

Network Arcade Cabinet

DESIGN DOCUMENT

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Definitions:

- ETG: Electronics Technology Group. A group located in Coover Hall that handles parts and computer renting & repairs.
- TLA: Transformative Learning Area. This is a room in Coover Hall that houses a myriad of computers and lab stations. It has housed most of the arcade cabinets at ISU.
- ECpE: Electrical and Computer Engineering Department. The department that handles Electrical, Computer and Software Engineering operations at ISU.
- NES: Nintendo Entertainment System. One of the consoles whose games are included in the system.
- SNES: Super Nintendo Entertainment System. One of the consoles whose games are included in the system.
- N64: Nintendo 64. One of the consoles whose games are included in the system.
- Dreamcast: Sega Dreamcast. One of the consoles whose games are included in the system.
- GameCube: Nintendo GameCube. One of the consoles whose games are included in the system and whose controllers are included on the exterior.
- NTSC: National Television System Committee. The format that most American DVDs and media forms adhere to, including video games.
- CAD: Computer Aided Design. A type of design creation that involves creating a design using computations and computers.
- UPS: Uninterruptible Power Supply

1 Introduction

1.1 ACKNOWLEDGMENT

The project is made possible due to the support of Dr. Joseph Zambreno, who has agreed to assist with the project in regards to technical assistance, equipment procurement and a general budget of around \$2,000. The team would also like to acknowledge the ETG for their support in setting up a workspace in the senior design lab and donating two computers that will be used in our final product. Along with a special thanks to Andrew Jordan, for helping with wood cutting for the foundation of the cabinets.

1.2 PROBLEM AND PROJECT STATEMENT

Coover Hall's large Transformative Learning Area (abbreviated as the TLA) has housed a multitude of arcade machines in the past, mainly from other senior design projects. These machines were designed to entertain students with visual flair and, in some cases, accommodate for multiple people to play together. At this time, however, none of the machines are in working condition. Common issues that have come up in past projects are wear & tear, tampering, and theft. As a result, the machines sit unused and no longer serve the public.

This project is designed to be the latest and greatest arcade machine in the TLA. Learning from the mistakes of past projects, the team will manifest a system with an expected lifespan of 5+ years. The new machine also intends to account and prepare for the shortcomings of previous arcade systems developed at Iowa State University.

1.3 OPERATIONAL ENVIRONMENT

The end product is designed to work in moderately intense environments and is user-oriented. While the product will typically reside in the TLA, it is designed so that it can be shared and presented at events.

In terms of operational conditions, the end product is aimed to be used primarily indoors. Weather conditions are not anticipated to be a concern during operation, but conditions such as dirt, sweat, and grime are expected.

1.4 INTENDED USERS AND USES

The users of this product are expected to be college-aged students that are usually located in the TLA. However, the product will be designed so that it friendly for all age groups that are

interested in video games. The product is designed to handle heavy strain as users are not expected to handle the product gently.

The uses for this product are to provide stress relief to the users, provide entertainment, and to create a friendly environment. After a day of work or during a break, individuals can use the product to eliminate stress. Also, the product will provide an enjoyable experience that will create an environment that will invite other individuals to join in. This provides a unique attraction and shows the capabilities of Senior Design and the ECpE Department.

1.5 ASSUMPTIONS AND LIMITATIONS

Assumptions:

- The maximum number of players that can play on a single side is 2.
- The maximum number of players that can play a game is 4.
- The end product will be able to connect back to back or side to side.
- The end product will be able to play retro arcade games such as MAME, NES games, SNES games, N64 games, Dreamcast games and GameCube games (NTSC preferred, can be international), Laser disc player (Daphne)
- The end product will be able to withstand the pressure of multiple users leaning on the product.
- The end product will keep internal parts locked inside of the system, accessible via keys.
- The end product is designed to last around 5 years.
- The end products are designed to communicate with each other.

Limitations:

- The cost of the project shall not exceed over \$2,000.
- The size of one cabinet cannot exceed a width over 34” and a height of 82”.
- The physical cabinet cannot be made with magnetic material.
- The wiring of the end product must not be seen in plain sight.
- The weight of a single cabinet can’t exceed over 350lbs.

1.6 EXPECTED END PRODUCT AND DELIVERABLES

- The Arcade Cabinet System
 - One two-set arcade cabinet system. These are to be powered by a traditional electrical socket that is then hooked up to a UPS.
 - To be delivered at the end of the Fall semester.
- Operations Manual
 - A document that explains the basic functions to the reader, including powering, selecting games, and troubleshooting.
 - To be delivered at the end of the Fall semester.

- Owner's Manual
 - A document for the client that explains more detailed troubleshooting, debugging and administrative access, as well as how to customize and alter aspects of the machine.
 - To be delivered at the end of the Fall semester.
- Parts List
 - A list of all parts including buttons, controllers, hardware and software used. This is included to give the client exact details of parts so that, in the case of defective or broken parts, they can have an idea of what parts to order. Also, the desire to buy cheaper alternatives and know the general operating requirements.
 - To be delivered at the end of the Fall semester.
 - Included with the Owner's Manual.
- Security Access
 - The necessary set of security options (intended to be a set of combinational lock numbers) to access the inner workings of the system. Prior systems have been prone to theft or tampering, thus necessitating this decision on the team's end. The keys will be kept together in a ring and maintained by the client for the foreseeable future, once the product's development has formally concluded.
 - To be delivered at the end of the Fall semester.
- Design Document
 - The design document, which details the inner workings of the expected end deliverables and the design.
 - To be delivered at the end of the Fall semester.
- Demonstration Report
 - A demonstration to the client that shows the progress of the product and the system in its current state.
 - To be delivered at the end of the Fall semester.

2 Final Design

2.1 DESIGN OVERVIEW

For the Final design, the team needed a design that will fulfill the requirements listed in Table 1:

Requirement	Description
Mobility	Be able to move freely or easily
Portability	Easily being to be carried into other rooms
Longevity	Last a minimum of five years
Maintainability	Little repair needed over the lifetime of the system
Seamlessness	The system works with minimal errors

Table 1: List of Requirements for Design

After brainstorming, the team has stuck with the Battle Station with a Connect-a-Cabinet design. Meaning that there are two cabinets that have two sets of joysticks and two sets of arcade buttons per unit along with 2 gamecube controllers. Allowing 1-2 payers to play on one cabinet, with the development of 2 cabinets it expands the amount of players from 1-2 to 3-4 since there cabinets are identical. The two cabinet and split game approach has lead us to the networking aspect of the project. Team 23 has customized a main menu that has incorporated multiple emulators that runs our 40+ games.

Taking the design from the previous semester, the team has built the arcade cabinets that are shown in Figure 1. To go more into depth of what is being shown in Figure 1 is at the bottom is a gutted Dell T1600 and Dell T1500 computer that is laid over a display board. On the display board is the power source, graphic card, CPU and hard drive. These are all being shown off and lit up by a customizable LED strip that the team soldered together inside the window frame. Above the window there will be two gamecube controllers, that has a limit switch in the mold holster that will tell the teams microprocessor which style is being played, the buttons or the controller. In more detail the limit switch will be hooked up the MUX as the selector switch, if closed it will proceed to take inputs from the buttons and joysticks and vice versa if opened. Working up to the middle section of the cabinet we have the 2 joysticks, 16 arcade buttons and then 1 volume control knob. The team then layed out the joystick and button layout that the

client later accepted and approved. After extensive comparison and research of how the arcade buttons should be laid out and what is the most comfortable to the users, the team came up with well placed buttons for easy back and forth gameplay with the buttons. Volume control knob was a vital piece to the design, with the cabinet being in the TLA majority of the time, having a control knob can immerse students into the games but kept quiet enough to not distract. With the bottom of the machine done the next big part of the arcade machine is an Insignia 32" TV this is what will portray the main menu customization, emulators and networking capabilities. A list of every hardware and software part used in the project is below.

Hardware:

- Computer #1 Arcade Beta
 - The main computer is a Dell T1600 with a MSI Geforce GTX 1050 TI 4 GB and i7 processor. It was donated by the ETG and deconstructed onto the display board. The operating system is running on Ubuntu 18.04.
- Computer #2 Arcade Alpha
 - A second computer, donated by ETG is a Dell T1500 also with a MSI Geforce GTX 1050 TI 4 GB and an i5 processor. The operating system is running on Ubuntu 18.04.
- GameCube Controllers
 - These are PowerA GameCube style controllers with a USB to MicroUSB connection. There are two per each system.
- Arcade Controls
 - These are a set of 8 buttons and a joystick per player (2 per system).
- Controller Holster
 - A controller holster designed to hold the GameCube Controllers and a Limit Switch.

