Mini Arcade Cabinet

Design Document

Team Number: sdmay23-26
Client: Brad Yenger
Advisers: Wymore, Mathew L [E CPE]
Team Members/Roles:
Bradley Yenger: Electrical Engineering
Mark Gores: Software Engineering
Jeffrey Marsh:Software Engineering
Liam Tureaud: Electrical Engineering
Alexander Glass: Software Engineering
David Helmick: Software Engineering

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Executive Summary

Development Standards & Practices Used

List all standard circuit, hardware, software practices used in this project. List all the Engineering standards that apply to this project that were considered.

For wire routing and standard powers, we will mimic the JAMMA standard:

This is a set of basic standards for easy repairs for arcade cabinets. This allowed for old arcade cabinets to be repaired and reused by using standard parts and standard voltages for components

OSHA standards:

Safety and preventive planning

ASAP(Appliance standards awareness project) (https://appliance-standards.org/national)

*While we cant meet all needs, we will try and match the power saving aspects (while not in use, save power)

Summary of Requirements

Client expected requirements

-a retro styled cabinet that is no bigger than a 2" by 2" by 2" cube.

-An ability to use several different controllers using USB connections

-Either connections to a laptop or to a Raspberry Pi on board.

-Portability

Applicable Courses from Iowa State University Curriculum

EE	CprE	SE/COMS	Others
303	281	227	ENGL 314
333	288	228	
230		309	
		319	
		317	

New Skills/Knowledge acquired that was not taught in courses

List all new skills/knowledge that your team acquired which was not part of your Iowa State curriculum in order to complete this project.

All - TinkerCAD, carpentry, visual design, AutoCad Inventor (3D modeling)

SE - soldering

EE - UI design, LED matrix display

Table of Contents

List of figures/tables/symbols/definitions (This should be the similar to the project plan)

LED matrix - A dot matrix using controllable LEDs, usually with a large display but low resolution

1 Team

1.1 Team Members

Bradley Yenger - Electrical Engineer

Liam Tureaud - Electrical Engineer

Mark Gores - Software Engineer

Alexander Glass - Software Engineer

David Helmick - Software Engineer

Jeffrey Marsh - Software Engineer

1.2 Required Skill Sets for Your Project

- PCB / Circuit Design
- Soldering
- Carpentry
- 3D CAD Design
- Coding in various languages for various applications

1.3 Skill Sets covered by the Team

Brad Yenger (EE)

- soldering experience, 3D CAD design, carpentry skills, along with project experience

Liam Tureaud (EE)

-Soldering experience, carpentry, PCB design, electrical work

Alexander Glass (SE)

-Capable coding in Java, HTML, JavaScript, willingness to learn a new skill during the course of this project

David Helmick(SE)

-Worked with many different computer programming languages in many different aspects (simple games, UIs, websites, embedded systems, databases, etc.). Taken both CprE and SE courses so I have lots of knowledge about computers from a hardware and software perspective.

Jeffrey Marsh(SE)

-pretty talented programmer also well versed in video game emulation

Mark Gores(SE)

-proficient in multiple coding languages. Good understanding of operating systems. Good understanding of computer engineering.

1.4 Project Management Style Adopted by the team

All work is shared, managed, evaluated, and completed equally by all team members.

1.5 Initial Project Management Roles

(Enumerate which team member plays what role)

Bradley Yenger: 3D CAD design of project housing, Carpentry, PCB Design

Liam Tureaud: PCB Design, Soldering, Wiring

Alexander Glass: UI design, backend design, unit testing, integration testing

David Helmick: frontend/backend design, unit testing, integration testing

Jeffrey Marsh: UI design

Mark Gores: UI design, unit testing, integration testing

All: Document/Presentation creation

2 Introduction

2.1 Problem Statement

What problem is your project trying to solve? Use non-technical jargon as much as possible. You may find the Problem Statement Worksheet helpful.

Arcade machines are becoming more and more rare to see. With COVID or the price of these machines in mind, some individuals are looking for a way to play the classic arcade games but from their own home. While there are emulators to simulate the game, the game can't feel the same without the cabinet and all its controls. Retro game enthusiasts, digital historians, and college students (AKA our client) are looking for a custom, affordable cabinet to be built. Along with this, there is a demand for portability and a set of size constraints that we will be expected to meet, along with a variety of older games to play like burger time.

2.2 Intended Users and Uses

Who will use the product you create? Who benefits from or will be affected by the results of your project? Who cares that it exists? List as many users or user groups as are relevant to your project. For each user or user group, describe (1) key characteristics (e.g., a persona),

(2) need(s) related to the project (e.g., a POV/needs statement), and (3) how they might use or benefit from the product you create. Please include any user research documentation, empathy maps, or other artifacts as appendices.

Users	Need	Characteristics	Use/ benefit
Retro game enthusiast	A nostalgic retro gaming experience (cabinet and controls)	-not used to modern gaming exp	-An at home, leisure activity. -Childhood memory
Digital historians	-document and preserve older historical games	-Very versed in gaming history -knowledge of arcades and cabinet design	- Teach the next generation early history -archive for old games
College students	-cheap entertainment	-low financial resources -low living area	- a fun, group activity

2.3 Requirements & Constraints

List all requirements for your project. Separate your requirements by type, which may include functional requirements (specification), resource requirements, physical requirements, aesthetic requirements, user experiential requirements, economic/market requirements, environmental requirements, UI requirements, and any others relevant to your project. When a requirement is also a quantitative constraint, either separate it into a list of constraints, or annotate at the end of requirement as "(constraint)." Ensure your requirements are realistic, specific, reflective or in support of user needs, and comprehensive.

Physical:

We were given a size constraint of a 2ft by 2ft by 2ft area

Able to be portable and light enough to be carried

User:

The user should be able to control audio volume

control scheme for the games

have responsive controls (10ms input delay)

Software:

Clean UI

Able to run ROMs / .exe files

Lag free gameplay

Able to read inputs from a controller

Material:

All devices contained must stay below 85 Celsius

Monitor should be behind glass/acrylic pane

Cabinet made out of a hardwood

2.4 Engineering Standards

What Engineering standards are likely to apply to your project? Some standards might be built into your requirements (Use 802.11 ac wifi standard) and many others might fall out of design. For each standard listed, also provide a brief justification.

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OSHA standards:

Safety and preventive planning

ASAP (https://appliance-standards.org/national)

While we cant meet all needs, we will try and match the power saving aspects (while not in use, save power)

3 Project Plan

3.1 Project Management/Tracking Procedures

Which of agile, waterfall or waterfall+agile project management style are you adopting. Justify it with respect to the project goals.

- Waterfall+agile is the system style we plan to implement. For parts that require our expertise (Electrical and Software) we want to split up into groups and divide the work. This follows an agile style. Once these parts are finished and to comes to building and testing, we need a structured flow to make sure we can both meet deadlines and test our system correctly.

What will your group use to track progress throughout the course of this and the next semester. This could include Git, Github, Trello, Slack or any other tools helpful in project management.

