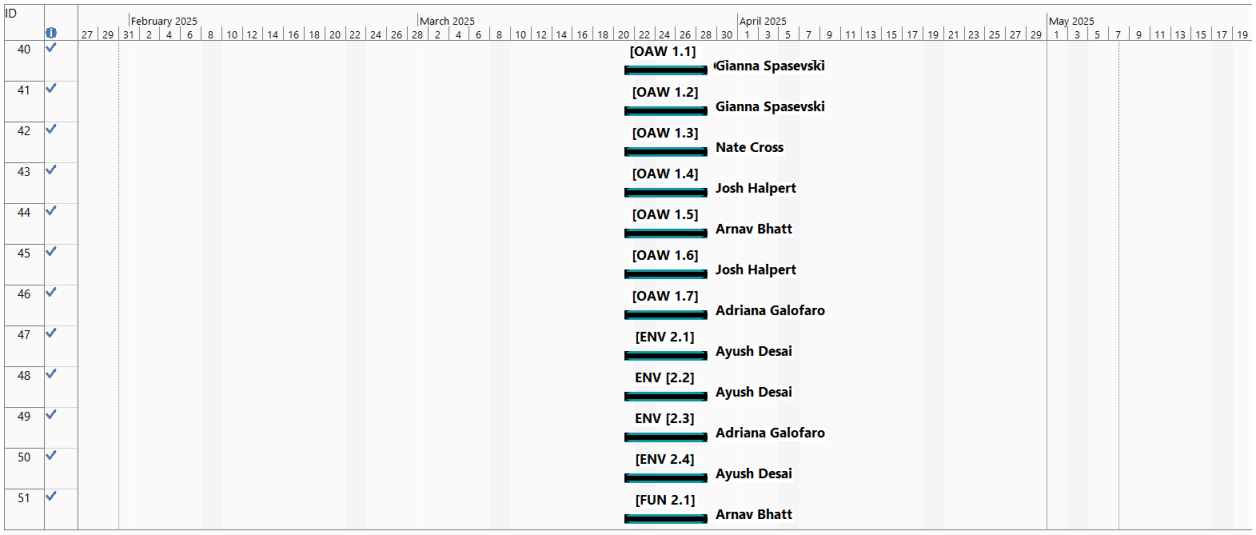
Figure 34: CAD Assembly Foot Pedal

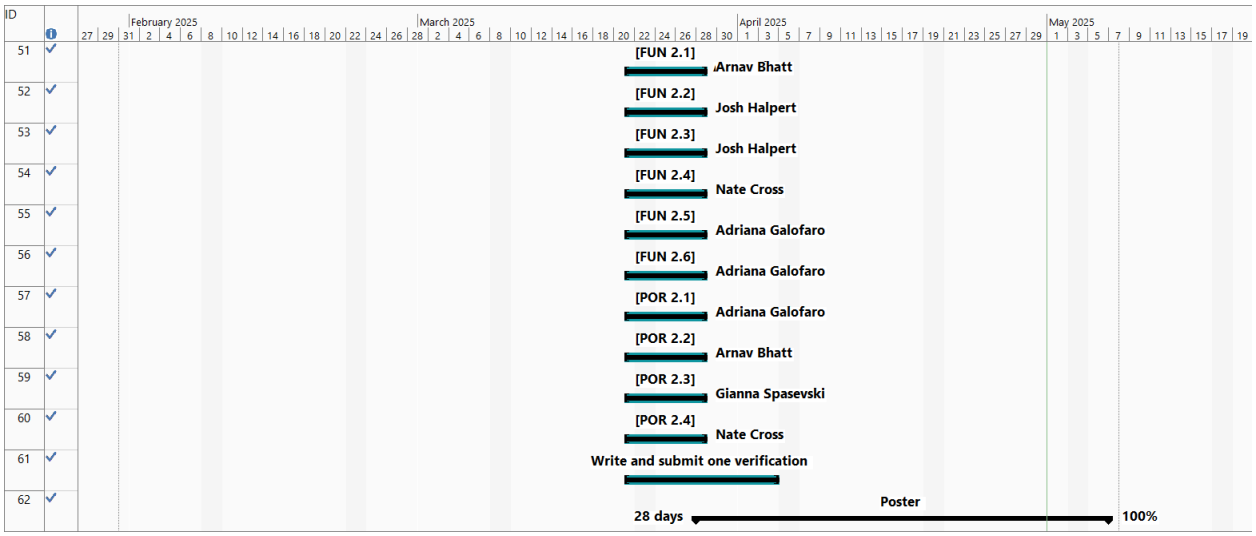
Figure 35: CAD Assembly Treadmill

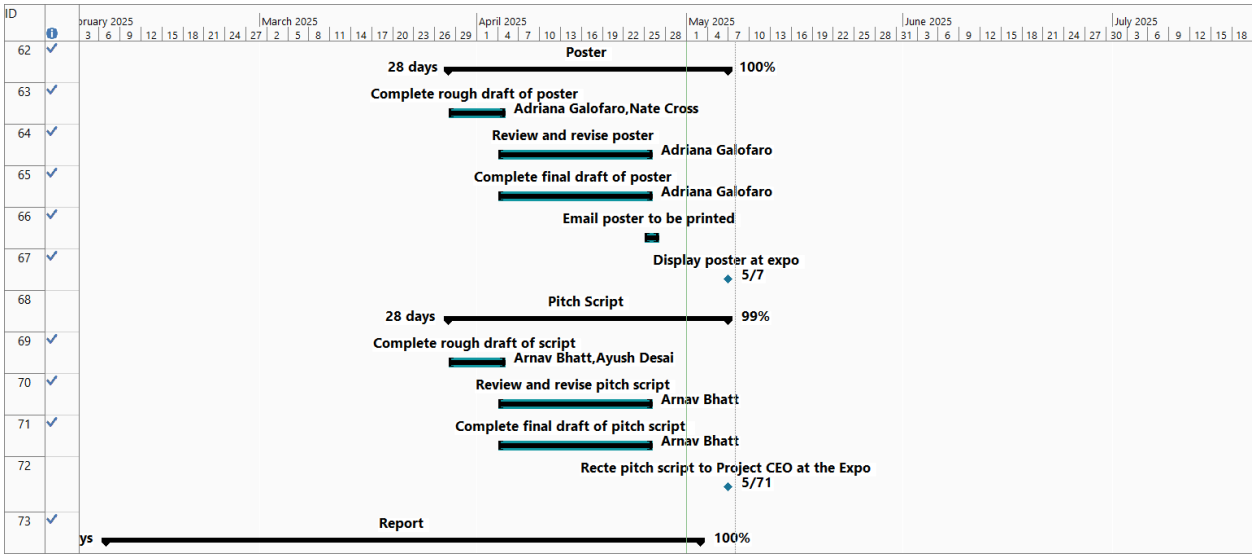
Appendix E: Gantt Chart

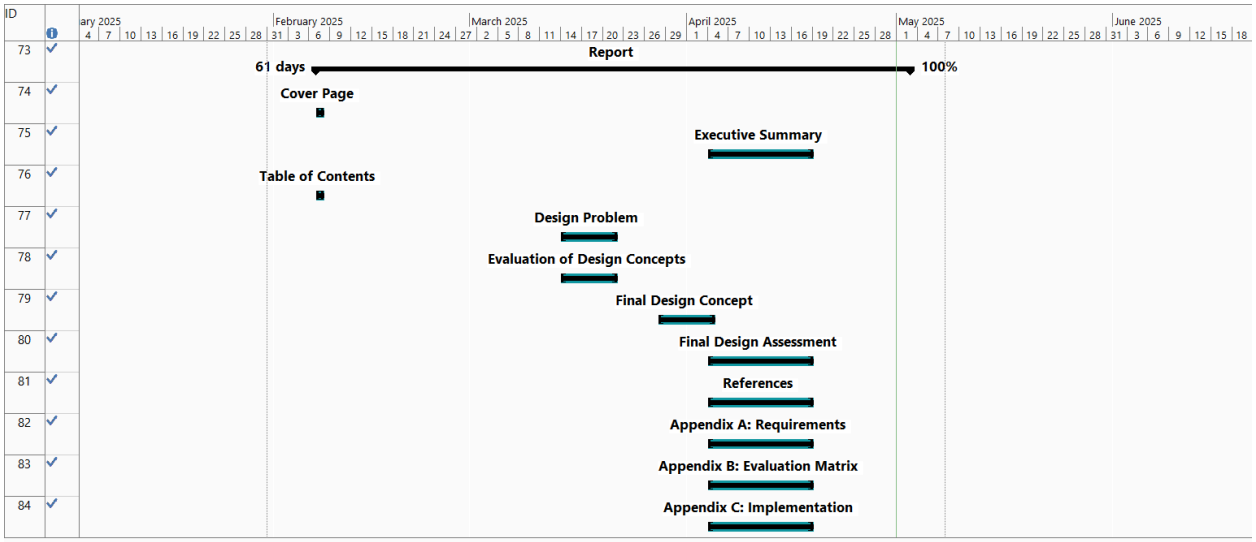