Software:

- RetroPie
 - An emulation frontend, that allows players to quickly load from a library of games and quickly setup emulation without having to dig too deeply into files. This was the primary frontend testing method and allowed the team to quickly troubleshoot.
- Dolphin
 - A GameCube emulator, also usable in RetroPie. This is more in-depth than RetroPie's and allowed the team to more stringently benchmark each game currently loaded on the system.
- Reicast
 - A Dreamcast emulator, also usable in RetroPie.
- MAME
 - Multiple Arcade Machine Emulator, also usable in RetroPie. This allowed the team to test arcade games.

The following figures below are the design of the final cabinets.



Figure 1: Final design

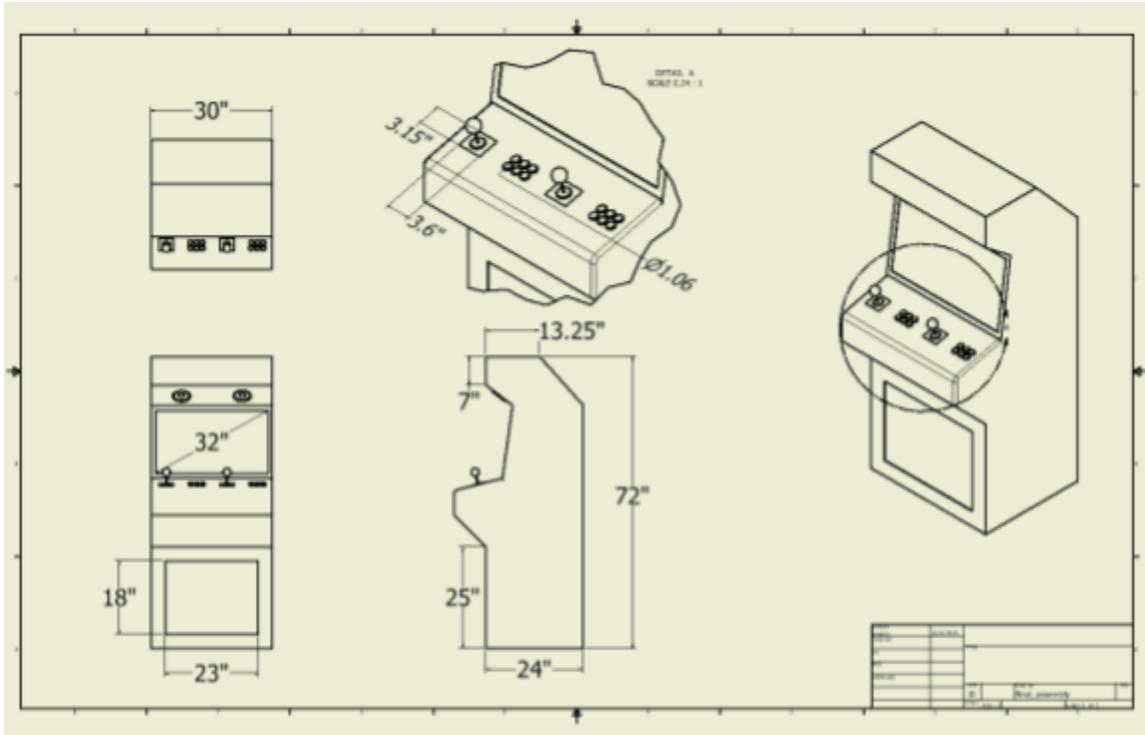


Figure 2: CAD Model Isometric View

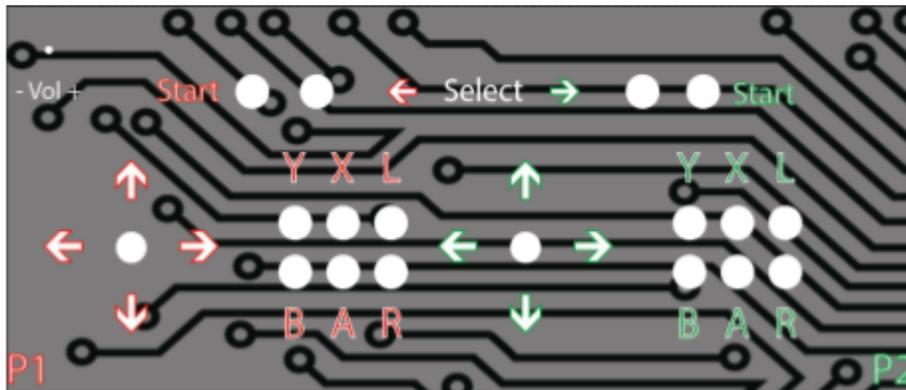


Figure 3: Vinyl Design on Arcade Beta Control board

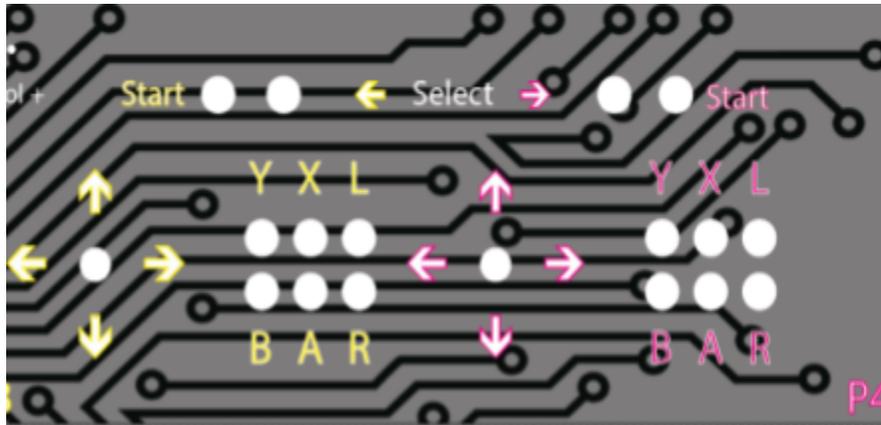


Figure 4: Vinyl Design on Arcade Alpha Control Board

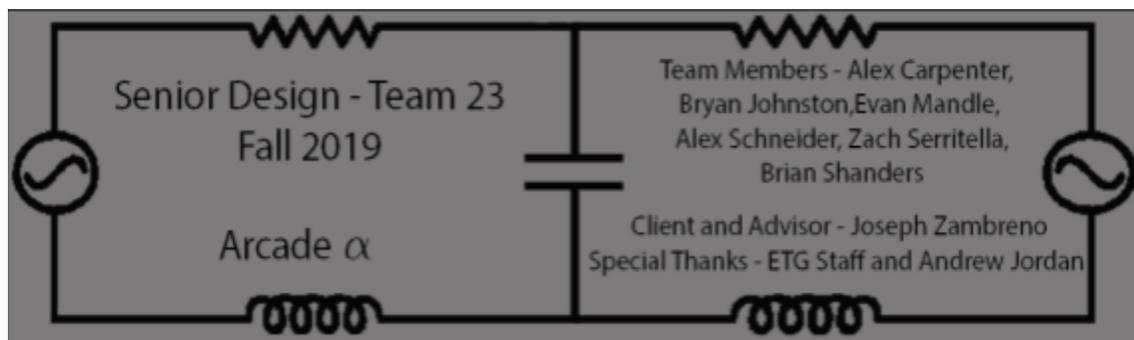


Figure 5: Vinyl Design on Arcade Alpha Headboard

In addition, the team had functional (physical and qualitative) and non-functional (more quantitative) requirements for the system, shown below:

Functional:

- Portable
 - A single unit will be attached to wheels and be able to move through a standard-issue door and elevator.
- Arcade controls & 6th console generation controls
 - Standard joysticks and push buttons are to be included with the project. In addition, GameCube controllers, from the 6th console generation, are included per person.
- Modern Screens
 - The system will run on High Definition screens rather than CRT retro screens.

- Structurally sound
 - The cabinet will be strong enough to support a human body leaning on it and have a wide enough base to prevent it from tipping over.
- Controllable sound
 - The cabinet sound can be adjusted from the outside of the machine to accommodate different game audio levels.
- Integration of networking
 - A unit is expected to be able to network within itself and to play select games together or separately.
- Main Menu
 - Each cabinet should have a functional menu that allows them to select the number of players and the game they wish to play.

Non-Functional:

- Able to load games in under 10 seconds
 - The games will be playable in a short time period.
- Concise and uniform wiring
 - The cabinet's wires should not excessively stick out and mainly protrude from a single area to connect to the back unit.
- LED lighting
 - The cabinet will look nice and inviting.

2.2 DESIGN PROCESS

The team started off by handling initial research for the construction of the cabinet. While there were initial issues with contacting one of the providers for our direct hardware and wood, we were able to order and determine the majority of parts for the system and order them so construction could occur as soon as possible. This resulted in the team well surpassing the budget.