- We plan on using Github for the software side of the project to organize and collaborate with code from all the members of the software team. We can also use the documentation tools of GitHub to show the intricacies of our project.

3.2 Task Decomposition

In order to solve the problem at hand, it helps to decompose it into multiple tasks and subtasks and to understand interdependence among tasks. This step might be useful even if you adopt agile methodology. If you are agile, you can also provide a linear progression of completed requirements aligned with your sprints for the entire project.

-To complete the building of the cabinet, we first have to get the required resources, such as the wood, wiring, computer, and glass to put it together.

-To complete the software side, we first have to make a UI, code games into the program, and make sure the backend and front end are communicating with each other. We could also set up automatic deployment to the cabinet for easy updates to the software.

3.3 Project Proposed Milestones, Metrics, and Evaluation Criteria

What are some key milestones in your proposed project? It may be helpful to develop these milestones for each task and subtask from 2.2. How do you measure progress on a given task? These metrics, preferably quantifiable, should be developed for each task. The milestones should be stated in terms of these metrics: Machine learning algorithm XYZ will classify with 80% accuracy; the pattern recognition logic on FPGA will recognize a pattern every 1 ms (at 1K patterns/sec throughput). ML accuracy target might go up to 90% from 80%.

In an agile development process, these milestones can be refined with successive iterations/sprints (perhaps a subset of your requirements applicable to those sprint).

- key milestones
  - Collect 100% of the necessary parts
  - creation of all control circuits
  - Create a basic UI that can be controlled with keyboard controls
  - run a basic game
  - creation of the physical box
  - final project test
  - design and aesthetics
  - Final presentation

3.4 Project Timeline/Schedule

• A realistic, well-planned schedule is an essential component of every well-planned project

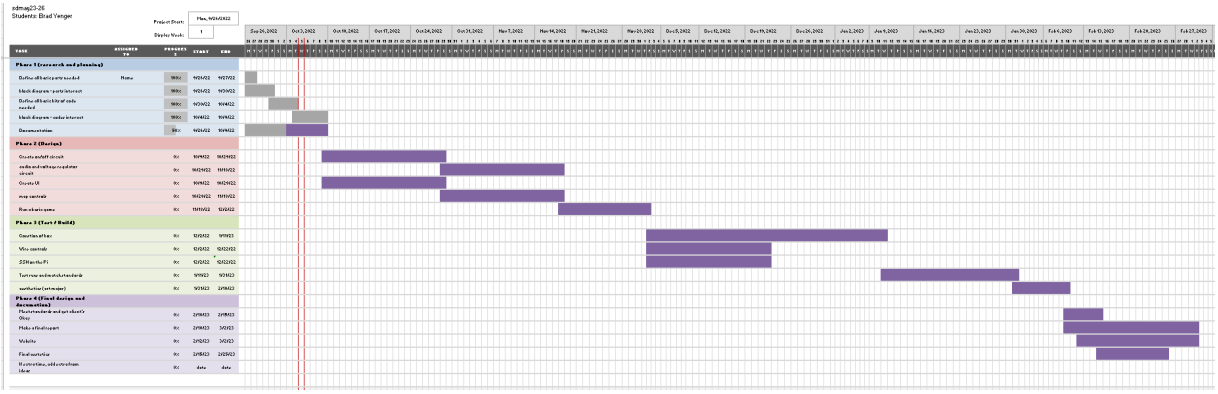
• Most scheduling errors occur as the result of either not properly identifying all of the necessary activities (tasks and/or subtasks) or not properly estimating the amount of effort required to correctly complete the activity

• A detailed schedule is needed as a part of the plan:

– Start with a Gantt chart showing the tasks (that you developed in 2.2) and associated subtasks versus the proposed project calendar. The Gantt chart shall be referenced and summarized in the text.

– Annotate the Gantt chart with when each project deliverable will be delivered

• Project schedule/Gantt chart can be adapted to Agile or Waterfall development model. For agile, a sprint schedule with specific technical milestones/requirements/targets will work.



Phase 1 (research and planning)				
Define all basic parts needed	Name	100%	9/26/22	9/27/22
block diagram - parts interact		100%	9/26/22	9/30/22
Define all basic bits of code needed		100%	9/30/22	10/4/22
block diagram - codes interact		100%	10/4/22	10/9/22
Documentation		50%	9/26/22	10/9/22

Phase 2 (Design)			
Create on/off circuit	0%	10/9/22	10/29/22
audio and voltage regulator circuit	0%	10/29/22	11/18/22
Create UI	0%	10/9/22	10/29/22
map controls	0%	10/29/22	11/18/22
Run a basic game	0%	11/18/22	12/2/22

Phase 3 (Test / Build)			
Constion of box	0%	12/2/22	1/11/23
Wire controls	0%	12/2/22	12/22/22
SSH on the Pi	0%	12/2/22	12/22/22
Test runs and match standards	0%	1/11/23	1/31/23
aesthetics (art major)	0%	1/31/23	2/10/23

Phase 4 (Final design and documation)			
Meet standards and get client's Okay	0%	2/10/23	2/15/23
Make a final report	0%	2/10/23	3/2/23
Website	0%	2/12/23	3/2/23
Final aestetics	0%	2/15/23	2/25/23
If extra time, add extra from ideas	0%	date	date

3.5 Risks And Risk Management/Mitigation

Consider for each task what risks exist (certain performance targets may not be met; certain tools may not work as expected) and assign an educated guess of probability for that risk. For any risk factor with a probability exceeding 0.5, develop a risk mitigation plan. Can you eliminate that task and add another task or set of tasks that might cost more? Can you buy something off-the-shelf from the market to achieve that functionality? Can you try an alternative tool, technology, algorithm, or board?

Agile project can associate risks and risk mitigation with each sprint.

	LikelyHood	Severity	Mitigation	severity after mitigation
Overheat/fire	moderate/low	major	Apply external cooling	low
Raspberry pi not able to run software	moderate/low	moderate	have other options to run software	low
Power being disconnected	low	low	ensure wire and cords are properly stowed neatly	low
software crashing	high/moderate	low	extensive testing and allow a reboot option for user	low

3.6 Personnel Effort Requirements

Include a detailed estimate in the form of a table accompanied by a textual reference and explanation. This estimate shall be done on a task-by-task basis and should be the projected effort in total number of person-hours required to perform the task.

Jobs	Expected time commitment (hours)
power circuit	15 - 20
on / off control circuit	15-20
audio control circuit	1- 5
UI	20 - 25
Memory and adding new game protocall	10 - 20
mapping controls	10-20
carpentry for frame	2-5
constructing frame	5
testing	30
final documentation	20

3.7 Other Resource Requirements

Identify the other resources aside from financial (such as parts and materials) required to complete the project.

- Lumber
- Workshop tools (saw. planer, hammer, nails, etc.)
- Monitor
- Raspberry Pi 3
- Keyboard
- Mouse
- Retro game controllers
- Arcade joystick and buttons
- Speaker and other audio equipment
- Various wires (power adapter, hdmi, etc.)
- Laptop with coding software
- fan
- temp sensor

4 Design

4.1 Design Context

4.1.1 Broader Context

Describe the broader context in which your design problem is situated. What communities are you designing for? What communities are affected by your design? What societal needs does your project address?

