Networked Arcade Machine

- Team sddec19-23
- Advisor: Dr. Joseph Zambreno
- Client: Dr. Joseph Zambreno
- Team Members: Alex Carpenter, Alex Schneider, Brian Shanders, Bryan Johnston, Evan Mandle, Zach Serritella
- Team Website: https://sddec19-23.sd.ece.iastate.edu/

Problem Statement

- Coover Hall's large transformative learning area (TLA) is missing classic arcade machines that were once held there for students to relax and enjoy gaming.
- The task of the team is to design a replacement for the arcade machines in the TLA that are rugged and reliable.
    - Primary audience: Students & faculty, general public
    - Product should be designed with a variety of different individuals in mind and be versatile

Project Planning

Conceptual Sketch

The team's design features:

- Four arcade style controls
  - 1 digital joystick & 6 buttons
- Four console controls
  - 1 Nintendo GameCube controller
- Two 32" modern screens
- Two systems
- Cooperative & competitive mode
  - Allows for a more cooperative experience, or a professional styled format

Functional Requirements

- Portable
  - Product can be moved
- Arcade controls & console controls
  - Traditional and 6th generation controls
- Modern screens
  - 720p
- Structurally sound
  - Capable of taking noteworthy physical damage
- Integration of networking
  - Play together on both machines
- Main menu
  - A customized interface to give a personal and professional edge to the cabinet

Non-functional Requirements

- Quick game loading
    - Games can be loaded quickly
- Concise wiring
    - Wiring is professional
- LED lighting
    - Make the inside of the cabinet have an attractive aspect, without being too distracting

Technical/Other Constraints/Considerations

Usability	Must be designed so that any student or staff member can use it
Security	Hardware and software must be secured and typically inaccessible to deter theft
Availability	The cabinet must be available on a 24/7 basis
Portability	The cabinet must be movable on wheels to showcase at events
Maintainability	The product is expected to last around 5 years with little serious repair
Cost	The cost of the cabinet should be around $1,000.

What makes the project unique?

- Additional & personalized features
  - Improved game library
  - Power management
- Streamlined and simplified local play across machines
  - Much of the connections have been automated
- Modularity in controls
  - Able to use controls from arcades or from 8th generation of consoles (GameCube)
- Automation in maintenance
  - The system uses sensors to determine when it needs to wake up
  - Automated restarts to prevent wear onto the hardware

Potential Risks & Mitigation

- Integrating multiple machines
  - LAN-based connections
- Tipping may be an issue if the base is not heavy enough
  - Structural testing and low center of gravity
- Cost of components
  - Work within allotted budget, but do not sacrifice quality
- Ordering materials
  - Research with ETG-friendly avenues from the start
- Programming the machines
  - Keep code documented and make sure team members know processes

Resource/Cost Estimate (as of 4/26/19)

- Current focus:
  - Lowering audiovisual costs
  - Obtaining prices from ETG-friendly avenues
- General Budget $1000.00
  - Client has expressed that he is less concerned with going over but team is focused on keeping within or around the budget

| Component	Source	Appx. Price (Rounded Up)	Quantity Expected	Full Cost
Audiovisual				
Audio Arcade Kit	https://www.arc	$40.00	2	$80.00
Insignia 32" @ 60Hz, 720p	https://www.bes	$100.00	2	$200.00
Total Cost				$280.00
Outer Casing				
Melamine MDF Board	https://www.low	$30.00	10	$300.00
SungMi 4 Pack Wheels w/Screws	https://www.am	$13.30	2	$26.60
150x Wood Screws Phillips	https://www.am	$7.00	1	$7.00
6 Pack door hinges	https://www.am	$20.00	1	$20.00
Total Cost				$353.60
Controls				
Suzo Happ 8-way Joystick	https://na.suzoh	$12.00	4	$48.00
Suzo Happ Pushbutton	https://na.suzoh	$3.05	24	$73.20
Suzo Happ Player Button	https://na.suzoh	$3.10	4	$12.40
Gamecube Controller	https://www.gar	$30.00	4	$120.00
Mayflash 4-Port Adapter	https://www.am	$20.00	2	$40.00
Suzo Happ 0 Delay Joystick Enco	https://www.am	$10.00	4	$40.00
Teensy Board	https://www.dig	$36.88	4	$147.52
Total Cost				$481.12
Power				
Garden Extension Cord	https://www.am	$13.00	1	$13.00
Surge Protector	https://www.am	$9.00	1	$9.00
HDMI Cable, 2-pack	https://www.am	$9.00	1	$9.00
Ethernet Cord	https://www.am	$6.30	1	$6.30
Total Cost				$37.30
Cost Sums				
Outer Casing, Controls, Power Sum				$1,152.02