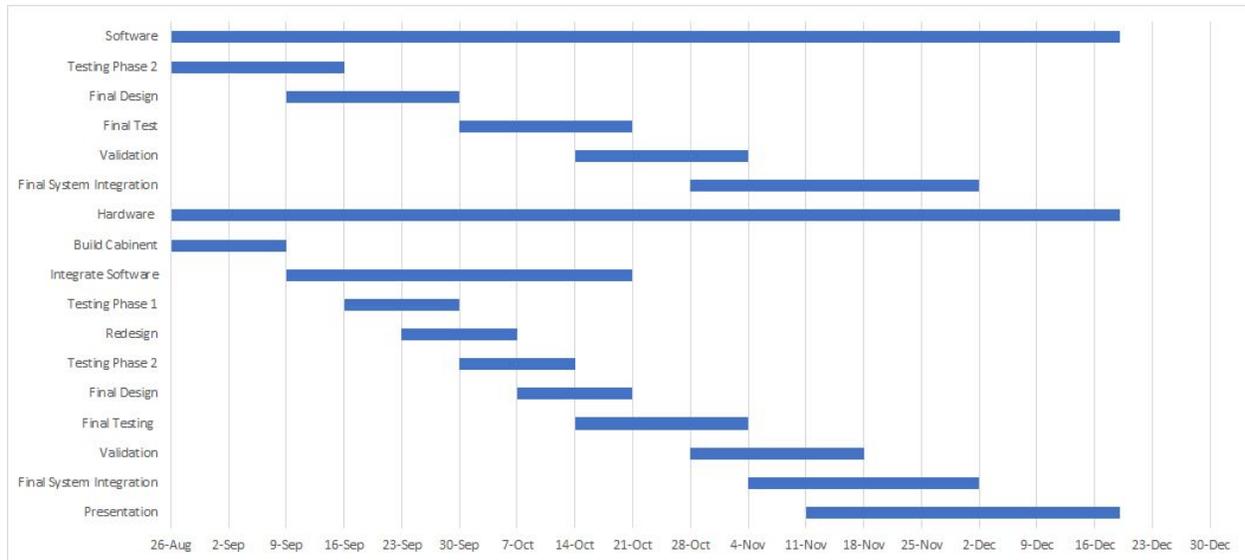


Figure 6: GANTT chart for Fall 2019 Semester .

The team was able to install and setup most of the games onto the system with little hiccups; most issues came from varying issues with differences in the machine’s components. As a result, the team and client decided to increase the power and order newer parts to make sure that the systems would run as close to each other as possible. While there were a handful of residual games, these were eventually culled so that the systems matched. As a consideration for another system, it is recommended that the specifications match as much as possible.

Once much of the integration with the software was completed, tuning was started and the team began to test utilizing controllers. While the team initially had a controller style that used more literal GameCube controllers, this needed to be changed later on, though this resulted in some issues being fixed.

As this occurred, the team finally was able to obtain the necessary wood parts and was able to start constructing the machine’s exterior. In addition, team members worked on the LED and configurations concurrently, planning for additional games and ironing out several kinks in the system, resorting to remove games if there was no determined fix by a specified date. This process was around 2 months considering other remaining obligations with the project. While designing the wood parts, there were several considerations and minor changes that needed to be made with minor errors in construction. It is recommended that, in the event of a new machine, components are assembled from the bottom up and exact tools are used when possible. After the initial construction and most parts were in place, the internals were painted. Three coats needed to be utilized and some errors with painting resulted in painting processes occurring up until the final weeks of the project. In hindsight, it would have been more beneficial to paint once all parts were constructed.

Once the team's main core was created to mount the machine, both machines were disassembled and then placed on as soon as possible to ensure testing and configuration would not be too stalled. This allowed the team to best construct and begin actual testing, which is outlined in Part 3. While initial tests were completed with aspects of the machine completed, the team decided to revisit all tests once the hyper majority of the cabinets were complete and ready for the show floor. This point would result in the final parts being assembled and placed onto the machine that would lock off access to general users and non-administrators (controller wiring, glass pane, locks on the back of the machine, machine set to Kiosk, etc) - these items needed to be placed on at the end to allow for as much configuration as possible.

While more flexible time would likely result in a quicker assembly, there are a handful of takeaways from the building process. Working on the software side of things before the hardware was ready to assemble was a good multitasking process, despite some issues occurring after the transfer that were unprecedented. The team had some residual issues with determining how to mount the controllers, but eventually found a workable solution with CAD modeling. Additional considerations can be found in Appendices II and III.

3 Testing and Implementation

3.1 INTERFACE SPECIFICATIONS

One of the main parts of hardware interfacing is the buttons and joysticks. The user will use the buttons to select, jump and or act (not defined to just these outputs) to control the game. The testing phase will include properly setting up the buttons and joysticks onto the cabinet which has been completed and had the approval of the client. Once in place all the buttons will be wired up accordingly and hooked up to an encoder. That makes the buttons go from analog to digital and the team can now determine what the controls of up, down, left and right are. That encoder then was then connected to a MUX board that will have inputs from the buttons and joysticks along with the gamecube controller. The MUX is designed with a lever switch so that when the user picks the gamecube controller the MUX will switch to the proper input (gamecube or buttons and joystick). From the MUX it will then go to a USB that will be connected to the computer where now the team need to decipher the controls and see what variables go with what controls. In figure 7 it will help show what the process is.

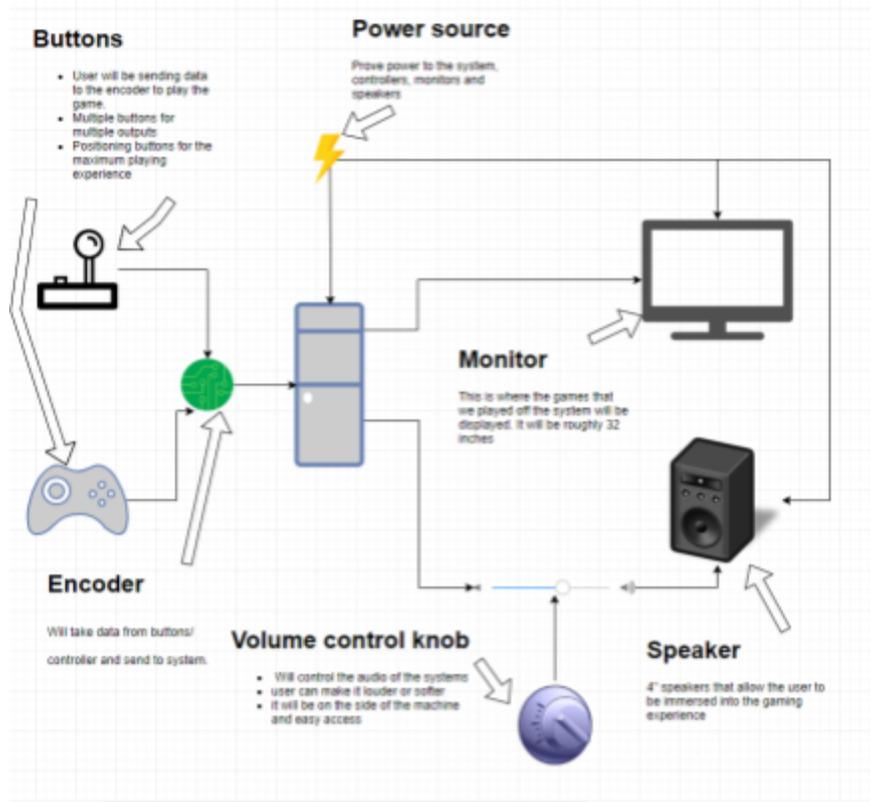


Figure 7: Interface Design

On the software interfacing side of the project, the user will be interfacing with a main menu. The main menu is built and a few screenshots are shown in operations manual in appendix II. The team has coded the system to immediately launch retroPie when system boots up so when the user is ready the system is ready to be used and launch any emulator and game. The main menu has been designed to match the design of the outside of the cabinet, it will be categorized by system, number of players and then co-op and single player games. All games are fully functioning and are already configured to each game. If there is an issue with gamecube controller not working then refer to the owner's manual.

3.2 FUNCTIONAL TESTING

Portability

This testing procedure tests for the unit's ability to both be portable and stationary. This also tests to make sure not too much personnel is required to move the unit. This test is passed or failed by both units simultaneously.

1. Unlock the cabinet wheels on both units. Place the units into the back-to-back mode.

2. The cabinets should be tested and rolled through the following doors and areas in Coover Hall's Floor Plan (Floor 1). For these tests, two people of average weight should move the carts around.
 - a. Room 1301 (Senior Design Lab) - Entrance + Exit
 - b. Room 1313 (Transformative Learning Area) - All 3 doors
 - c. Room 1016 (Coover Hall Classroom) - North Entrance + Exit
3. Return the cabinet to Room 1301, and lock the cabinet wheels on both units.
4. Have two people of average weight apply force in the following manners:
 - a. Push the machines forward.
 - b. Pull the machines towards themselves.
 - c. Attempt to move the machines from a back-to-back mode to side-to-side while they are active.

PASS/FAIL CRITERIA: PASS

Pass: Steps 1-4 are passed and there is no damage to the machine.

Fail: Any of the following occur:

- The machine is unable to be moved by two people without noticeable strain.
- The units are unable to pass through any doors.
- The machine moves significantly while the wheels are locked.