List relevant considerations related to your project in each of the following areas:

Area	Description	Examples
Public health, safety, and welfare	• fire hazard from the heat of the electronics. • could cause individuals to have a vitamin D deficiency from playing all day. • could cause extensive blue light exposure.	• with the heat of the electronics in an enclosed area it could cause a fire that could be a safety and welfare hazard for users if not properly cooled. • if the user stays inside all day playing they could develop vitamin D deficiency by not getting enough sunlight which could lead to multiple health concerns • users could be exposed to blue light from the display which has potential to cause different health concerns
Global, cultural, and social	How well does your project reflect the values, practices, and aims of the cultural groups it affects? Groups may include but are not limited to specific communities, nations, professions, workplaces, and ethnic cultures. • Our product will positively impact the social groups that still are interested in old arcade games. These communities are low in numbers but our product may also bring younger generations into these groups	• A group could buy these and min-max the settings to help them in a game. • The controls are adaptable, so new players used to modern controllers could still play using what they are experienced in
Environmental	What environmental impact might your project have? This can include indirect effects, such as deforestation or unsustainable practices related to materials manufacture or procurement. • air pollution • power consumption	• power needed to run machine will result in more coal/gas burning

Economic	What economic impact might your project have? This can include the financial viability of your product within your team or company, cost to consumers, or broader economic effects on communities, markets, nations, and other groups. ● Our product would need to be cheap, as it only runs some older games. It could be marketed to college towns as a simple group project, sold in parts and explained how to build. It would be sold as a kit to EE 186 students	average salary for college students = 32,070 https://www.ziprecruiter.com/Salaries/College-Students-Salary--in-Iowa#:~:text=How%20much%20does%20a%20College,%2Fweek%20or%20%242%2C483%2Fmonth.

4.1.2 Prior Work/Solutions

Include relevant background/literature review for the project

– If similar products exist in the market, describe what has already been done

– If you are following previous work, cite that and discuss the advantages/shortcomings

– Note that while you are not expected to "compete" with other existing products / research groups, you should be able to differentiate your project from what is available. Thus, provide a list of pros and cons of your target solution compared to all other related products/systems.

Detail any similar products or research done on this topic previously. Please cite your sources and include them in your references. All figures must be captioned and referenced in your text.

- On Amazon, there is a cheap handheld version of an arcade cabinet. (Found here: https://www.amazon.com/Arcade-Machine-Handheld-Gaming-System-electronic/dp/B00S4HI1NY) Pros are that it is small and cheap. It also requires just a battery for power. Cons are that it is small, controls are very hard to use both hands and it can not accept new games or controls.

- There have been some senior design groups that have had similar design projects as ours. one can be found here https://sddec19-23.sd.ece.iastate.edu/docs.html the difference between ours is size and price, ours is smaller and can be moved easier and cost far less.

4.1.3 Technical Complexity

Provide evidence that your project is of sufficient technical complexity. Use the following metric or argue for one of your own. Justify your statements (e.g., list the components/subsystems and describe the applicable scientific, mathematical, or engineering principles)

1. The design consists of multiple components/subsystems that each utilize distinct scientific, mathematical, or engineering principles –AND–
2. The problem scope contains multiple challenging requirements that match or exceed current solutions or industry standards.

Component/subsystem	Justification
Audio/Speaker system	Needs knowledge of Gain/operational amplifiers and how that can be controlled with potentiometers to have a working audio system
Raspberry Pi	Needs basic knowledge of computers such as processors, I/O ports, and specifications and how they limit what we can do
Buttons/Inputs/Display	Know how to read/write inputs of the buttons and wire them up to the correct pins
Software	know how to write software that is able to run arcade games without crashing or lagging.
Lighting/Cooling	Know how to do certain functions using pins on the Pi to control lighting and cooling
Power	Know how to take 120Vac, step it down, and regulate it at 5Vdc to power needed components
UI	Creating a startup display to select the game you want to play. This will choose the emulator or exe file and start it up
System for uploading new games	know how to format files in a way such that the software can read and run the games
Adapting controls to keyboard strokes	Know how to map controls of a set controller to specific keys on the keyboard.

4.2 Design Exploration

4.2.1 Design Decisions

List key design decisions (at least three) that you have made or will need to make in relation to your proposed solution. These can include, but are not limited to, materials, subsystems, physical components, sensors/chips/devices, physical layout, features, etc. Describe why these decisions are important to project success.

(To use a Raspberry Pi or a modern laptop)

- Our code will function differently depending on the operating system.

(material for physical build)

- Using wood will give an authentic look and feel. Using acrylics or clear plastics will show the wiring inside and allow for LEDs to glow through.

(to use a pre-built emulator or create our own)

- Creating our own is going to be a ton of work but will allow us complete control in the games. Using a pre-built emulator will be easier but may pose problems when trying to change the controls.

4.2.2 Ideation

For at least one design decision, describe how you ideated or identified potential options (e.g., lotus blossom technique). Describe at least five options that you considered.

One major decision we had to make was choosing how we wanted to run the games, it seems very infeasible for us to write our own emulator to play the original versions of the game so we had to brainstorm some other ways to run the games we want to run. Some of the solutions we thought of were

-Run exe games from our own program

-Use MAME to run original versions of arcade games

-Write our own emulator to run original versions arcade games

-Include a couple different emulators to run multiple types of games

-Use our own program to run exe games and launch emulators to play original versions of games

4.2.3 Decision-Making and Trade-Off

Demonstrate the process you used to identify the pros and cons or trade-offs between each of your ideated options. You may wish you include a weighted decision matrix or other relevant tool. Describe the option you chose and why you chose it.

Selection Criteria	Criterion Weight	EXE Runner		MAME		Create Emulator		Multi-Emulator Launcher		EXE and Emulator Launcher	
		Score	Total	Score	Total	Score	Total	Score	Total	Score	Total
Simplicity	0.4	5	2	4	1.6	0	0	3	1.2	3	1.2
Authentici	0.3	2	0.6	5	1.5	4	1.2	5	1.5	5	1.5

ty											
Game Selection	0.3	4	1.2	2	0.6	2	0.6	4	1.2	5	1.5
Total	1.0		3.8		3.7		1.8		3.9		4.2

-We decided to go with a program that includes multiple emulators and an exe launcher as it has the highest rating on the decision matrix. Even though it has a higher complexity to write, it allows us to run any game we want. This also allows us to give more work to the 4 SE majors we have.

4.3 Proposed Design

4.3.1 Overview

Provide a high-level description of your current design. This description should be understandable to non-engineers (i.e., the general public). Describe key components or sub-systems and how they contribute to the overall design. You may wish to include a basic block diagram, infographic, or other visual to help communicate the overall design.

Our project is creating an arcade style cabinet. This cabinet needs to have audio, visual outputs and have a couple inputs for controlling these. It also needs to have the controls as inputs, with several different controllers as options.