Project Progress & Milestones

- Schedules for the team are over the next two slides.
- Spring slide has been updated compared to the original to reflect team progress.
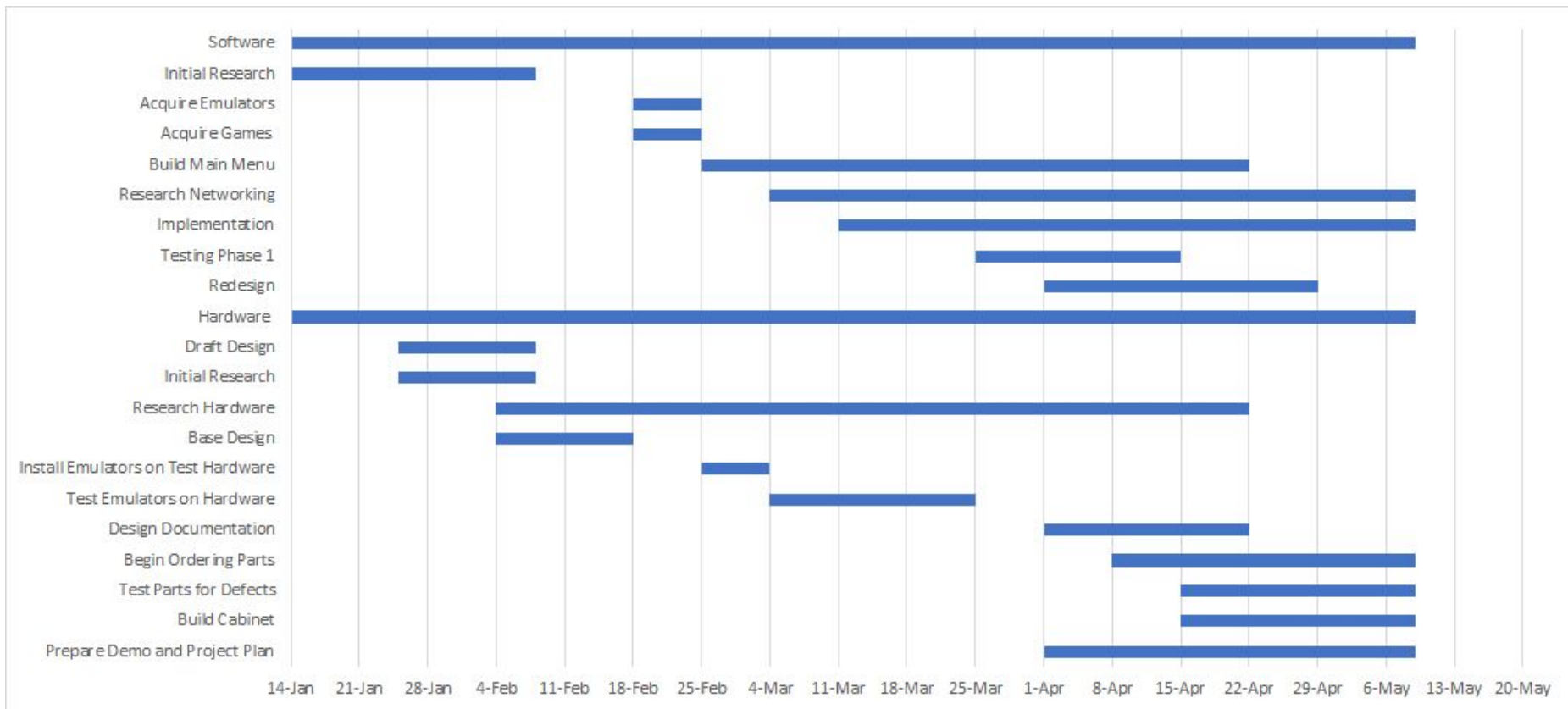