Arcade Controls & 6th Generation Controls

This testing procedure looks towards our unit's ability to both use console controls and arcade controls to operate the system. This test may be passed individually.

1. Boot up the system, and let it go to RetroPie through startup.
2. Select the Game Collection "Single Player" using the Arcade Controls.
3. Select the Game "NBA Jam", using the Arcade Controls.
4. Ensure that the game functions as intended and is playable.
5. Press Start and Select, the top buttons on the machine, and return to RetroPie.
6. Remove the GameCube Controllers from their holsters on the machine.
7. Select the Game "NBA Jam", using the GameCube Controls.
8. Ensure that the game functions as intended and is playable.
9. Swap back to the Arcade Controls by returning the controller to its holster.
10. Ensure that the controls are correct and match the previous ones.
11. Press Start and Select, the top buttons on the machine, and return to RetroPie.

PASS/FAIL CRITERIA: PASS

Pass: Steps 1-9 are passed and there are no major hiccups with the controls.

Fail: Any of the following occur:

- The controls do not correspond to the intended diagram, for either Arcade or GameCube.
- Either control type is unable to return to the menu.
- The game does not load or boot correctly.

Modern Screens

This testing procedure looks at the unit's 720p monitors to make sure items load correctly, and that the screen does not move out of its intended position. This test may be passed individually.

1. Boot up the system, and let it go to RetroPie through startup.
2. Select the Game Collection "Single Player" using the Arcade Controls.
3. Select the Game "Dodonpachi Daifukkatsu Black Label", using the Arcade Controls.
 - a. This game features a RAM/ROM Check.
4. Move the system to side-to-side position.
5. Exit the game.
6. Select the Game "Mortal Kombat II", using the Arcade Controls.
 - a. This game features an abnormal RAM/ROM Check.
7. Move the system from back-to-back position.
8. Exit the game.
9. Exit RetroPie and restart the system.
10. Turn off both units.
11. Boot up the system.

PASS/FAIL CRITERIA: PASS

Pass: Steps 1-9 are passed and there are no immediate issues with the screen.

Fail: Any of the following occur:

- There is noticeable screen burn-in.
- There are dead pixels on the screen, or part of the screen does not display.
- The screens fall out of their intended sockets.
- The screens experience visual errors while the systems are moved.
- The screens do not display an image after the system has been booted for more than 30 seconds.

Structurally Sound

This test looks towards applying force to the cabinet while it is standing still and moved to simulate leaning and force applied against it. This test is passed or failed by both units simultaneously.

1. Place the cabinets into the back-to-back position.

2. Have two people place their weight onto each machine (one each) through the control panel.
3. Have two people place their weight onto one machine through the control panel.
4. Have two people place their weight onto the same side of both machines.
5. Place the cabinets into the side-to-side position.
6. Have two people place their weight onto each machine (one each) through the control panel.
7. Have two people place their weight onto one machine through the control panel.
8. Have two people place their weight onto the back side of both machines.

PASS/FAIL CRITERIA: PASS

Pass: Steps 1-8 are passed and there are no issues with the soundness of the machine.

Fail: Any of the following occur:

- The machines tip during the process and are unable to support the weight of the individuals.
- Either machine experiences a sink-in (IE: parts collapse upon themselves).

Controllable Sound

This test looks towards the sound systems of either machine. This test may be passed individually.

1. Boot up the system, and let it go to RetroPie through startup.
2. Ensure that sound is on.
3. Select the Game Collection “Single Player” using the Arcade Controls.
4. Select the Game “Kirby Air Ride”, using the Arcade Controls.
5. Turn off the sound.
6. Turn on the sound.
7. Exit the game.
8. Move the system from back-to-back position to side-to-side position, and vice versa.
9. Select the Game “Kirby Air Ride”, using the Arcade Controls.
10. Turn off the sound.
11. Turn on the sound.
12. Exit the game.

PASS/FAIL CRITERIA: PASS

Pass: Steps 1-12 are passed and there are no issues with the sound system.

Fail: Any of the following occur:

- The sound does not turn on when desired.
- The sound does not turn off when desired.

- The sound plays improperly, with stutters, excessive compression or glitched audio.

Netplay

This test looks at the netplay functionality of the machine. Not all games are compatible with netplay, so this test looks at two, three and four player games to test their functionality with the application. This test is passed or failed by both units simultaneously.

1. Boot up the system, and let it go to RetroPie through startup. Have one system set as Client and one as the Host; these should be set up before the test begins.
2. Select the Game Collection “Single Player” using the Arcade Controls.
 - a. 2 player game.
3. Select the Game “Mortal Kombat II”, using the Arcade Controls.
4. Start the game, but force it into netplay mode by going into the settings by pressing a button before the game starts. For full usage, set the machine into a low-settings UI Mode.
5. Test the controls and latency.
6. Exit the game on both systems using the Arcade Controls
7. Select the Game Collection “Single Player” using the Arcade Controls.
8. Select the Game “Alien Vs Predator”, using the Arcade Controls.
 - a. 3 player game.
9. Start the game, but force it into netplay mode by going into the settings by pressing a button before the game starts. For full usage, set the machine into a low-settings UI Mode.
10. Test the controls and latency.
11. Exit the game on both systems using the Arcade Controls.
12. Select the Game Collection “Single Player” using the Arcade Controls.
13. Select the Game “The Simpsons”, using the Arcade Controls.
 - a. 4 player game.
14. Start the game, but force it into netplay mode by going into the settings by pressing a button before the game starts. For full usage, set the machine into a low-settings UI Mode.
15. Test the controls and latency.

PASS/FAIL CRITERIA: **PASS**

Pass: Steps 1-15 are passed and there are no issues with the sound system.

Fail: Any of the following occur:

- Any of the selected games for testing do not enter netplay, either because of a MD32 mismatch or connection error.

- The gameplay and latency produce an arguably unplayable connection (~100+ millisecond latency).
- Exiting netplay results in a program softlock.

Main Menu

This test looks at the functions of our main menu. It makes sure that our menus are working as intended and don't show features we want public users (IE: not our client or us) to change. This test is passed or failed by both units simultaneously; the machines should have matching menus, after all.

1. Boot up the systems, and let them go to RetroPie through startup.
2. Open up each of the Game Collections through Arcade Controls. Ensure that there are no errors and games are erroneously included in the wrong collection.
3. Access the options. Make sure that administrative controls are limited for a public scenario.
4. Select the Game Collection "Single Player" using the Arcade Controls.
 - a. 2 player game.
5. Select the Game "NBA Jam", using the Arcade Controls.
6. Press Start and Select, the top buttons on the machine, and return to RetroPie.

PASS/FAIL CRITERIA: PASS

Pass: Steps 1-6 are passed and there are no issues apparent with the Main Menu.

Fail: Any of the following occur:

- The Main Menu has errors in the game lists from the team's mistakes.
- The UI does not load in any capacity.
- Upon exiting a game, the UI fails to load.

Uninterrupted Power Supply

This test looks at our Uninterrupted Power Supply (UPS), and makes sure that it properly allows the system to restart safely, and reboot as well. This test is passed or failed by both units simultaneously.

1. Boot up the systems, and let them go to RetroPie through startup.
2. Unplug the system from their current power source.
3. Allow for the system to reboot by using a timer that goes for 3 minutes.

PASS/FAIL CRITERIA: PASS

Pass: Steps 1-3 are passed and the system reboots in a timely manner.

Fail: Any of the following occur:

- The system turns off when the power source is unplugged (the UPS fails to store a charge).
- The system does not reboot correctly.
- The system does not reboot within 3 minutes of removing the power source.

3.3 NON-FUNCTIONAL TESTING

Quick Game Loading

This test looks at the game loading of our games, and makes sure that RetroPie loads them properly. Note that loading into a RAM/ROM check counts as loading into the game. This test may be passed individually.

1. Boot up the systems, and let them go to RetroPie through startup.
2. Select the Game Collection “Single Player” using the Arcade Controls.
3. Select the Game “NBA Jam”, using the Arcade Controls.
4. Setup a timer for 10 seconds.
5. Exit the game using Arcade Controls.
6. Select the Game Collection “Single Player” using the Arcade Controls.
7. Select the Game “Kirby Air Ride”, using the Arcade Controls.
8. Setup a timer for 10 seconds.
9. Exit the game using Arcade Controls.
10. Select the Game Collection “Daphne” using the Arcade Controls.
11. Select the Game “Dragon’s Lair”, using the Arcade Controls.
12. Setup a timer for 10 seconds.
13. Exit the game using Arcade Controls.
14. Select the Game Collection “SNES” using the Arcade Controls.
15. Select the Game “Street Fighter 2 Turbo”, using the Arcade Controls.
16. Setup a timer for 10 seconds.
17. Exit the game using Arcade Controls.

PASS/FAIL CRITERIA: PASS

Pass: Steps 1-17 pass and the games load within the time limit.