For our design, we decided to have a Raspberry Pi 3 control many subsystems to display the game. The first sub system is a display, which will be shown using a HDMI monitor. Next is audio, which will be connected through a set of speakers. The user will have a potentiometer to control the volume of the game for this speaker. Next is controls, which will be mapped and connected through the USB ports for the Pi. Next will be a fan and temperature sensor. When the temperature inside the box is to hot the fan will pull air out from the top. Lastly, an on/off switch is needed, so we have a plan to use an authentic coin drop button to turn the machine on and off.

4.3.2 Detailed Design and Visual(s)

Provide a detailed, technical description of your design, aided by visualizations. This description should be understandable to peer engineers. In other words, it should be clearly written and sufficiently detail such that another senior design team can look through it and implement it.

The description should include a high-level overview written for peer engineers. This should list all sub-systems or components, their role in the whole system, and how they will be integrated or interconnected. A visual should accompany this description. Typically, a detailed block diagram will suffice, but other visual forms can be acceptable.

The description should also include more specific descriptions of sub-systems and components (e.g., their internal operations). Once again, a good rule of thumb is: could another engineer with similar expertise build the component/sub-system based on your description? Use visualizations to support your descriptions. Different visual types may be relevant to different types of projects, components, or subsystems. You may include, but are not limited to: block diagrams, circuit diagrams, sketches/pictures of physical components and their operation, wireframes, etc.

For Electrical:

Three circuits are needed. A power circuit, on/off circuit, and an audio control circuit. In the block diagram above, these circuits are shown with a blue box.

Power circuit:

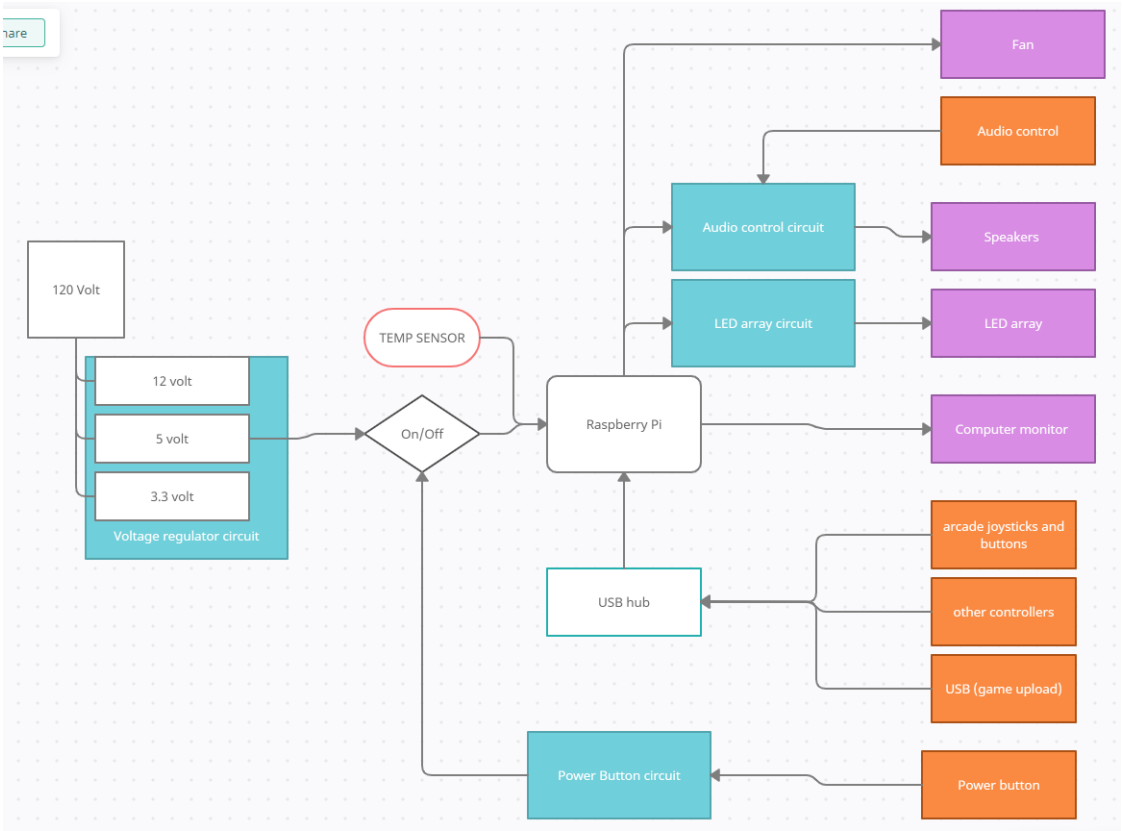
For many of the devices, we need a select DC power. 12V, 5V, and 3.3V are the most common needs. So a circuit that can supply this is needed.

On/Off circuit:

A simple switch would work for this, but our client wanted this to look much like an old arcade. So the coin drop button would increase the authenticity of the device. When pressing the button, we need a circuit to hold a high state to the rest of the subsystems. When it is pressed for a second time, we need the circuit to stop all power to the other devices.

Audio control:

With the speakers being encased in the device, controlling audio would be easiest with a potentiometer. This means a circuit will need to interrupt the connection from the Pi to the speakers. Clean audio is expected, but also with the games being relatively old the quality of the audio will already be a much lower expected quality.



For software:

A general user interface will be needed for this design that has at least 6 different screens. A basic start menu that will give the user a few options like game list and settings. Then we will have two storage directories that will store games and user settings.

Our app will launch on start up, with an easy feature that is provided by the PI.

The first screen will be a basic start menu for the user to see that will have limited options like play menu or settings

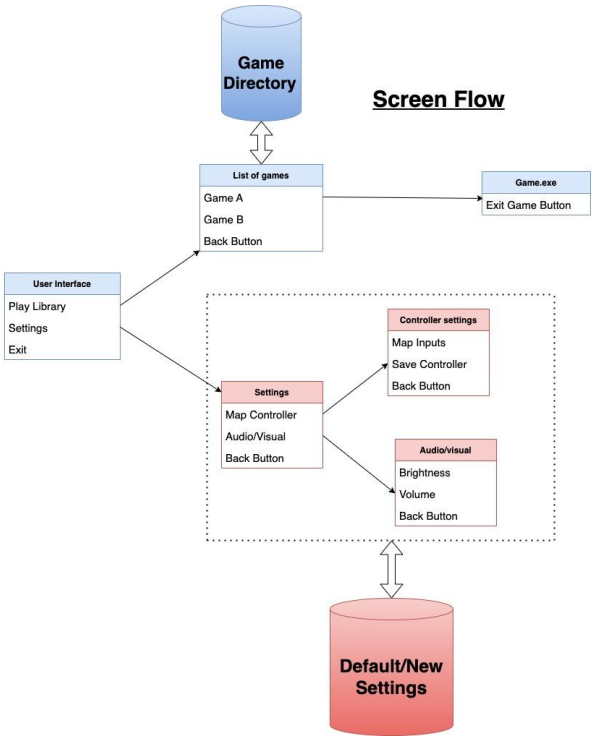
If the user chooses to play a game the next screen will display a list of games in alphabetical order from the local game directory.