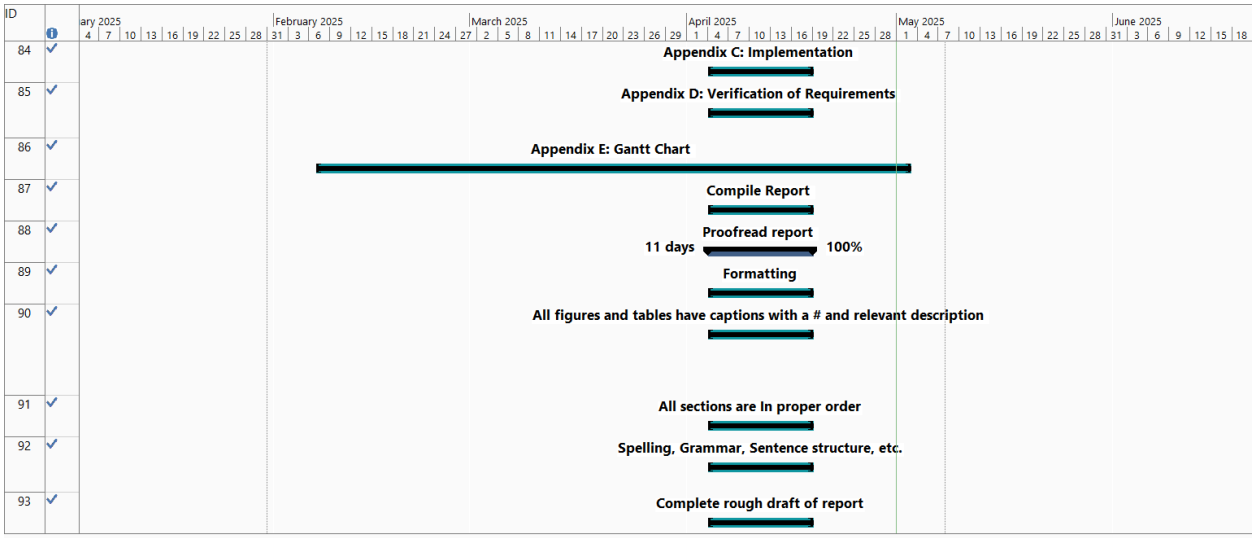

ID
February 2025
March 2025
April 2025
May 2025
30
3/7
31
Evaluate viable designs
32
Final Design
11 days
100%
33
Determine final design concept
34
Make final design proposal presentation
35
Implementation
16 days
100%
36
Design layout
37
CAD model, Simio model, etc. (Depends on the project and design)
38
Verification
11 days
100%
39
Write verification plan and determine who is responsible for each verification
6 days
100%