Fail: Any of the following occur:

- Games fail to load within the time limit.
- Games load with significant errors.

Concise Wiring

While seemingly qualitative, this operation looks at a few hard facts and quantitative measurements that can be used to better show that our wiring does not stick out. This test may be passed individually.

1. Inspect the front of the machine.
2. Inspect the back of the machine and open up the back window.

PASS/FAIL CRITERIA: PASS

Pass: Steps 1-2 are passed with no wiring checks failed.

Fail: Any of the following are observed:

- The wiring obscures the LED interface, barring the intended motherboard showcase.
- Wires are visible and exposed beyond what is absolutely necessary (ethernet/power cables)
- Wires for the TV, controllers, etc are exposed when not intended.

LED Lighting

This test looks at the LED lighting interfaces located within the glass window at the bottom of our cabinets. This test may be passed individually.

1. Boot up the systems, and let them go to RetroPie through startup.
2. Turn off the system manually.

PASS/FAIL CRITERIA: PASS

Pass: Steps 1-2 are passed with no wiring checks failed.

Fail: Any of the following are observed:

- LEDs do not correspond to intended operation.
- LEDs do not turn on or off when intended.

APPENDIX I

Owner's Manual



sddec19-23

Networking Arcade Machine

INTRODUCTION

This manual is designed for the usage and viewing of Joseph Zambreno and any future collaborators or maintainers that he so declares. This document will provide an introduction to troubleshooting potential issues that may arise from the system, how to handle them, repairs and maintenance, and instructions for implementing a new system entirely. The team itself cannot be around forever, and thus this document is necessary.

This document will not cover items that are included within the Operations Manual that can be found online publicly here. More detailed instructions on implementing a new machine can be

found in the Final Report.

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1 - Troubleshooting

1. RetroPie issues

- a. The controllers are not responding to inputs and cannot advance through menus.
 - i. In the event that you must re-assign controllers, ensure that the machine is set into All-Access. From there, use the start button on the currently active controller and go to “Configure input”. Follow the protocol listed in section 4.D.
- b. RetroPie is not letting me access administrative settings.
 - i. Ensure that the cabinet is set from “Kiosk” settings to “Full” settings. You’ll need to go into the UI Settings in the Start Menu and enter the Konami Code (Up, Up, Down, Down, Left, Right, Left, Right, B, A, Start), which will get you into the full menu.
 - ii. From there, you should have access to admin settings. By default, the password for the system is “user”. Type this in and hit return; you will need this for configuration, netplay, and the like.
 - iii. Keep in mind that if you happen to access these settings at any point, **you will need to restart the computer; otherwise, the credentials will be retained. You will also need to switch back the UI settings to “Kiosk”.**
- c. You need to access the internal configurations to update one or both of the machines.
 - i. You will need to go to Configuration settings for RetroPie and input the console password (“user”). From there, you can find the configuration UI. The machine must be connected to the internet to accomplish this.

2. UPS system issues

- a. The system is not turning back off immediately after it is unplugged.
 - i. Please let the system sit to drain the UPS. In rare cases, this can occur if the UPS does not detect there is an issue.
- b. The UPS is beeping and causing a significant noise disturbance.
 - i. This is built into the UPS. Please hold down the Power Button for approximately 3 seconds.

3. Game boot up issues

- a. A screen stating the the program has closed unexpectedly is obstructing the view during bootup.
 - i. You will need to plug in the mouse to remove this obstruction. When a game is starting up, move the mouse over to the screen and close the window.
- b. The game is not starting under the current emulator.
 - i. Change the UI settings to “full” using the instructions above. Then, hit a button during the startup and select a different emulator; if the game continues to work, you may need to remove the game from public view.
- c. The game is not booting up if netplay is utilized.
 - i. Change the UI settings to “full” using the instructions above. Then, hit a button during the startup and select a different emulator; if the game continues to work, you may need to remove the game from public view.
- d. You want to get to the configuration screen for a game to test out a different emulator.
 - i. Change the UI settings to “full” using the instructions above. Then, hit a button during the startup and select a different emulator using the “set emulator settings for this game”.
- e. The games are not establishing netplay.
 - i. Ensure that the machines are connected locally in the connection settings. Go into the Internet Settings, and check the connections; make sure that they are marked as “Link - Local Only” and that the ethernet cable is in both computers.
- f. The netplay is presenting a “CRC32 Mismatch”.
 - i. The emulators or ROMs are different. You’ll need to decide which one to remove from a console and follow the instructions listed later in this document.
 - ii. You may need to update RetroPie entirely. Do this in the RetroPie settings under “Update Core Packages”. It is strongly recommended to do this at the same time for both computers; you will need to switch the internet settings to be a standard Ethernet connection.

4. Audiovisual issues

- a. The volume knob is no longer working. There is either no audio, or the audio is not turning off even when the knob is all the way to the lowest setting.
 - i. Ensure that the volume on the potentiometer is set to be on. If that is not pressed, then no audio will play. If you need to more permanently mute the audio, this is an option. If the audio is on, ensure that the sound cables are connected to the audio ports and the audio system itself.
- b. You just need to turn off the audio entirely.
 - i. Ensure that the volume on the potentiometer is set to be on. If that is not pressed, then no audio will play. If you need to more permanently mute the audio, this is an option.
- c. The TV is not displaying anything and is off.
 - i. Make sure that the TVs are connected to the HDMI cables. Make sure that the TVs are actually on (the respective remotes for each TV are included in the cabinet).
- d. I need to replace the TV.
 - i. You will need to unscrew or remove the bolts that lock in the TV. From here, you can select a new TV that fits within the dimensions or a replacement of the same TV.

5. Controller issues

- a. One of the buttons does not appear to work anymore and is either needing repairs or a replacement.
 - i. You'll need to unscrew the self-lock within the button itself, and then remove the specific connection wires (it does require a bit of force). If you need to replace all of the parts, place the button from the outside of the cabinet inwards, and then screw it into place with the self-lock. When applying the connection button, make sure that the outside piece faces outside.
- b. The joysticks appear to be loose.
 - i. The joysticks should be screwed in with 2 screws on opposite corners. If additional screws are necessary, apply more screws on the opposite corners.
- c. The Gamecube controllers are not responding to input even when removed from the holster.

- i. Ensure that the limit switch is de-pressed. If it is, you may need to check the connection between the jumper cable and the limit switch to ensure it is changing the selector in the MUX.
 - d. When swapping controllers, some of the games are desyncing the assigned controls.
 - i. In rare scenarios, the games may desynch controller assignments if done at a very specific interval. If this occurs, exit the game and start with the intended controller.

6. Hardware issues

- a. The computer is not turning on.
 - i. The computer can be manually turned on with a button, accessible from the inside of the computer. If the UPS is plugged in but is not automatically booting, hit this switch.
- b. The computer appears to be running on a low-power mode and is running the games poorly.
 - i. In extremely rare cases, the GPU may not load correctly. You will just need to restart the computer, which usually will fix the issue.

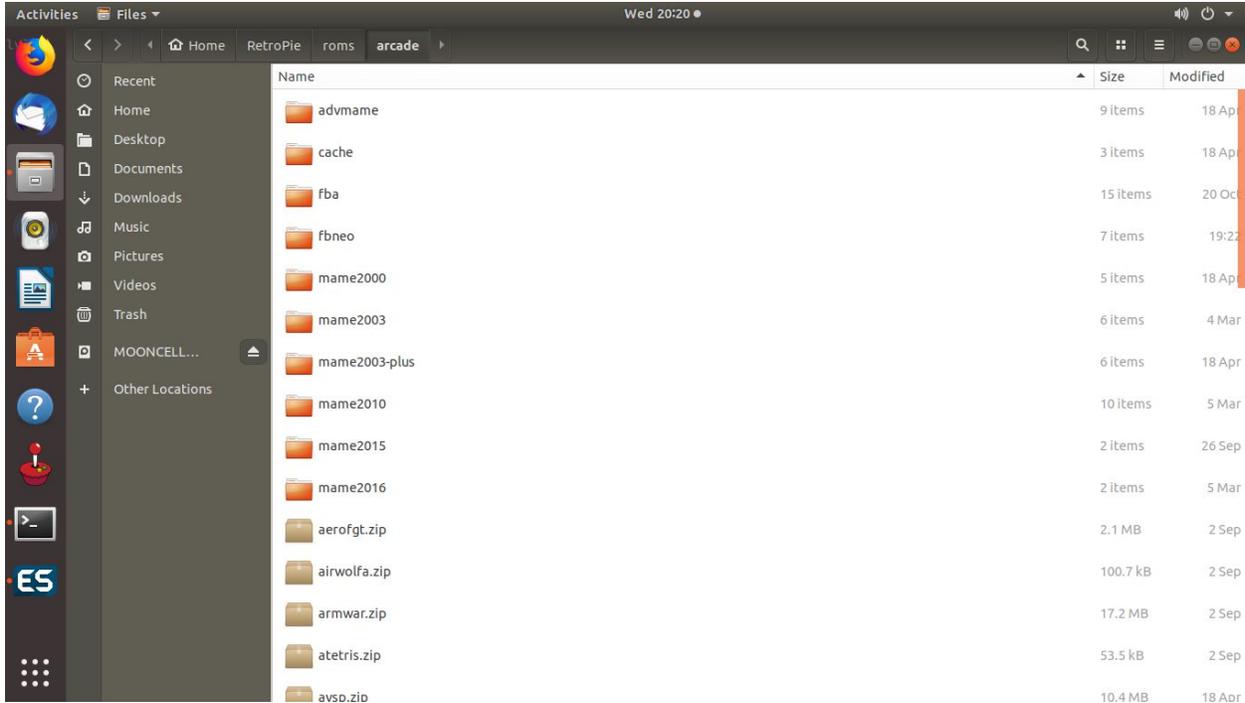
2 - Games on system

1. Adding games

Games may be added onto the system by taking the needed ROM file and placing it into... For obvious reasons, you will need to obtain these on your own.