A user will be able to choose a game from the list and once selected the file will launch the game and if a user wants to exit they will be sent to the start menu

The settings screen will allow users to map controls or update the audio/visual settings these settings will be saved in a different settings directory.

The application will be written in java and plan to have CI/CD implemented on git so if we want to add games, we can do it online and it will be auto deployed to the pi.

As of right now we are debating between downloading emulators that are able to run original games and custom exe games. If possible we would like to use both. The limitations of running both could be the amount of storage space and usability of exes.



4.3.3 Functionality

Describe how your design is intended to operate in its user and/or real-world context. What would a user do? How would the device/system/etc. respond? This description can be supplemented by a visual, such as a timeline, storyboard, or sketch.

The user first needs to plug in the device. This will be made easy by having all the subsystems be powered by just one extension cord. This will be long enough to reach down under a table that the device would sit on. Once plugged in, the user would need to press the coin drop button to start the device up.

Once started up, The Pi will have a startup phase and then display a simple UI. This will allow the user to select a game. Once selected, the Pi will open the needed emulator and begin the game.

For controls, the user has a couple. First is the power button. Second is an audio control potentiometer. Next is a selection of controls. Built in is a set of arcade buttons and joysticks. These work as a base set of controls. Using a UBS extension, a user can select a different controller.

Lasty an automatic system will regulate the internal temperature of the device with a fan and a temperature sensor

4.3.4 Areas of Concern and Development

How well does/will the current design satisfy requirements and meet user needs?

It keeps the aesthetics of an arcade cabinet. It keeps the look, the controls, and the display.

Based on your current design, what are your primary concerns for delivering a product/system that addresses requirements and meets user and client needs?

With different games, we need to use a different emulator. This may get difficult to swap between emulators while still using the basic arcade controls. We may have to just turn the device off and on to select a new game.

What are your immediate plans for developing the solution to address those concerns? What questions do you have for clients, TAs, and faculty advisers?

For now, we may have to just turn the device off and on to select a new game. We are also planning to add a reset button for this purpose.

4.4 Technology Considerations

Describe the distinct technologies you are using in your design. Highlight the strengths, weakness, and trade-offs made in technology available. Discuss possible solutions and design alternatives.

The Raspberry Pi has many pros and cons which will affect our project.

Pros- cheap, small, and very adaptable

Cons- not a powerful, runs only linex, may have problems running .exe files

4.5 Design Analysis

Discuss what you have done so far, i.e., what have you built, implemented, or tested? Did your proposed design from 4.3 work? Why or why not? Based on what has worked or not worked (e.g., what you have or haven't been able to build, what functioned as expected or not), what plans do you have for future design and implementation work? For example, are there implications for the overall feasibility of your design or have you just experienced build issues?

As of November 26th...

HAVE	**NEED**
Raspberry Pi 3	Wood frame
Speaker system	Acrylic sheets (LED matrix)
HDMI cable (for monitor)	monitor
a keyboard	LED bulk
Arcade style button (power on/off)	Circuits • on/off button press • temp sensor and fan • LED matrix (+ controller) • Power adaptor
Arcade style controller kit (and adaptor for USB)	Fan (and fan mounting / covers)
Surge protected Power Strip	
Jumper wires (and Wagos)	

5 Testing

Testing is an extremely important component of most projects, whether it involves a circuit, a process, power system, or software.

The testing plan should connect the requirements and the design to the adopted test strategy and instruments. In this overarching introduction, given an overview of the testing strategy and your team's overall testing philosophy. Emphasize any unique challenges to testing for your system/design.

In the sections below, describe specific methods for testing. You may include additional types of testing, if applicable to your design. If a particular type of testing is not applicable to your project, you must justify why you are not including it.

When writing your testing planning consider a few guidelines:

- **Is our testing plan unique to our project? (It should be)**
- **Are you testing related to all requirements? For requirements you're not testing (e.g., cost related requirements) can you justify their exclusion?**
- **Is your testing plan comprehensive?**
- **When should you be testing? (In most cases, it's early and often, not at the end of the project)**

5.1 Unit Testing

What units are being tested? How? Tools?

- Temperature
  - Will have a temperature sensor to measure temperature within the case to ensure the device does not overheat. To test we will set a temperature lower than the average body temperature. Then we will hold the probe and insure the fan turns on and turns off once cooled
- Cabinet
  - Measuring and verifying it fits within a 2'x2'x2' area
- Audio
  - Manually turning the volume potometer up and down to make sure the audio works at all settings.
- Power
  - Tested by multimeter
- Circuits
  - Tested by multimeter
  - Simulated through TinkerCad before finalizing
- Software
  - Manual testing when needed
  - JUnit for edge case testing
  - each screen will be tested

5.2 Interface Testing

What are the interfaces in your design? Discuss how the composition of two or more units (interfaces) are being tested. Tools?

- User Interface
  - Controls interact with the UI and games
- Cabinet Frame
  - components fit and are secure within frame
- Raspberry PI
  - Receives inputs from controls
  - Displays on monitor
  - Audio output

5.3 Integration Testing

What are the critical integration paths in your design? Justification for criticality may come from your requirements. How will they be tested? Tools?

Hardware:

- the Case is 2x2x2
- Simulating the needed circuits using TinkerCad or another software
- Creating each PCB
- Verify each module (audio, temperature, lighting, controls, display, power) is working correctly and separately
- Combining each one by one Raspberry Pi testing each component as we integrate them
- Power circuit will supply 12 volts, 5 volts, and 3.3 volts and have screw terminals for attachments.

Software:

- testing each page connects well together
- testing that the file system connects to the frontend pages user interface pages
- testing that our controls will integrate to the game button presses
- integrating all of the software onto the raspberry pi and ensure it can run reliability with the expected stresses

5.4 System Testing

Describe system level testing strategy. What set of unit tests, interface tests, and integration tests suffice for system level testing? This should be closely tied to the requirements. Tools?

- Input from arcade joystick to software
- Output from software to speakers and monitor
- Input from on/off switch to pi
- Output from software to LED strips on side of machine
- Input from game filled USB

This is not a comprehensive list, but just to get a general idea of components that may be broken because of how different from each other these problems are it will probably be necessary to test each manually as thoroughly as possible.

5.5 Regression Testing

How are you ensuring that any new additions do not break the old functionality? What implemented critical features do you need to ensure they do not break? Is it driven by requirements? Tools?

Hardware: As we add more ideas to create our arcade machine, we try to implement new or improve prior components. Our machine is pretty modular on the hardware side, regression testing

isn't an important factor if we add something new but it will still be done. We will check the power, our circuits, the audio and display, and other components frequently to ensure everything runs as it should. As we add more features we will test the core components and make sure they continue to function as expected.

