Fall 2023
Project Department: School of Engineering Technology
Project Sponsor: School of Engineering Technology

XR Hub

ENGT 481
Dr. Berry, Dr. Garcia-Bravo

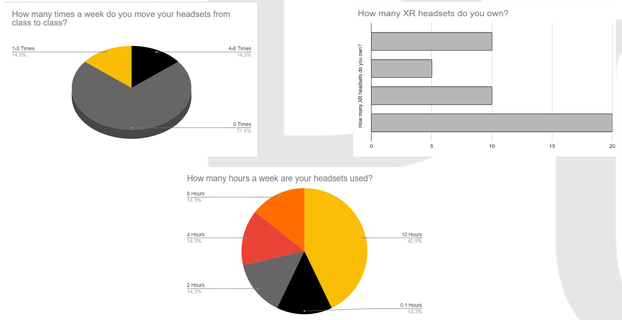
Team (Group 9): Emmani Ellis, Ananmay Ruia, Shane Gibson, Benjamin Traylor, Ryan Woodard, Anish Vutukura, Joshua Revour, Kyler Neuman

Customer Background

The School of Engineering Technology (SoET) uses Virtual Reality and Augmented Reality headsets to facilitate learning and Research. The current storing method is impractical and takes up a lot of space.

Problem Statement and Scope of Work

The SoET needs an effective way to store and Charge the headsets.



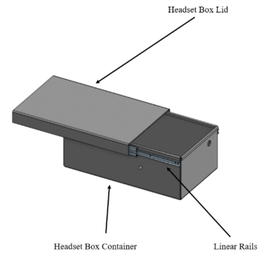
- Store and Charge up to 24 XR Headsets, simultaneously.
- Independent protection and charging for each headset.
- Temperature regulated fan speed control for heat exhaustion.

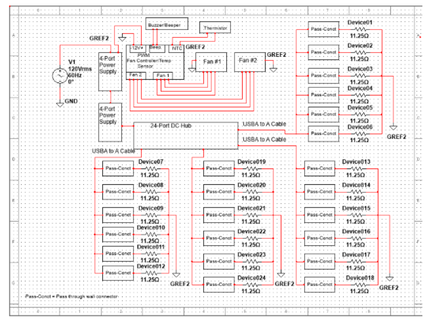
Failure Mode and Effect Analysis

Failure Mode and Effects Analysis

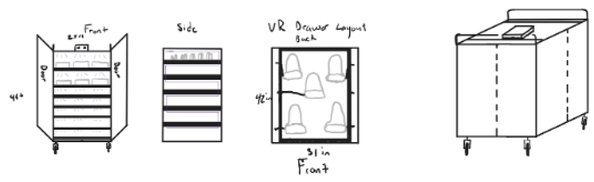
Key Process Step	Potential Failure Mode	Potential Failure Effects	Severity	Potential Causes	Occurence	Current Detection	Detection	Priority	Actions Taken
Housing	Housing can Crack or deform under stress	Cart Frame will not be able to hold all Headsets	5	One or multiple shelves on the cart are overloaded, causing the 80/20 to experience stresses higher than its yield stress.	2	Test Max load forces of frame	8	Low	Ensure 80/20 frame is constructed in a that effectively distributes weight and loads across the board
Power Source Fans	Can overheat and potentially create fire hazard	Damage the cart and headsets inside, create fire	8	Fans are powered by a source that also powers other cart components which overloads the power supply, causing the fans to overheat	4	Run ventilation system, simulate heat and ventilation, test temperatures when cooling	7	High	Ensure fan power supply is not connected to a power strip that is near overloading
Charging System	USB Hub doesn't effectively share power	Headsets take very long to charge or aren't able to charge at all	1	Other components such as the fans are also powered via the USB hub.	3	Run Charging test with max load, and variable load	4	Low	Separate power sources as to not overwhelm the USB Hub
Base	Base can crack or deform	Deformation of the base results in the cart frame deforming and creating structural issues	5	Cart is loaded with a larger load than originally designed for.	3	Measure loads put on wheels during testing, different loads	2	Low	Ensure frame weight is properly distributed and wheel weight can handle it
Door Locks	Not Lined up properly, lock isn't secure enough	Cart will be unlocked and can have potential for theft	2	Locking mechanism is mounted in the incorrect location	2	Test functionality of lokcing mechanism	4	Low	Test open and close functions of lock
Power Strip	Power strip can short circuit, power efficiency will be reduced	The energy will dissapate into the wall outlet becuase the cart is grounded, none of the electronics on the cart would work	8	Too many devices connected to power strip	5	Measure efficiency of the device, test for short circuits	7	High	Ensure that devicve power output circuit is a parallel setup
Charging System	Power source supplies to much or not enough power to charging system	Too much power can result in a overheating problem, and too little power can result in longer charge times	9	User plugs in device in a faulty outlet. USB Hub fails to effectively charge headsets	1	Measure how charging works under different loads	4	Low	Run short circuit tests on device and measure output to see if output fits within device charging range
Door hinges	Hinges cannot support the door	Restricts Door from closing, doors will break the hinge, doors will not line up correctly	4	Hinges with insufficient load capacity purchased	4	Test the load of the door on the hinges, opening and closing doors, slamming the door	2	Low	Run tests opening and closing the hinge
Door Frame	Doors are too small or large	Door won't be able to close, can result in breaking the frame	4	Door frame components cut to incorrect length.	4	Test hardness of the door and if it bends under stress. Does the door fit into the frame?	2	Low	Run tests opening and closing the door