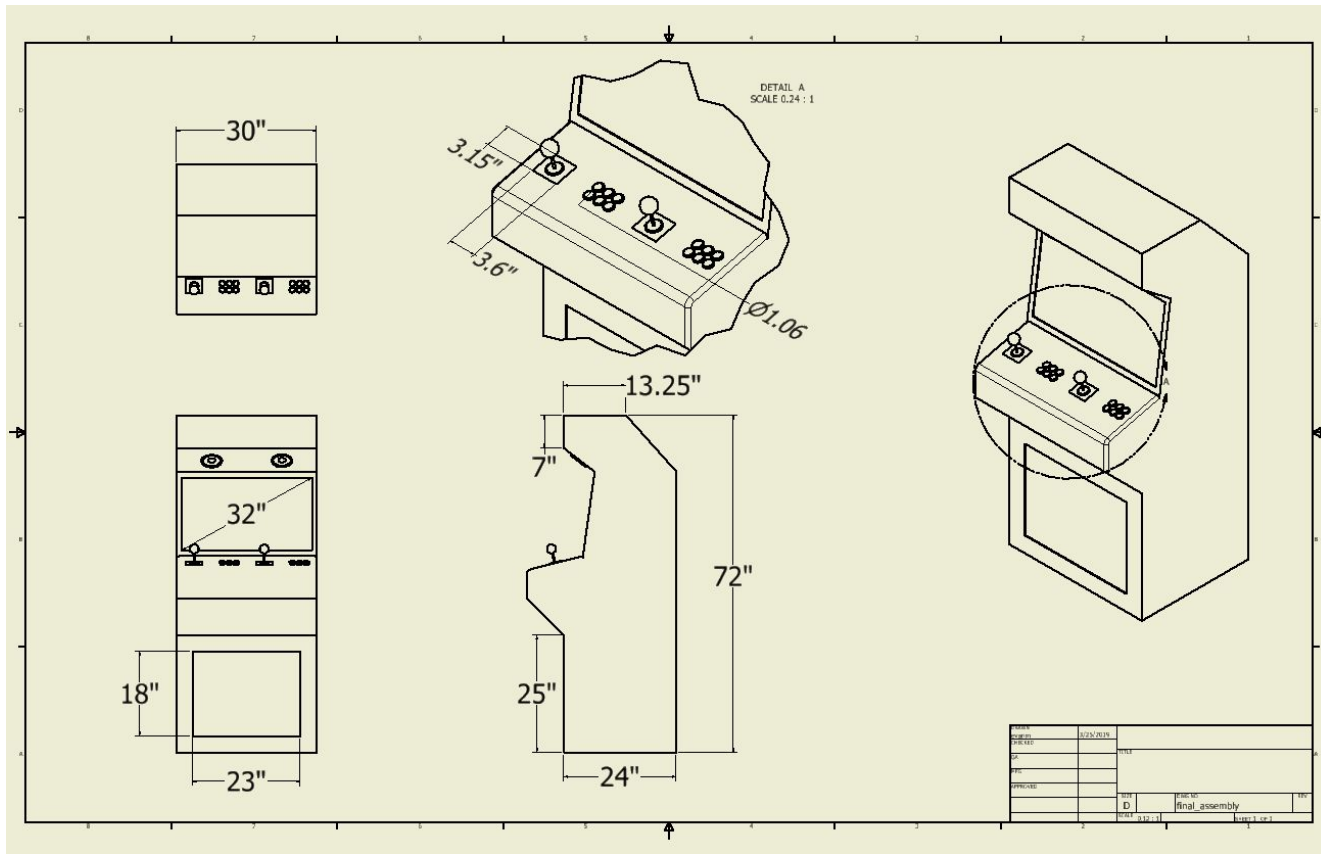Project Progress & Milestones - Spring Semester