Software: The addition of new games to the cabinet need to be addressed in regards to testing. We plan on implementing a CI/CD system to push new additions to the system without it breaking the current version. We plan to have low coupling and high cohesion so that if we wanted to change one portion of our software it would not break or cause major changes to other units.

5.6 Acceptance Testing

How will you demonstrate that the design requirements, both functional and non-functional are being met? How would you involve your client in the acceptance testing?

Our acceptance testing will include actually playing the games on the machine. We will look for things like consistent frame rate and reliable controls. Our client is in our group so as long as he determines that the games are playable at a reasonable level, then we will meet our acceptance testing criteria.

5.7 Security Testing (if applicable)

N/A

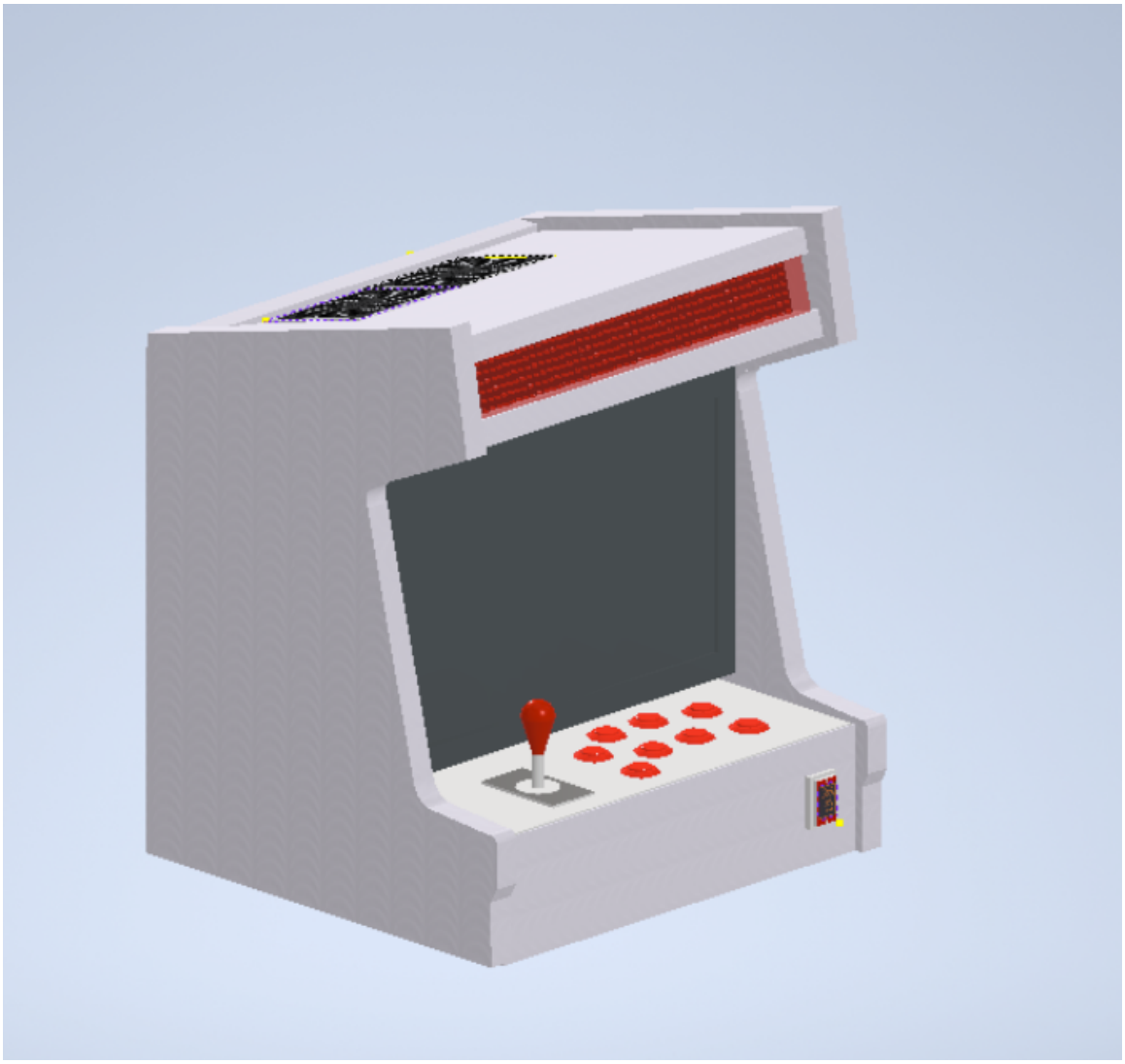
5.8 Results

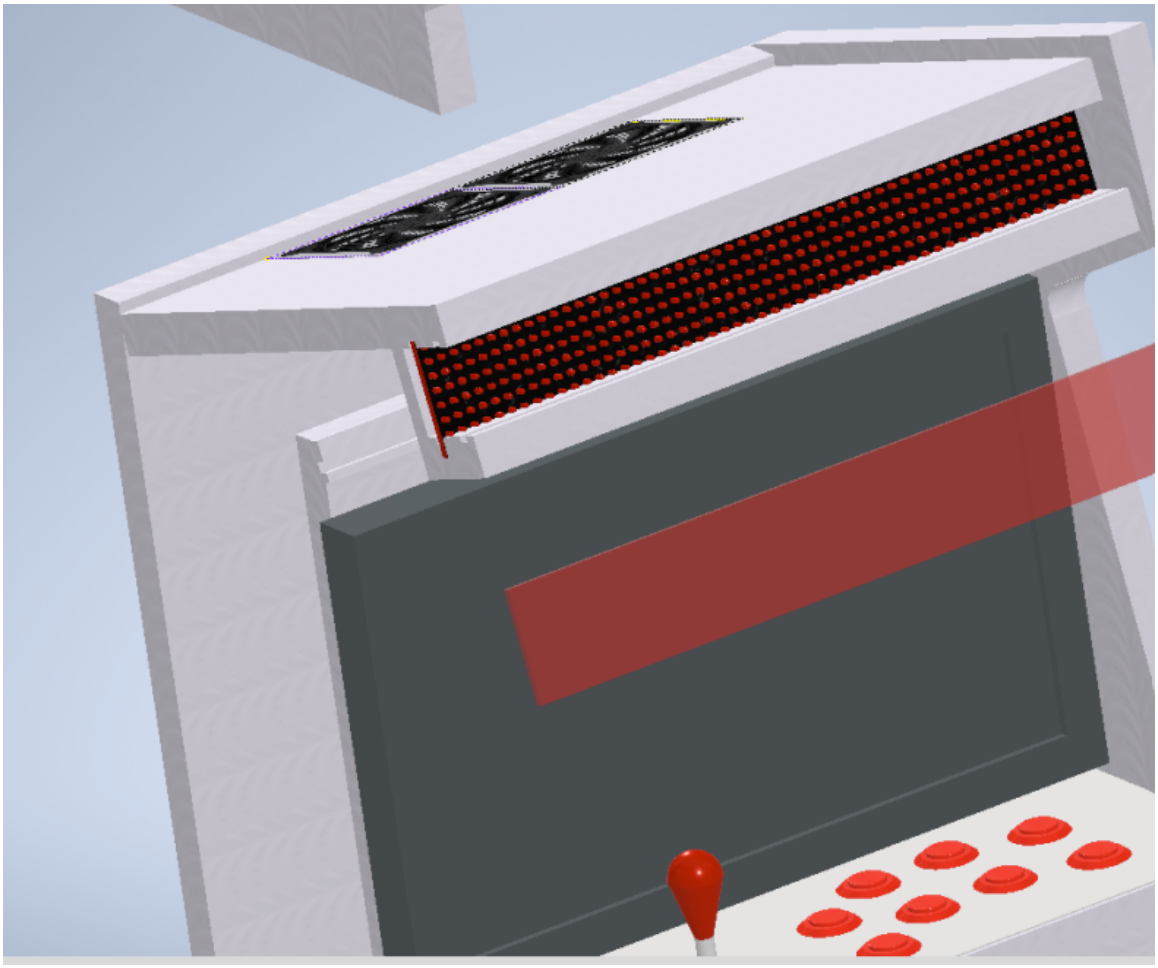
What are the results of your testing? How do they ensure compliance with the requirements? Include figures and tables to explain your testing process better. A summary narrative concluding that your design is as intended is useful.