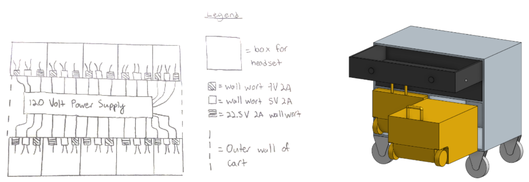
Final Design





Experimentation and Concepts





Requirements Matrix

Req. #	DESIGN REQUIREMENTS	DESIGN TARGETS	VALIDATION
	RATIONALE		
1	Charging function	Direct connection to power source	Do the headsets charge?
	Creating a storage unit for the headsets is quite simple and not practical. By making the station have the ability to produce power into the headsets it allows for the headsets to sit and charge making them ready for use every time. Our goal for the design is to go by voltage required by the headset. We are planning on creating a box that will hold 5V, 9V, and 22.5V. These boxs will allow for the user to plug the charging cord that comes with the headset in and get power into		
2	Portable	4 Rubber wheels	Does it move?
	Because several teachers in various departments will want to have access to XR headsets, making the cart portable will make it easier for teachers to take the cart from room to room with ease. We also plan to include a way for the cart to stay stationary in a classroom if that is the desired outcome for a specific		
3	Security function	Pods equipped with locks	Does it lock?
	In order to allow for this cart to be placed anywhere in the building and not worry about the concern of theft. Adding a security fuction to the modular unit through a lock allows for the teacher to be the master key holder and only open the pod up for student use at the desired time.		
4	Heat Ventilation	Vents on pods	Do the headsets remain cool (to
	This is neccesary to make sure that the that the headsets do not overheat while charging within the pod and also so that the pod and headsets won't be damaged. The other alternative was to create a pod that is fire resitant, however, this is not practical for cost and the product will run the risk of lighting on fire still.		
5	One Cart	Be able to fit through standard doorway	24"x44"x56"
	Our client will not want to have to make several trips so it is important to focus on a way for only one cart to be the focus on the project. This cart will be slightly larger than expected due to the amount of headsets that are desired to be held within. Our goal is to have a cart that will hold six pods that hold four		
6	Modular	One box per headset	TBD
	By creating pods that are modular by voltage, it allows for a pod to be taken away or added to the cart. For example, this will make it easier for a customer who only owns headsets that require 5V power to make the cart smaller and easier to move around from room to room.		
7	Allow users to clean headsets between uses	Wipes included on the cart for wiping down headset after use	Will the wipes effectively clean the headsets?
	Because several students or customers may use the headsets daily within short periods of time, having a way to make sure that the headsets are clean for use, as needed		
8	Headset Specific holder	Custom storage for each headset within pod	Does each headset have its own
	Dedicated place for each headset to live when not in-use		

Testing

Testing			
Step	Test	Details	Outcome
1	Loading Test	Calculated bending stress and deflection. Compared to the yield strength of the material. Heaviest headset is placed on the shelf for two days.	Calculated stress is lower than yield stress. There is no deflection from the load.
2	Electrical components Test	Applied a load on the USB hub and magnetic wires using discharged Hololens to test functionality of the components.	It was found that the charging was very slow at 1.65W
3.	Power Test	Connected multiple loads to the charging system and measured the change in output using a multimeter.	The magnetic wires are not ideal for charging. The output does not change with change in load. Nonmagnetic wires charge the headsets much faster at 2.5W.
4.	Heat Testing	Charged 2 Hololens headsets overnight with the ventilation system on. Recorded the temperatures at the start and end.	The hottest point inside the system was the motor for the fan at 90 F. The headsets were fully charged.
5.	Grounding Test	Using a multimeter, check for continuity on every shelf, screw and section of 80-20.	The DMM demonstrated connectivity between that point and ground.