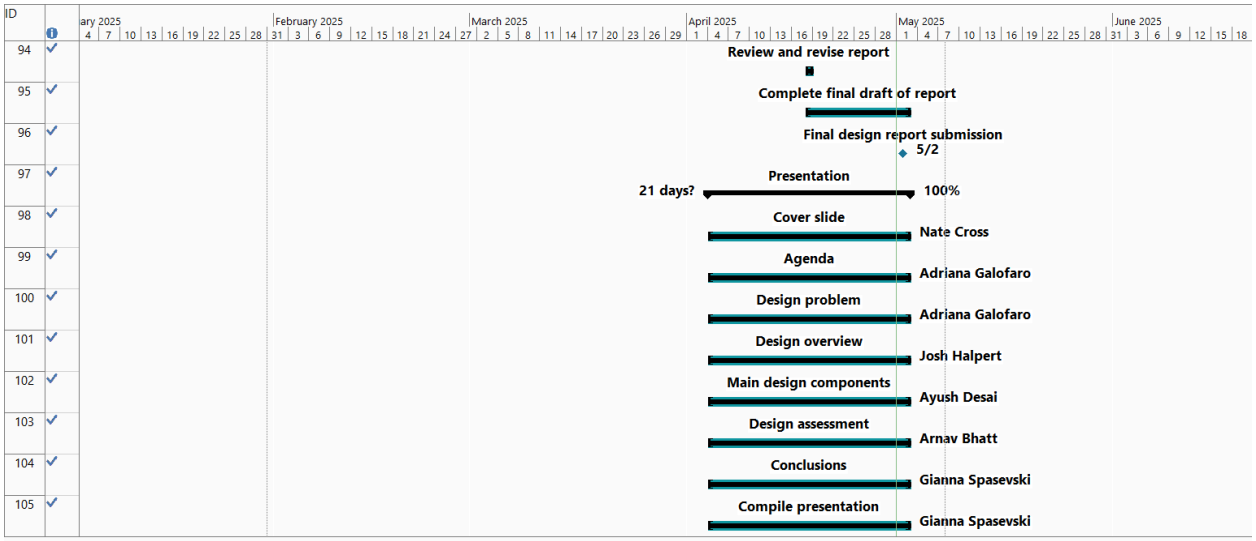

ID
February 2025
March 2025
April 2025
May 2025
40
[OAW 1.1]
Gianna Spasevski
41
[OAW 1.2]
Gianna Spasevski
42
[OAW 1.3]
Nate Cross
43
[OAW 1.4]
Josh Halpert
44
[OAW 1.5]
Arnav Bhatt
45
[OAW 1.6]
Josh Halpert
46
[OAW 1.7]
Adriana Galofaro
47
[ENV 2.1]
Ayush Desai
48
ENV [2.2]
Ayush Desai
49
ENV [2.3]
Adriana Galofaro
50
[ENV 2.4]
Ayush Desai
51
[FUN 2.1]
Arnav Bhatt