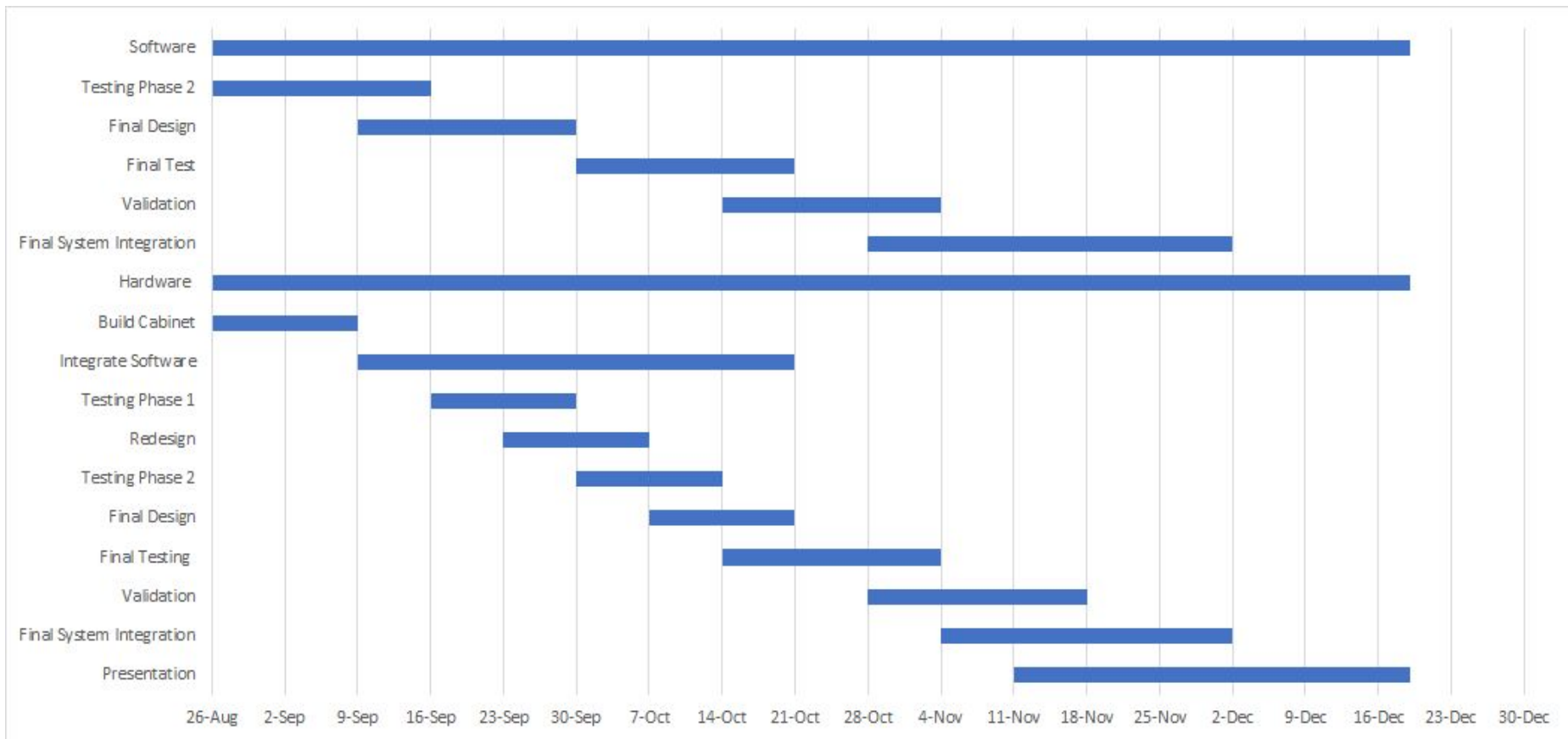
Project Progress Milestones - Fall Semester