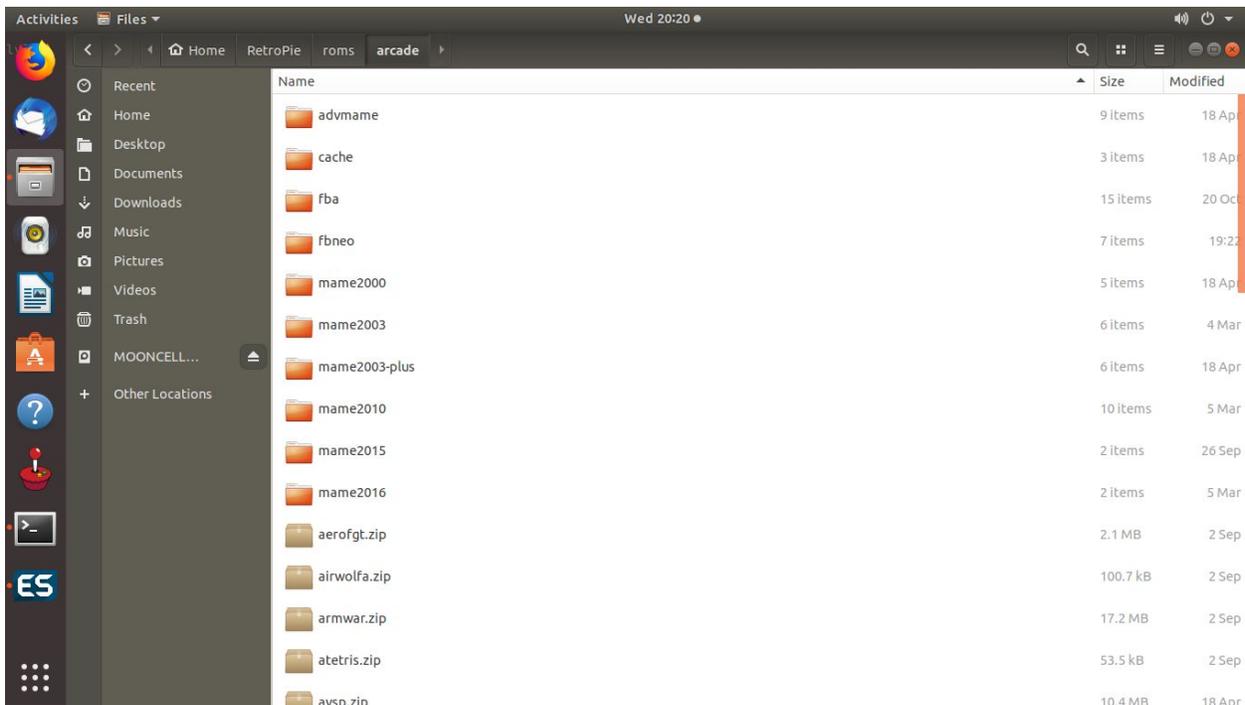
Once a file has been placed into here, RetroPie will attempt to detect it and throw it into one of the preset collections. If you want to add it onto a specific collection, do the following:

Enter the RetroPie directory in Home. You'll need to enter roms and then go to the specific emulator/platform of your choice (if you are adding a new platform, you'll need to do it in RetroPie first). From here, drop a zip file of the game. Seen below is the Arcade Directory.



2. Deleting games

If a game is no longer functioning, or you no longer want the system to hold the game for whatever reason, there are a few methods to isolate or remove the game entirely. Do the following:



From the same screen that you went to to add a game, you just need to delete the game. This will make the game no longer appear in RetroPie.

If you want to add a new platform onto the system, you need to enter the “RetroPie settings” and then enter the system password. From there, you can opt to look at normal branches or experimental branches and download them (note that some of the experimental branches may not download properly). **You must be connected to the internet to do this and it will take some time for some emulators.**

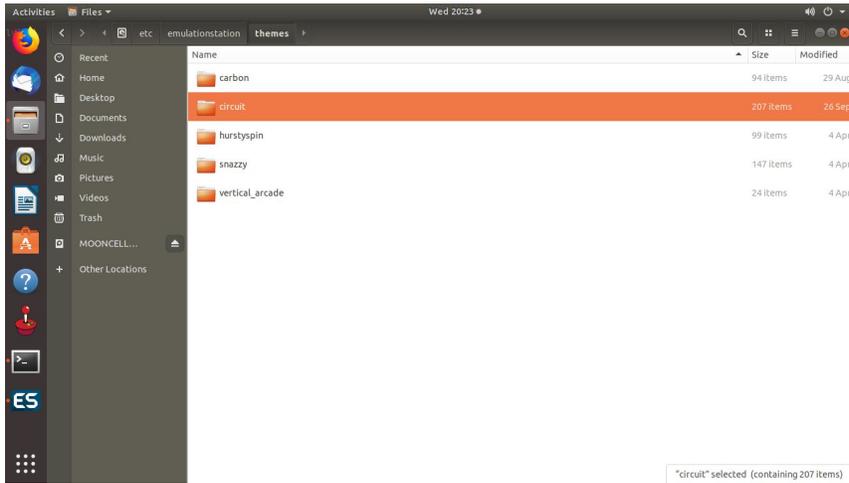
3. Explanation on configurations

Games on the system have a few general configurations, including Collection placing and categories. This will briefly explain how each is configured.

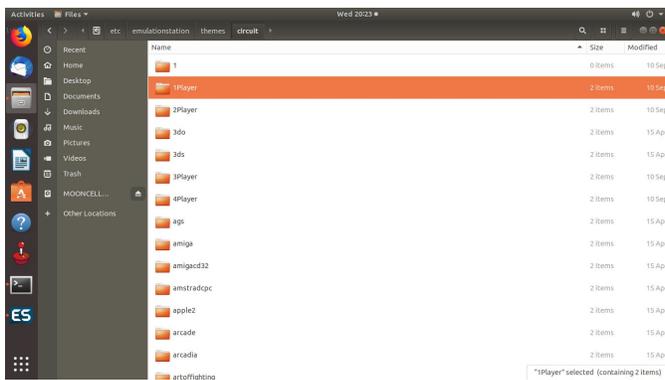
Each game is categorized under a “Collection”; that is, a specifically curated list of games placed in manually by the system. Collections can be edited utilizing RetroPie’s settings, and can be added as follows:

First, go to the specific theme you want to add a collection for. Our network uses the “Circuit”

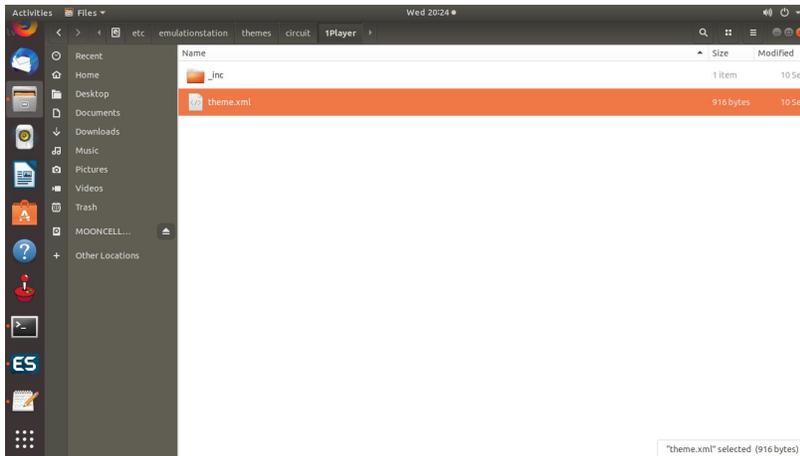
theme.



