Pop-Up Classroom Overview

The Pop-Up Classroom (PUC) is a device that creates a new campus experience. The device provides a collaborative environment that is nomadic and has the capability of being ordered online. The product allows for educational instruction outside of the standard classroom setting. It enables a comfortable interaction between professors and students, faculty, and classmates. The PUC includes all the necessary tools and classroom features so that lectures, meetings, and conversations are pleasant enough for its users.

Components and Modules Description

This section lists all the device components and their respective descriptions. Relevant information is provided on function and design of the components, as well as their intended purpose.

Roof:

The length of the roof is 66 inches long. With the shaded parts added, it is 114 inches long with a width of 32 inches. The roof is intended to provide shelter for the device components and the user that is on the device.

Roof Legs:

The legs support the roof to be a height of 6 foot 5 inches above the base of the cart. They also connect the roof to the cart.

Cart

The cart itself, which holds all the PUC components, is 5.617 feet in length, 2.279 feet in height, and 2.292 feet wide. It includes a gate that is magnetically coupled to the main frame. This will prevent the gate from moving from its desired place. The cart also holds three junction boxes, each holding different electrical sub-components of the PUC.

Media Modules

Speaker:

The speaker that was chosen was the SONOS Bar. The speaker is mounted on the rear wall to be easily accessed by the user. It has bluetooth capabilities as well as wired features as well such as aux cord capabilities.

Microphone:

> The microphone would be used with the speakers in the event there is a crowd, background noise, or if someone is soft spoken. Simply plug in the mic into the speakers and turn the devices on they are ready to use.

Monitor:

> The monitor used for this design would be the Samsung 32 inch Smart HDTV. It would operate the same way a normal TV would, with wifi capabilities. For a complete understanding one should consult the manual that is provided with the TV.

Monitor Mount:

> The mount is secured to the AV cabinet below it and is attached to the monitor to be raised and lowered by adjusting the neck according to the user's needs. It's also able to slide the monitor forwards and backwards by adjusting the base.

Whiteboards:

> The whiteboards are attached to each side of the cart that will fold out when in use.

Electrical Components

Battery

Arduino Nano 33 - Information input from user

Raspberry Pi - Interprets user input into instruction for motors

Wifi Repeater - Allows convenient internet connectivity

Motor

The PUC works with two different motors, each for a caster wheel. These are placed at the bottom of the cart. Each motor is controlled separately enabling zero point turning and they are powered by a 24V battery. There are caster wheels on the front and back of the RTC. It is equipped with a gate which lowers to allow easy access to the containers. To operate the RTC, a wireless controller is used to steer by varying the speed of each motor.

AV Cabinet

For further information on the cost and specific models brought by this team, please refer to our **Bill of Materials**. Further information on the costs and specific models bought by the team who designed the cart can be found **here** beginning on page 74.