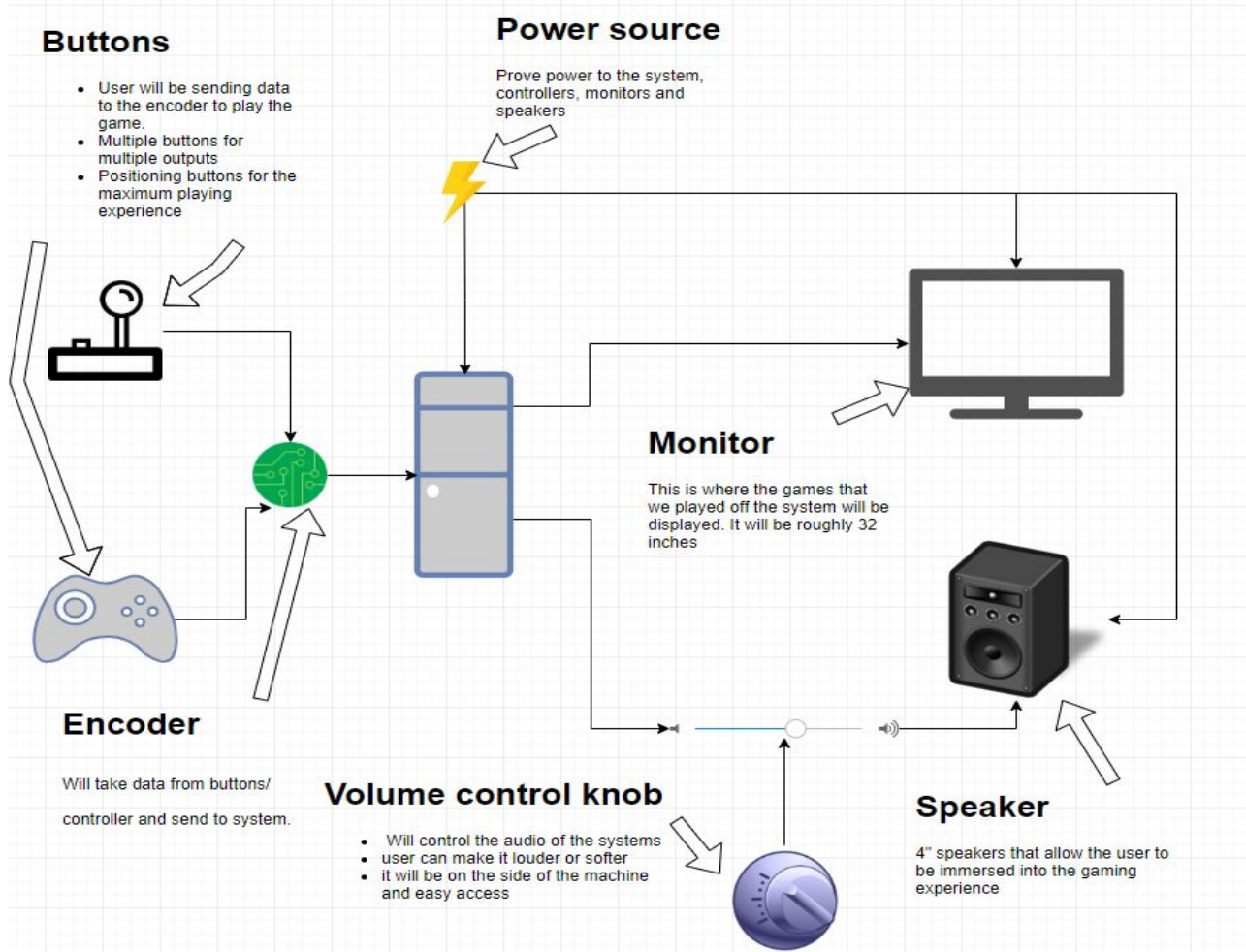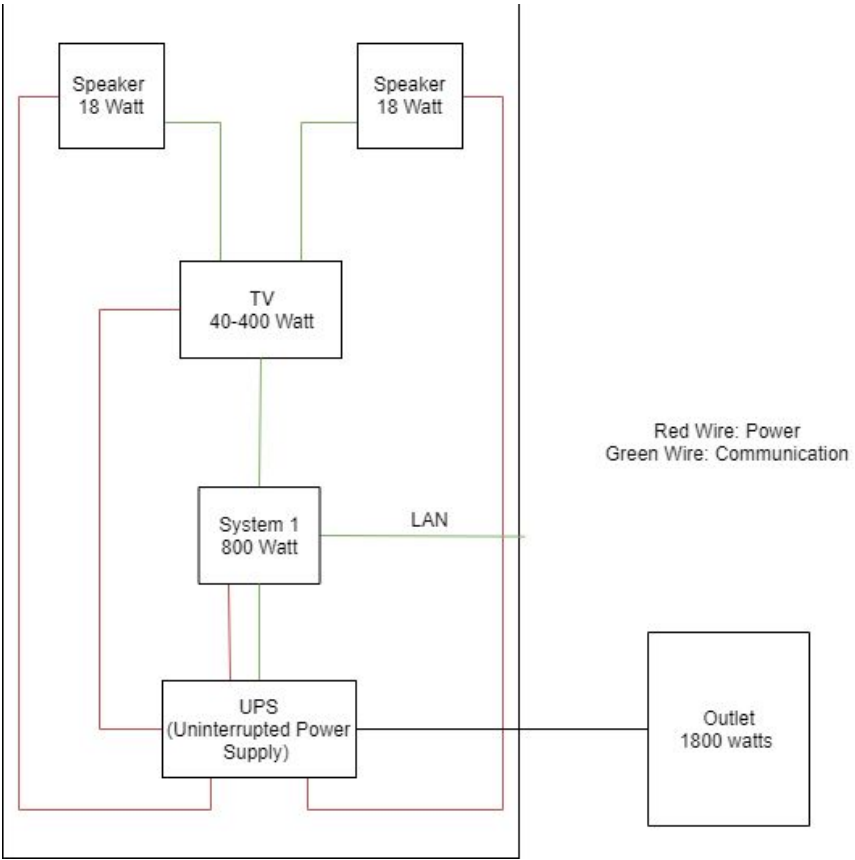
Functional Decomposition