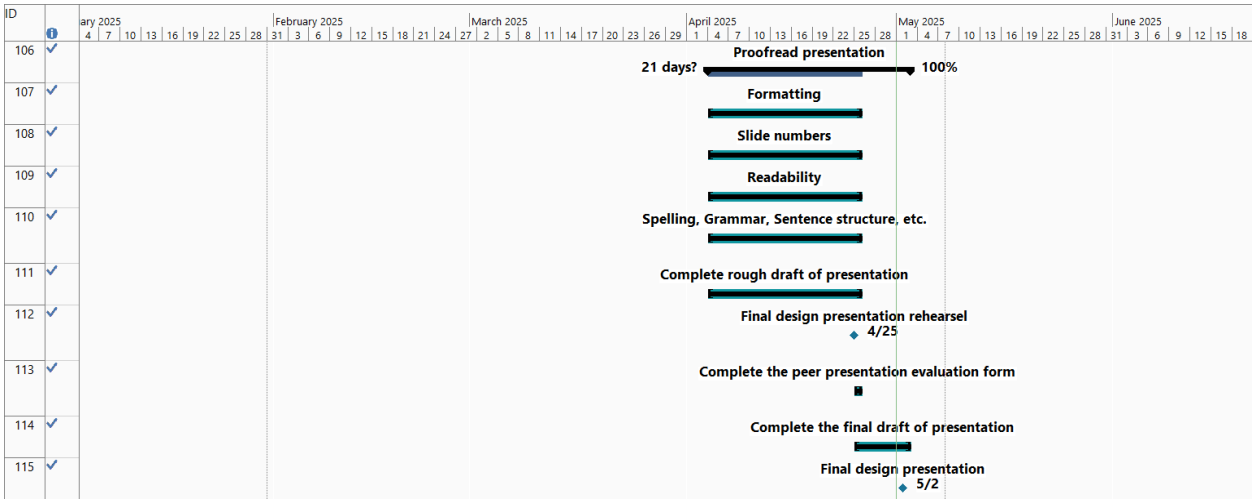

ID
February 2025
March 2025
April 2025
May 2025
51
[FUN 2.1]
Arnav Bhatt
52
[FUN 2.2]
Josh Halpert
53
[FUN 2.3]
Josh Halpert
54
[FUN 2.4]
Nate Cross
55
[FUN 2.5]
Adriana Galofaro
56
[FUN 2.6]
Adriana Galofaro
57
[POR 2.1]
Adriana Galofaro
58
[POR 2.2]
Arnav Bhatt
59
[POR 2.3]
Gianna Spasevski
60
[POR 2.4]
Nate Cross
61
Write and submit one verification
62
Poster
28 days
100%


ID
March 2025
April 2025
May 2025
June 2025
July 2025
62
Poster
28 days
100%
63
Complete rough draft of poster
Adriana Galofaro,Nate Cross
64
Review and revise poster
Adriana Galofaro
65
Complete final draft of poster
Adriana Galofaro
66
Email poster to be printed
67
Display poster at expo
5/7
68
Pitch Script
28 days
99%
69
Complete rough draft of script
Arnav Bhatt,Ayush Desai
70
Review and revise pitch script
Arnav Bhatt
71
Complete final draft of pitch script
Arnav Bhatt
72
Recte pitch script to Project CEO at the Expo
5/71
73
Report
100%


ID
February 2025
March 2025
April 2025
May 2025
June 2025
73
Report
61 days
100%
74
Cover Page
75
Executive Summary
76
Table of Contents
77
Design Problem
78
Evaluation of Design Concepts
79
Final Design Concept
80
Final Design Assessment
81
References
82
Appendix A: Requirements
83
Appendix B: Evaluation Matrix
84
Appendix C: Implementation


ID
February 2025
March 2025
April 2025
May 2025
June 2025
84
Appendix C: Implementation
85
Appendix D: Verification of Requirements
86
Appendix E: Gantt Chart
87
Compile Report
88
Proofread report
11 days
100%
89
Formatting
90
All figures and tables have captions with a # and relevant description
91
All sections are In proper order
92
Spelling, Grammar, Sentence structure, etc.
93
Complete rough draft of report


ID
ary 2025
February 2025
March 2025
April 2025
May 2025
June 2025
94
Review and revise report
95
Complete final draft of report
96
Final design report submission
5/2
97
Presentation
21 days?
100%
98
Cover slide
Nate Cross
99
Agenda
Adriana Galofaro
100
Design problem
Adriana Galofaro
101
Design overview
Josh Halpert
102
Main design components
Ayush Desai
103
Design assessment
Arnav Bhatt
104
Conclusions
Gianna Spasevski
105
Compile presentation
Gianna Spasevski


ID
ary 2025
February 2025
March 2025
April 2025
May 2025
June 2025
106
Proofread presentation
21 days?
100%
107
Formatting
108
Slide numbers
109
Readability
110
Spelling, Grammar, Sentence structure, etc.
111
Complete rough draft of presentation
112
Final design presentation rehearsel
4/25
113
Complete the peer presentation evaluation form
114
Complete the final draft of presentation
115
Final design presentation
5/2