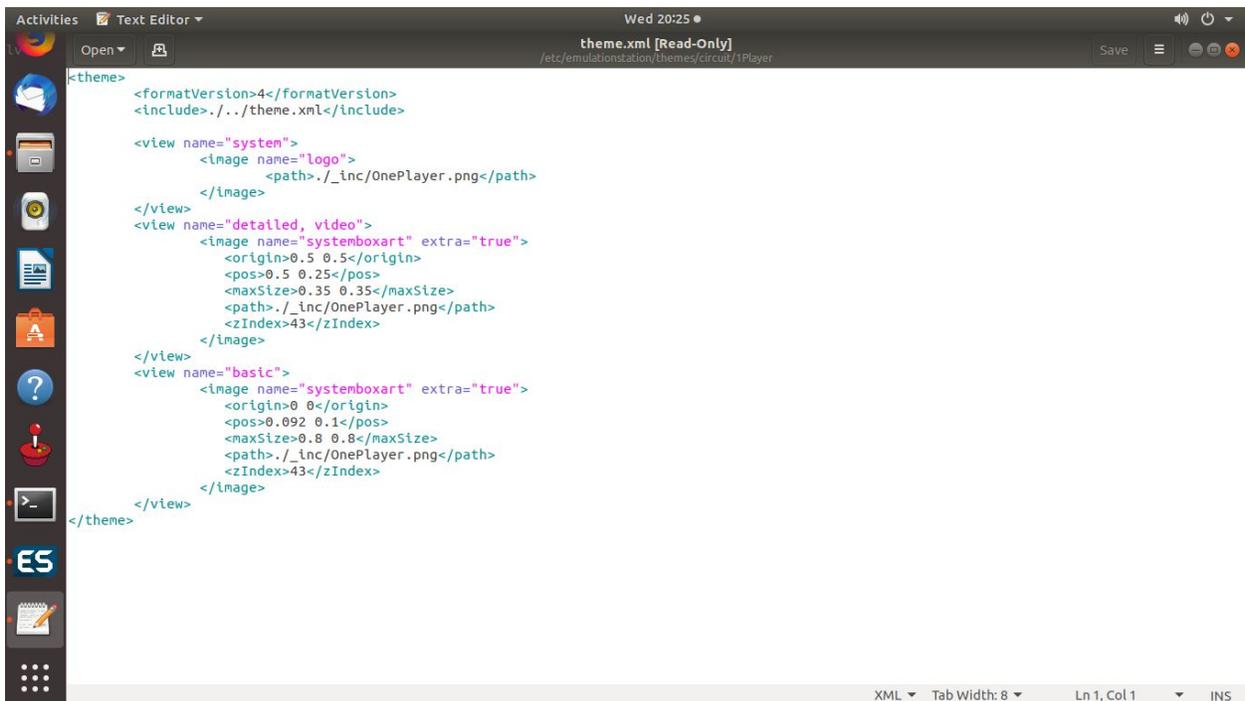
You'll need to make a new folder for your collection. Examples seen here that we have made are "1Player", "2Player", etc.



In that, go into the "theme.xml" file seen here:



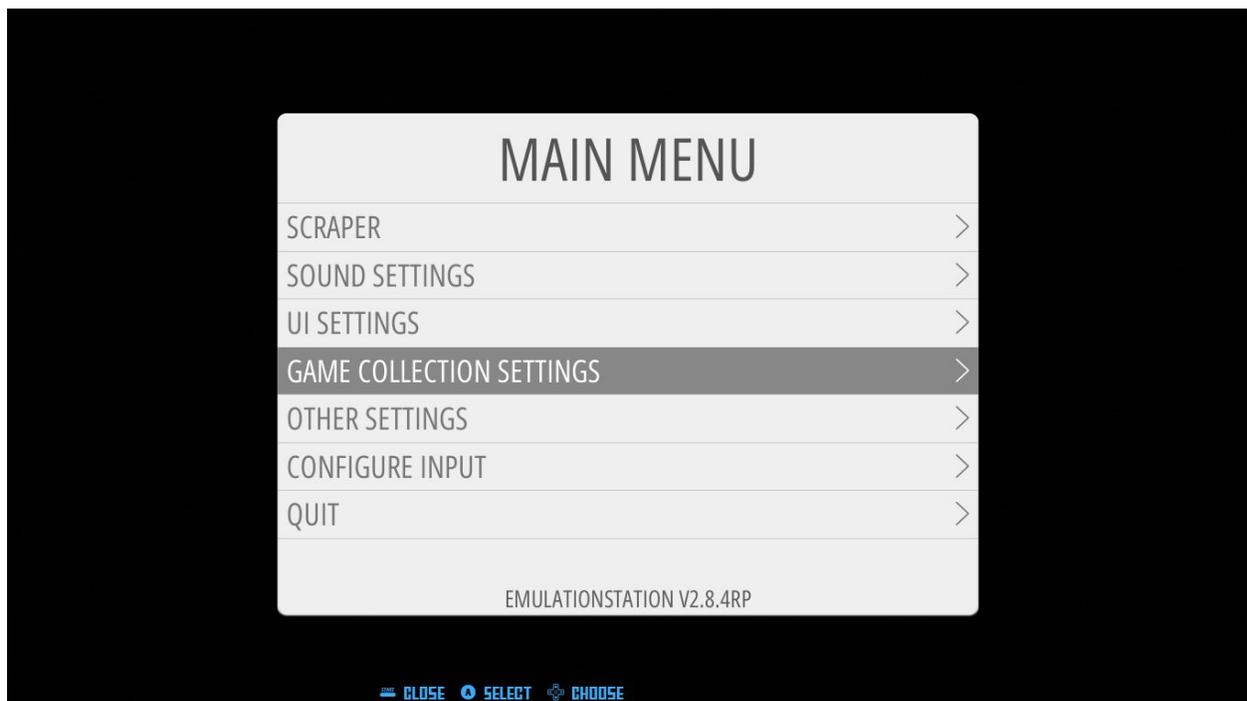
Edit this file. You'll need to modify this from an existing custom collection. Shown below is our "1Player" theme edit. You'll also need to specify an image for the layout to detect.

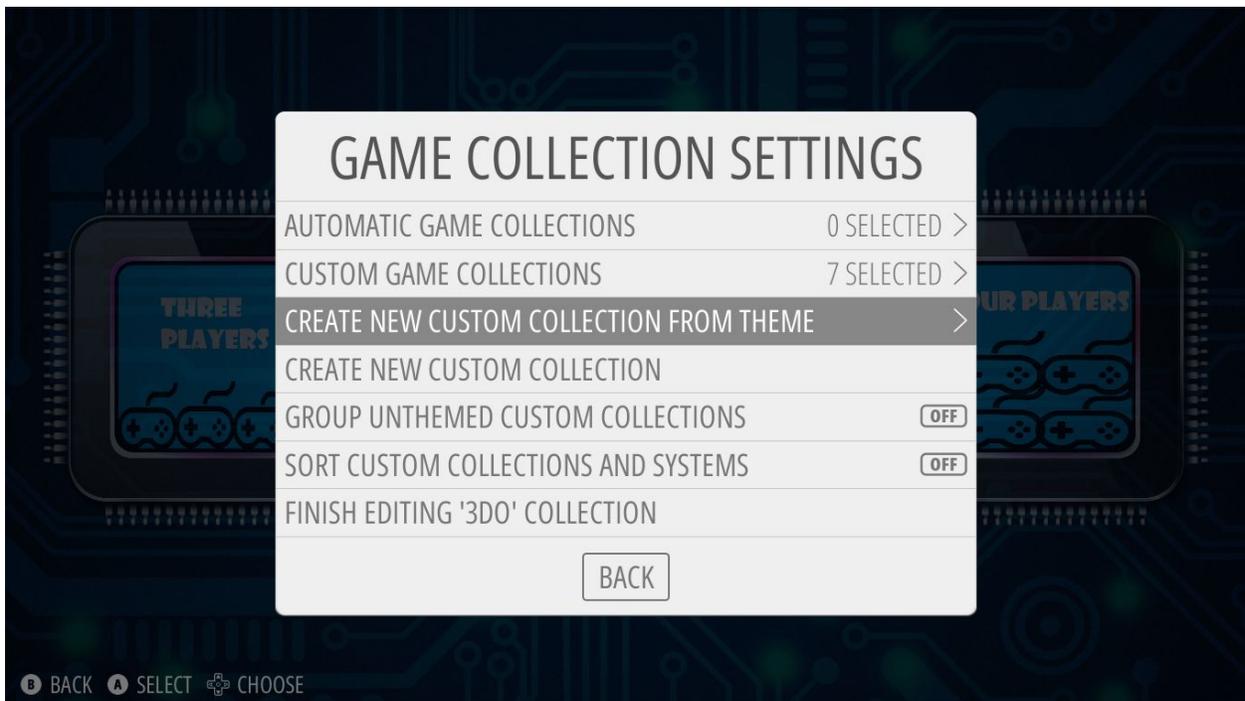


Once this is complete, enter the terminal and enter the following code. The password for the system is "user".

```
user@localhost:~$ cd ..
user@localhost:/home$ cd ../../
user@localhost:/$ cd ../../etc/emulationstation/themes/circuit
user@localhost:/etc/emulationstation/themes/circuit$ sudo mkdir example
[sudo] password for user:
user@localhost:/etc/emulationstation/themes/circuit$
```

Once this is complete, enter RetroPie. You'll then need to enter the Start Menu under Full UI (if you need to change the UI settings, go to Section 1).