Detailed Design

DETAIL A
SCALE 0.24 : 1

30"

3.15"

3.6"

Ø1.06

13.25"

7"

32"

72"

25"

18"

24"

23"

final_assembly

Isometric view

System overview

Buttons
- User will be sending data to the encoder to play the game.
- Multiple buttons for multiple outputs
- Positioning buttons for the maximum playing experience

Power source
Prove power to the system, controllers, monitors and speakers

Monitor
This is where the games that we played off the system will be displayed. It will be roughly 32 inches

Encoder
Will take data from buttons/ controller and send to system.

Volume control knob
- Will control the audio of the systems user can make it louder or softer
- it will be on the side of the machine and easy access

Speaker
4" speakers that allow the user to be immersed into the gaming experience

Power management overview

Speaker 18 Watt

Speaker 18 Watt

TV 40-400 Watt

System 1 800 Watt

LAN

Red Wire: Power
Green Wire: Communication

UPS
(Uninterrupted Power Supply)

Outlet 1800 watts

Arcade machine
- Client block
  - The client will be responsible for upkeep of the system once the team is gaduates
  - Transportation needs to be authorized by client.
- User block
  - Will have full control over any game he/she would like to play
  - User will be able to control all volume controls that they feel satisfies them
  - While playing games the user will have the opportunity to switch between GameCube and or arcade in game.
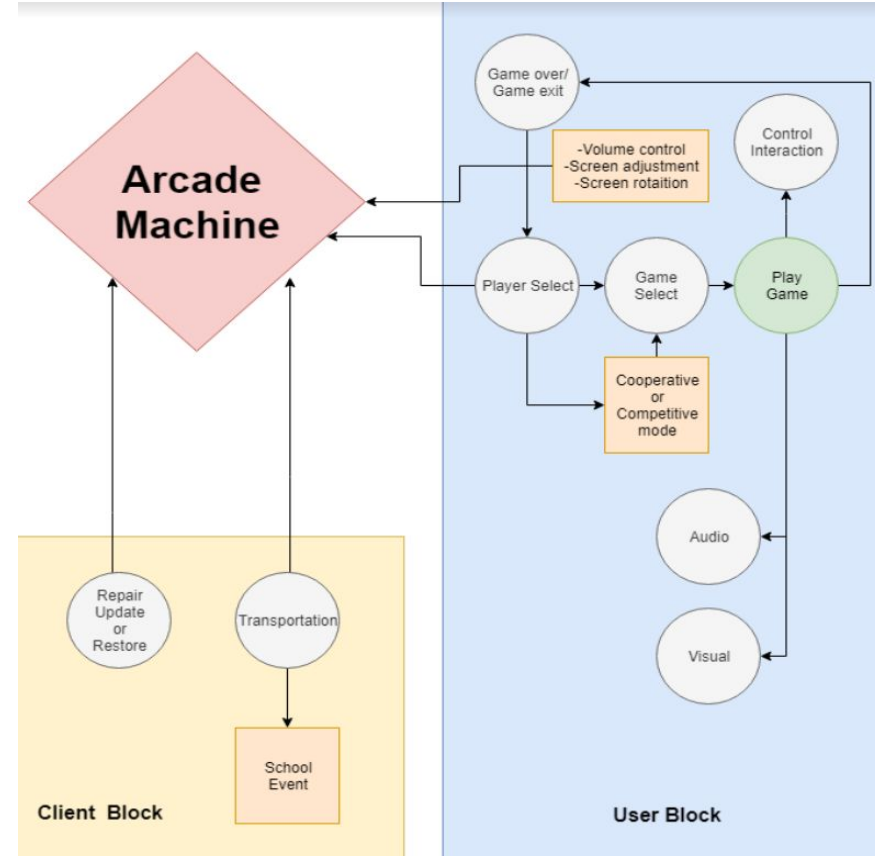
Use Case Diagram

Hardware Platforms

- ETG Computer #1
  - I5 Processor
  - GTX 480 graphics card
- ETG Computer #2
  - I7 Processor
  - Nvidia Quadro graphics card
- Microcontrollers
  - Teensey board
- Sensor
  - Magnetic sensor

Software Platforms

- Linux Ubuntu
  - Operating system that is used for the ETG computers
- RetroPie
  - Application that allows for multiple emulators
- MAME
  - Arcade game emulator used to play arcade ROMs
- Dolphin
  - GameCube emulator used to play GameCube ROMs
- Daphne
  - Arcade Laserdisc emulator used to play Laserdisc ROMs

Testing Overview

Functional:

- Portable
- Arcade Controls
- Modern Screens
- Structurally Sound
- Controllable Sound
- Network Integration
- Main Menu

Non-functional:

- Quick Game Loading
- Concise Wiring
- LED Lighting

Testing Overview (cont.)

- User Testing
  - Four users decide to play a 4-Player Game
  - At least two users decide to play two different games that will require the use of different emulators
  - Testing out the same game at the same time with different amount of users
  - Aspects of the functional/non-functional testing scenarios are carried out here as well

Current Implementations

- Current limitations
  - Very few parts have been ordered
  - Software can be tested, hardware is limited/cannot be tested
- Game performance
  - All games that do run do so at the intended framerate
  - Most of the desired games run
- Networking results
  - The emulator shows that it can be networked, will need to be tested further next semester.