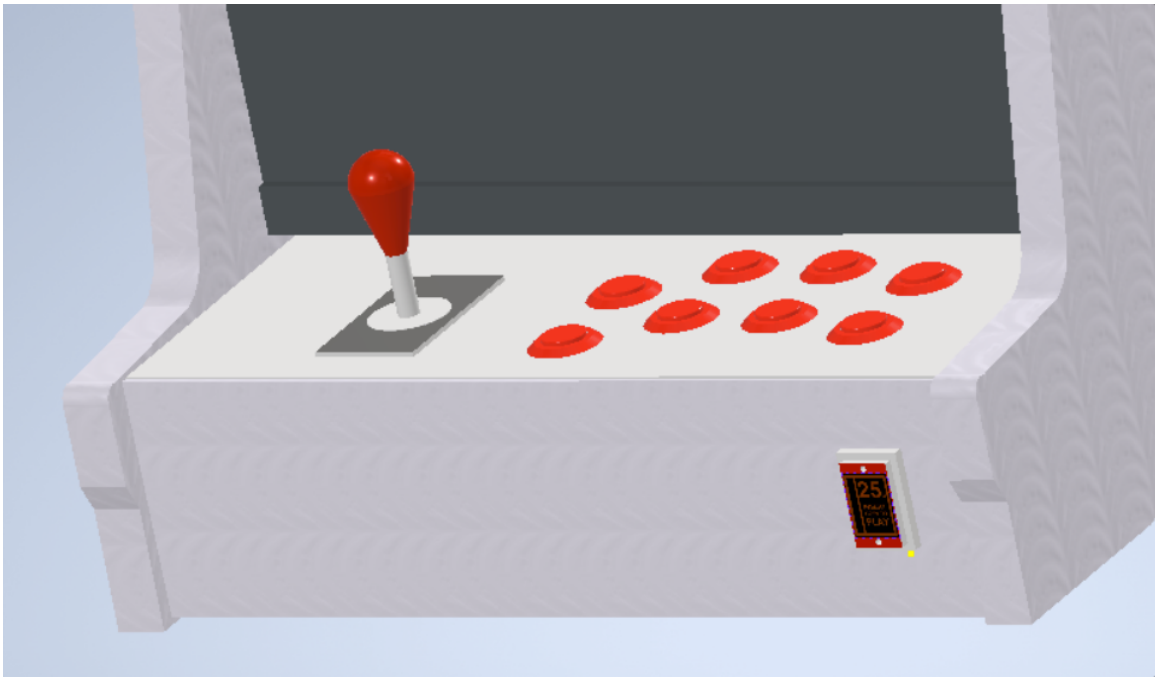
- Audio
  - an ability to control the output volume of the speakers from 0% to 100%
- Power
  - To adapt 120 volts wall power to the needed powers or our systems
- Circuits
  - (on/off) to control the power reliability (99% of the time) on and off with a button press.
  - (temp sensor and fan) to have a temperature sensor as an input to the Raspberry Pi. When too hot, the Pi will turn on the fan. When the temperature returns to a good operating temp, the fan will turn off.
- Software
  - Ability to boot up into the UI after being turned on
  - Ability to use UI to load games and display them on monitor
  - Ability to play game with no interruption or unintended effects

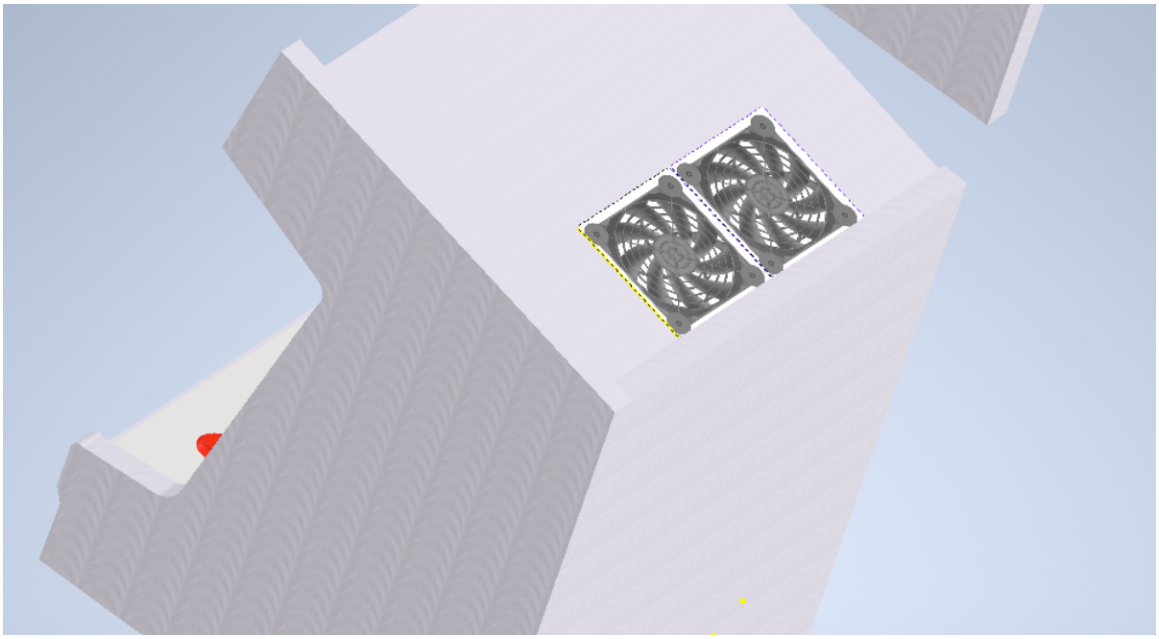
6 Implementation

Describe any (preliminary) implementation plan for the next semester for your proposed design in 3.3. If your project has inseparable activities between design and implementation, you can list them either in the Design section or this section.