From here, you can find your specified theme and then add games using the prompts.

Games that go into collections are sorted alphabetically and typically are automatically detected by a Scraper if possible. The scraper can be ran when the system is connected to the internet rather than locally to the other machine (see Section 1). New games with no prior data on them will need to be scraped to display info.

4. What is a good game for the system?

While the controller variance allows for many games to be played, not all games are going to be workable.

Games that have the following may not be suitable for the system:

- They have a proprietary mechanism on top of traditional face buttons.
 - EG: Games with light guns (Time Crisis), Rhythm games (Dance Dance Revolution, Sound Vortex), Racing games (F-Zero AX, Cruisin USA), games that utilize dual sticks for players (Smash TV) - traditionally, console ports are preferred if possible.
- Console games that require an excess of buttons.
 - EG: Games that may have come with proprietary items (Samba de Amigo) or

games that utilize any form of motion controls or sound (Mario Party 7).

- Single player games.
 - Adventure games, RPGs, etc. Avoid games that need a save system unless it's a multiplayer game.
- Games that may not be suitable for a public environment.
 - Features excessive, more realistic blood, etc.

3 - Audiovisual

1. Overview

The systems have an arcade-audio styled system mounted within the cabinets to create an authentic system but allow for others to control or mute the audio entirely to respect that it is in a public space.

By default, volume is controllable by users of the machine on the outside. If, for whatever reason, you wish to turn this off (in the event that there are significant noise concerns), follow the instructions in Section X.Y.

The TVs with the system are “smart TVs” and can also automatically turn off to preserve power if no activity is detected (if the computers fall asleep). The TVs, however, are also manually mounted over to the arcade system.

Parts for the Audiovisual aspect of the system can be found in Section 6.

4 - Controller

1. Introduction

With several methods to control games, there are a multitude of parts needed for a single cabinet, predominantly coming down to GameCube and Arcade controls. Parts utilized in this aspect can be found in Section 6.

2. How to hook up Controls

To properly assign up controllers, items must be connected in a specified manner. You will need to insert a keyboard to finish these instructions. Please see the below table for the specific layout that the controls must go through:

RetroPie	Arcade	GameCube
A	A	A
B	B	B
X	X	X
Y	Y	Y
Left Shoulder	L	ZL
Left Trigger	Unused	L
Right Shoulder	R	ZR
Right Trigger	Unused	R
Select	Select	Minus (-)
Start	Start	Plus (+)
Left Analog	Joystick	Analog Stick
Left Analog Thumb	Unused	Press on Analog
D-Pad	Unused	D-Pad
Right Analog	Unused	C-Stick
Right Analog Thumb	Unused	Press on C-Stick

Make sure that you do not set a Hotkey, and instead let it select the “Default” Hotkey in the menu immediately following the application menu. This will set the reset and exit to menu button as Start and Select held together. For items marked as “Unused” by the Arcade Controls, you must scroll through them with a keyboard to properly set it up.

3. Microprocessor (Holster + MUX system)

One major hook of the system is the MUX configuration that lets us swap from Arcade to GameCube controls. This is accomplished both by utilizing a limit switch to toggle jumper cables to short the selection bit, and individual connections for the system. By default, the Arcade controls should be set to be input 0, and the GameCube controller’s USB should be set to input 1. The Arcade controls use a X cable, whereas the GameCube controllers utilize a USB-B type connection; if cables must be replaced, use these.

4. Controller configuration

Internal settings allow the team and you to make specific configurations on controls and make games individually correspond to specific buttons. [This spreadsheet](#) details the specific configurations and how the Arcade and GameCube controllers will match up to each emulator and game type.

5 - Parts List

1. Parts List

[A parts list can be found in this spreadsheet](#). It splits items into 4 categories: Audiovisual, Computer & Controller, Hardware & Power, and Auxiliary (optional parts predominantly pertaining to paint or visuals). Nails are listed under “Hardware & Power” despite having usage in all 4 components.

The following items are excluded from this list:

- Paint coloring (paint pricing is used from blue color utilized for both cabinets)
- Items that were planned for the project, but were ultimately not utilized
- General connection wires (specifically, these were provided by the ETG, but approximate prices from ISU-friendly sales sites were provided)
- Tools provided by ETG to construct the cabinet (either from the Hoover/Coover hardware labs or the Senior Design lab, such as drill presses, sanding machines, etc) - Paint tools were not provided by ETG, so these were ordered.
- While motherboards, limit switches, acrylic glass holders and power supplies were provided by ETG, we have researched and added similar parts to the list.

Parts that deviate from the actual used source (due to availability as they may not be on most online markets anymore, or being a functional equivalent obtained by ETG) are highlighted in red.

6 - Startup

1. Startup & Shutdown

The system is designed to be started up by the UPS system and the power buttons located within the machine. These can be used to manually start the machine if a forced shutdown is necessary. Otherwise, the machine will typically restart itself after it has been unplugged while connected to the UPS and then plugged back into a new power source.

The machine may be turned off by one of the following methods:

- Unplugging the UPS from a power source and letting it drain will automatically turn off the machines.
- Plugging in the necessary components (mouse) to browse the computer and shutting down the machine using Ubuntu's UI.
- Holding the buttons outside of the Left or Right systems for 3 seconds. This will automatically turn off the machines via a safe shutdown.
- Unplugging the central power source. This will alert the system to turn off via the UPS protocol and is not recommended if you are not moving the other systems around.

2. Establishing netplay

Netplay must go through a handful of steps to start off by actually doing it. By default, games will boot in the netplay state; games that boot into netplay will sometimes wait for a response from the client or the host (the Left system, Beta, is the Host, whereas the Right system, Alpha, is the client in all cases).

If you need to probe test the system, when a game is loading, press any button on the system (not the joystick) you will need to enable the Boot Menu by going into the Runcommand Configuration in RetroPie. Note that only libretro (lr-prefix) emulators can do Netplay.

APPENDIX II ALTERNATIVE VERSIONS OF THE DESIGN

1. Versions that resulted in failure to achieve specifications

a. Portable Tablets

- i. This design followed the requirement of portability and mobility but failed the 2 of the 3 requirements. It failed the longevity part since being a hand held with potential careless users, it can cause the tablets to be dropped and or stepped on. Failed the maintainability since the parts used would have to be small and hard to replace if broken. Seamlessness is too hard to say it failed since we didn't do a lot of research into it to see if was possible to make a product that small with Wi-Fi and Bluetooth capabilities. It was also just overall an idea tha client didn't like in the slightest and was scrapped within the first meeting.

b. Pyramid/ Mirror Design

- i. The idea of this was very promising but after learning more of what the client wanted and what was possible after some research, this idea suffered and tossed out. Having a Pyramid / Mirror design meant that it would have a regular base of an arcade system with standard joystick setup, but the screen was a pyramid. So the 4 users would essentially be looking at the same pyramid but looking at a different side of the pyramid. Each side would then be somehow designed to only show what player 1, 2, 3 and 4 was exclusively doing. It would have fit most of the requirements, besides longevity since if the mirror was out of place or cracked it would have to replace the whole pyramid.

c. Table

- i. In this design idea, the idea itself just wasn't a good design overall and the client wanted a design that was different than the previous table idea that was built before. The table design was projected to be very expensive and would be too expensive to fix if it ever broke. This was also a design that was set aside in the first meeting with the client.

2. Versions considered before learning more about the project
 - a. Controller change
 - i. In the project team had 4 authentic controllers that the client approved and a design that the team thought that would work. But the team ran into 2 problems, 1 of the 2 problems was that the controller wasn't a USB, so the team order a hub that would take the Non-USB output into a USB output, downside it added a lot of wiring. Second problem was that when trying to configure the controllers, the team figured out that the controllers were analog and was giving the system and input and output where it needed only to be giving an output.
 - b. GPU Upgrade Change
 - i. This was more a courtesy to the users, so not one cabinet is better than another. The team wanted them to run the exact same and have zero to no differences. Installing identical new GPU's insured that no discrepancies were in the system.
 - c. Teensy Change
 - i. Teensy change was one of the bigger failures of the project. This was supposed to allow switching between gamecube and joystick/ arcade buttons. It ended up not working as planned and the team switched to the evaluation board that had a MUX built in.

APPENDIX III OTHER CONSIDERATIONS

This project was a lot more software than hardware than originally expected, the team learned a lot about Linux and how to change the finest details of the computer. Got better at soldering wires such as the volume control knobs and the lever switches. Better understanding of how a MUX works and the possibilities of MUX's in the future. The team can now design and edit using AutoCAD very efficiently and in a timely manner.