Integration of Components

(a)   **(b)**
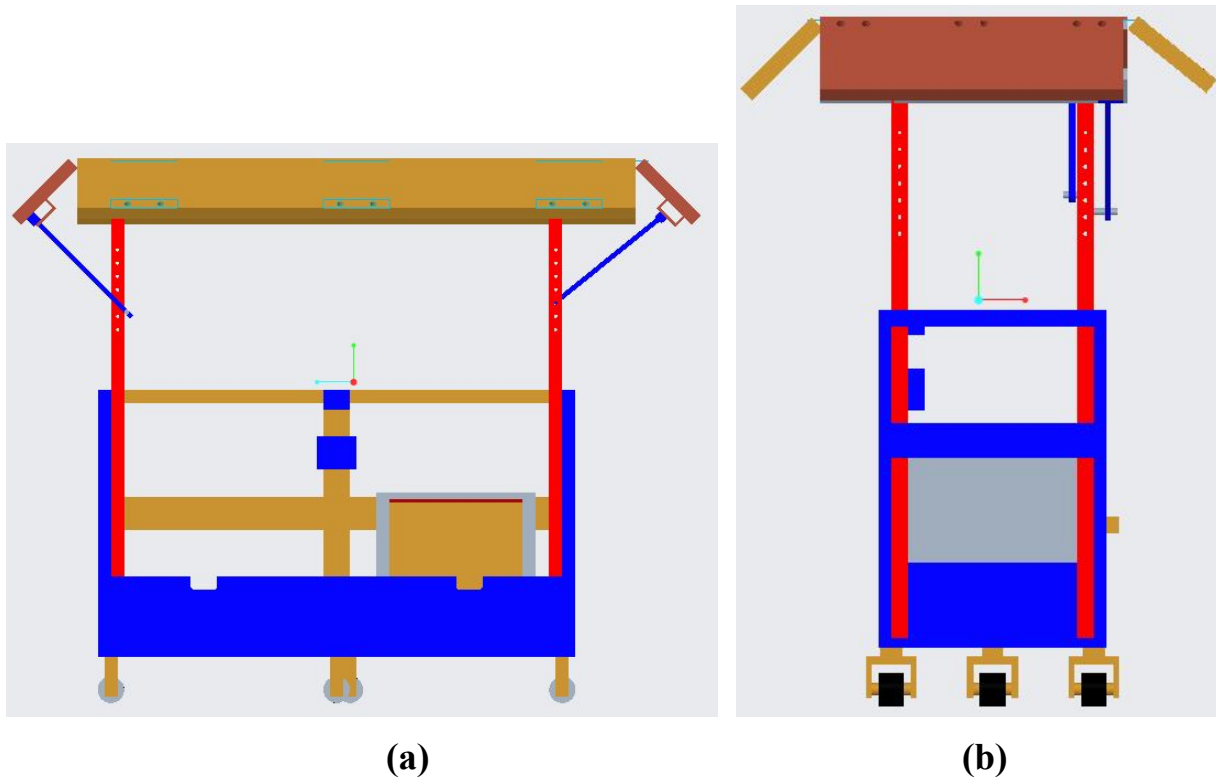
Figure 1: (a) Frontal view of the PUC, (b) side view of the PUC.

Media modules are attached around the perimeter of the cart. On the front side of the cart, the monitor is attached to the mount on the inside part of the cart and to the side will be a speaker attached to the speaker mount. Make sure that the mounts are securely attached to the cart before attaching the monitor and speaker. On the sides will be the white boards, connected to the cart with a cylindrical revolute joint. The cabinet will be placed in the side space of the cart on the same side as the monitor. On the side of the cabinet facing the power supply, there should be a circular cavity big enough for wiring to pass through; providing a connection for the power supply to the DC-AC inverter and to power the electronics on board that requires a plug. The battery housing compartment should contain the power supply and wheel motors responsible for transportation. In future iterations it would seem convenient to place all essential power supplying elements such as the inverter into the middle housing compartment.
The roof legs are fitted inside the perimeter of the cart and attached to the sides via connecting bolts.

Electronic components are inside the junction boxes. The boxes are labeled J1, J2, J3. They hold the operation controls that provide power to the control system, the battery fuel gauge display, and the circuit breaker; the control system including the motor controller (Cytron SmartDriveDuo) and the ESP32; and the wireless charger, the motor and battery connections, respectively. Refer to figure 2 for illustration.
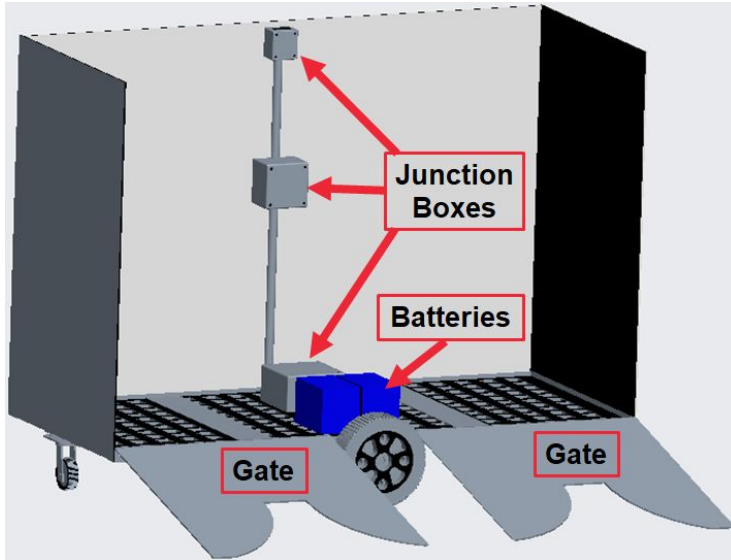
Figure 2 - 3D rendering of the cart and its components.