Current Results

- Software
  - Retropie - Running
  - Dolphin - Running
  - Mame - Running
  - Daphne - In Progress
- Hardware
  - Computers - Running
  - Power Management - In Progress
  - Game controls interface - In Progress
  - Cabinet - In Progress

Conclusion

Plans for Fall 2019

- Implement the Software Design
  - Main menu & UI personalization
  - Better file structure/hierarchy
- Implement the Hardware Design
  - Building the cabinet itself (audiovisual, lighting, computer hardware)
  - Implement video gaming controls
- Perform testing and validation
  - Fix known & major issues
 - Tamper-proofing

Responsibilities & Contributions

- Alex C:
  - Hardware design & procurement
  - Internal Documentation
- Alex S:
  - Game curation & quality/performance control
  - Presentation-based documentation
- Brian S:
  - Website Management & Weekly Reports
  - Main Menu Design

- Bryan J:
  - Game Testing/documentation
  - System Setup and Installation
- Evan M:
  - Team Leader; delegated tasks and responsibilities.
  - CAD designer
- Zach S:
  - Meeting facilitator & documentation throughout the semester
  - Main researcher for hardware and software designs

Q&A

Addendum: Demonstrations
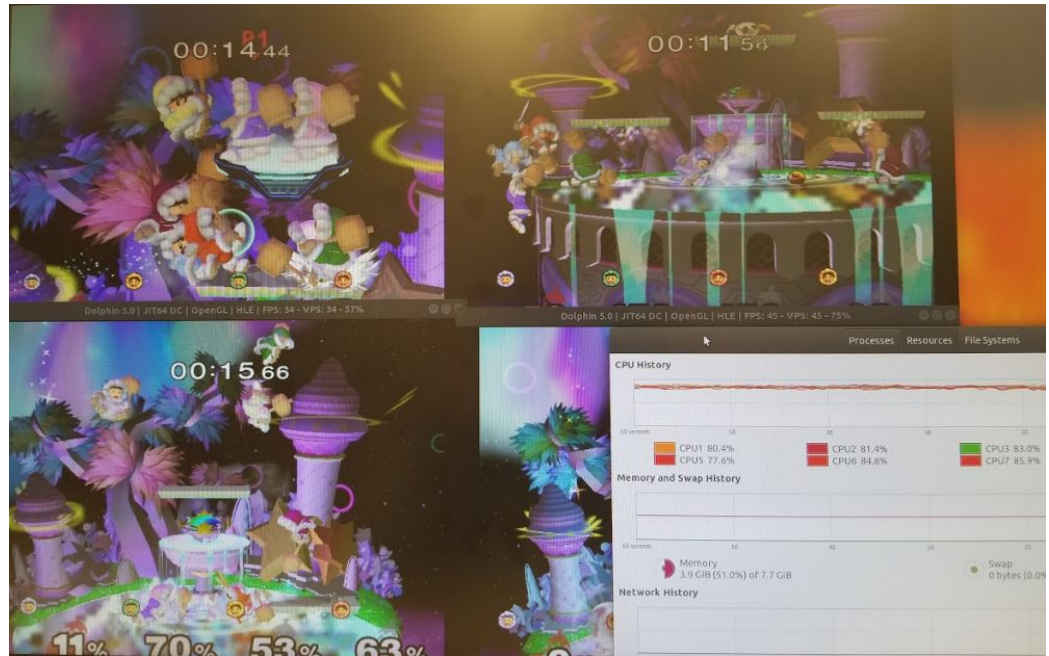
Addendum: Legality

- The majority of emulators are legal
  - Given as long as the emulators do not appropriate proprietary code from the consoles they are emulating
- However, the majority of ROMs do infringe on intellectual property rights or copyrights, except in rare exceptions (okayed abandonware)
  - It is not illegal to own a ROM, given that you did not make it

Addendum: Yearly cost of operation

Max kilowatt -hour of system per day: 1800*24/1000=43.2

Average price of kilowatt per hour in Iowa: 10.5 cents

Max price of operation: $166,713.75

Addendum: Orientation

- Why have modularity in two modes?
- The cabinet styles encourage various modes of play
- Transportation
  - The side to side cabinet may seem more effective for an area like the TLA
  - But it is not effective in transportation

Addendum: Rugged and Reliable

- How is the system going to be reliable?
    - Lower center of gravity compared to previous systems
    - Traditional lock security
    - Operational datasheet