Pseudo Code

```
While PowerOn== TRUE
{
if forward button == 1

        Roll both wheels forward;

if right button == 1
        {
        Roll left wheels forward;
        Roll right wheels backward;
        }
if left button == 1
        {
        Roll right wheels forward;
        Roll left wheels backward;
        }
if back button == 1

        Roll both wheels backward;
if Stop==1
        Don't move;
}
```

<u>Operation</u>

To Navigate

Using the phone app, the users will have a power button, and a basic directional pad for controlling the movement of the cart. In order for the cart to move, the power button on the physical cart (located on the highest junction box) must first be pressed. To have the cart move forward (in relation to the front of the cart) press the forward/up arrow. To have the cart move backward (in relation to the front of the cart) press the back/down arrow. To have the cart turn its front end left, press the left arrow, and to have the front end of the cart turn right, press the right arrow. To engage the breaks on the cart without powering the system off, press the middle button.

To Set Up for Instruction

The roofing component should start at a stationary height of 6 feet 5 inches. If one would like to increase the height of the roof, you should remove the screws or pin connecting the roofing to the body of the cart, raise the roof to the desired height based on the pin holes provided, then place the screws back into the poles and secure them. To open the shading for the sides of the roof, simply raise each end by extending the shafts connecting the folding section of the roof to the body then tighten the wing nut in place to prevent it from closing in.

Disengage the gate from the lower junction box. This will require an initial large amount of force, but that is just to disengage the gate from the magnet. Once the gate is lowered, step onto the cart carefully by stepping over the gate to enter.

Turn on the media devices that will be in use (i.e. monitor, speaker, and microphone) while standing on the cart. These devices can be turned on how they typically

To Instruct Students

There are many ways to utilize the vehicle for instruction. Below we will detail the recommended method.

Instructor is to stand upon the cart once its set up is complete. The instructor will be facing out towards the students, who may be situated in front of and to the sides of the professor on the ground. During typical instruction, the monitor can be utilized to display instructional material. As the monitor is a smart TV, it allows the user to bluetooth their screen onto the device or utilize an HDMI cord. Students are recommended to be to the front of the device when utilizing the monitor. When breaking the students into groups, the sides of the carts are most optimal as it provides the students with a space to jot their ideas. The instructor can feel free to move around the cart at this time to examine what is occurring and facilitate learning. It is recommended to close the gate of the cart when not intending to stand on the platform.

The speaker and microphone are provided for convenience, especially for soft-spoken professors or for when the PUC is used in a noisy environment. The monitor can also produce auditory sound, but should not be connected with the speaker.

To Break Down after Instruction
All devices should be powered down upon completion of instruction, with the audio of the monitor being muted as well. Return all media options to their original state (i.e. wipe off the dry erase boards and place everything back in the drawers they were found in). Place the gate into its engaged position.
Fold the roofing components back down to allow for clearance during navigation. If the roof legs were lowered, please return them to their extended height. Navigate the cart back to its desired location based upon the instructions found in "To Navigate." Turn off the vehicle using the power button.

Troubleshooting

If the device does not work as the manual instructs, please refer to this guide to solve the issue.

- Media device is not turning on
  - Make sure that the power is properly connect
  - Check and see if the there is power being supplied to the inverter
  - See if the battery is charged
- Roofing component is not stable
  - Tighten the bolts on the roof legs to the body of the cart itself
  - Make sure everything is in its proper place and not damaged
- Roofing folds are not going down
  - Loosen the wing nut on the shaft holding the roof up
  - Possible lubrication needed
  - Clear anything obstructing it
- Device is not in motion
  - Make sure the battery for the motors are fully charged as well as the remote controlling them
  - Make sure there is nothing obstructing the wheels or the cart itself
- Gate not opening
  - The magnet holding the gate up is strong so applying more force may be necessary
  - May need lubrication at the hinges

Work to Be Done

The basic frame of the cart is completed, but converting it into the Pop-Up Classroom is not completed. The batteries need to be replaced, since the current batteries do not have enough power due to extended time of disuse. The code is complete besides the aspects regarding connecting the hardware. Once hardware connection is completed, the code should be troubleshooted and fully implemented into the system. Due to the current situation, some of the components needed had their orders canceled (such as AV Cabinet, new batteries, white boards, mic), with a full list being defined within the BOM. Some of these components can still be purchased through personal funds and the BOM will be updated accordingly. The basic structure of the device is complete, though, the media devices just currently do not have a power supply nor are they attached to the PUC.