7 Professional Responsibility

This discussion is with respect to the paper titled " Contextualizing Professionalism in Capstone Projects Using the IDEALS Professional Responsibility Assessment", *International Journal of Engineering Education* Vol. 28, No. 2, pp. 416–424, 2012

7.1 Areas of Responsibility

Pick one of IEEE, ACM, or SE code of ethics. Add a column to Table 1 from the paper corresponding to the society-specific code of ethics selected above. State how it addresses each of the areas of seven professional responsibilities in the table. Briefly describe each entry added to the table in your own words. How does the IEEE, ACM, or SE code of ethics differ from the NSPE version for each area?

7.2 Project Specific Professional Responsibility Areas

For each of the professional responsibility area in Table 1, discuss whether it applies in your project's professional context. Why yes or why not? How well is your team performing (High, Medium, Low, N/A) in each of the seven areas of professional responsibility, again in the context of your project. Justify.

	SE code	**Project**	**Teams current level**
Work Competence	Relates to SELF topic- continuity learning	HIGH- building the product from scratch, we want to make it last over years and still function as expected.	HIGH- keeping on task, documenting
Financial responsibility	Nothing exactly relating, maybe PROFESSION to take responsibilities	MED- We know we can keep inside our budget, but keeping it in mind is a good habit to get into	HIGH- We are keeping a budget on what we are buying

Communication honesty	Relates to CLIENT AND EMPLOYER- discussing that designs must be consistent with wants of the public	MED- Documenting and reporting all our errors is helpful for us to fix and change our product for the better.	MED- We do all the work in groups, so all info is shared
Health, safety, well being	Relates to PUBLIC topic – act in the public interest	LOW- keeping our client safe is important, but the client is in the group so he should understand each sub system and can repair any problems	MED- Really haven't had to deal with it. But we are keeping it in mind when designing
Property ownership	Closely relates to PRODUCT- Discussing how the product should be made.	HIGH- the games we download wouldn't be owned by us	MED- keeping the clients Pi in good condition is a concern
Sustainability	Would be closest to JUDGMENT, making calls on how sustainable a plan is.	LOW- a simple project that isn't going large scale.	LOW- all our parts will be ordered new and not recycled.
Social responsibility	Can relate to both COLLEAGUES and PROFESSION, discussing how to work with piers.	MED- this may benefit a small community of old gamers	MED- we want to design it for older generations but have not contacted someone like that

7.3 Most Applicable Professional Responsibility Area

Property ownership: We may have to find a way to license the games legally. For an individual project its fine but if we wanted to license this as a product it would become a concern

8 Closing Material

8.1 Discussion

Discuss the main results of your project – for a product, discuss if the requirements are met, for experiments oriented project – what are the results of the experiment, if you were validating a hypothesis – did it work?

-Fits 2' by 2' by 2' rule

Not yet met:

Software, control laggy, and weight

8.2 Conclusion

Summarize the work you have done so far. Briefly re-iterate your goals. Then, re-iterate the best plan of action (or solution) to achieving your goals. What constrained you from achieving these goals (if something did)? What could be done differently in a future design/implementation iteration to achieve these goals?

Our goal is to create an arcade cabinet that fits within a 2 foot cube. This cabinet should allow for the user to control the power with a button, control the volume for the audio, and finally control the came with different controllers. The cabinet will have several subsystems to control, such as power and a fan for venting heat. The cabinet will be able to display a large list of classic arcade games, but also have the capability to upload new games via a usb stick.

So far we have done the following. We have laid out all of the needed parts. We have created a plan for how to construct the wooden frame. We have collected the Raspberry Pi, the controllers, a keyboard for debugging and coding, and some other necessary parts. We still need to find wood for the frame, a display that can connect the HDMI, a fan, and the USB hub.

Plan: With our overall design done, the plan going forward is as follows. Before December we want to have all our parts ordered, to start simulating our circuits, and have a very siple UI designed. After break we plan to spend the first month creating the wooden cabinet. With this, we want to wire up our controls to let the software side start working on mapping the button presses. From here the next month will be focused on mapping controls on the software side and testing and implementing our circuits for the electrical side. With these done, we will spend the next couple of months testing systems and once they work implementing them into the cabinet. Once all parts are

in, we will work on fixing problems that come with attaching all the working parts. Finally with any time left to spare we will add additional games and feedback responses from the game.

Future, we would like to dedicate more time to the project. Starting one or two hours a week was okay, but we spent most of our time working on documentation rather than the project itself. We would also divide up the workload more evenly so everyone has the same understanding of the project. Finally we would like to have found a monitor by now. It has hampered the softwares team ability to make a UI without knowing the screen size.

8.3 References

List technical references and related work / market survey references. Do professional citation style (ex. IEEE).

From page 15, a link to another similar product on amazon

"Amazon.com: My Arcade Retro Machine Playable Mini Arcade: 200 retro ..." [Online]. Available: https://www.amazon.com/Arcade-Machine-Handheld-Gaming-System-electronic/dp/B00S4HI1NY. [Accessed: 03-Dec-2022].

From page 15, a link to another similar product produced from a fellow ISU senior design team

"23 • Networked Arcade Platform," *sddec19*. [Online]. Available: https://sddec19-23.sd.ece.iastate.edu/docs.html. [Accessed: 02-Dec-2022].

8.4 Appendices

Any additional information that would be helpful to the evaluation of your design document.

If you have any large graphs, tables, or similar data that does not directly pertain to the problem but helps support it, include it here. This would also be a good area to include hardware/software manuals used. May include CAD files, circuit schematics, layout etc,. PCB testing issues etc., Software bugs etc.

Bill of Materials

product	price	use
Raspberry Pi	$0 (client had)	for running the games
HDMI cord	$0 (client had)	Pi to monitor
keyboard	$3	for coding and for working

		around bugs with control mapping
speaker system	$7	audio output
arcade controls	$27	basic controls for games
arcade power button	$9	authentic power button
other USB controllers	$0 (client had)	client has an xbox controller
TOTAL	**$46**	**money left = $454**
other needed products	**expected price**	**how to acquire**
wood (2' cube)	75	lowes
acrylic cover (for led)	30	amazon
LED array and controllers	30	digikey
USB hub	25	amazon
power circuit	5	PCBdesign and digikey
on/off circuit	5	PCBdesign and digikey
USB mounts	10	amazon
Total (got and still need)	**$301**	**Money left = $199**

8.4.1 Team Contract

Team Name: sdmay23-26, mini arcade cabinet
Team Members:
1) Bradley Yenger
2) Mark Gores
3) Jeffrey Marsh
4) Liam Tureaud
5) Alexander Glass
6) David Helmick

Team Procedures

1. Meet up Wednesday, from around 4pm to 6pm at Coover (1301 or 1313) to discuss the project and work together.
2. Communication will be through Discord and in person.

3. Work will be divided up and worked in groups or individually.
4. Specialized tasks will be given to those with experience (EE and SE).
5. Expected to make 80% of meetings and mention to the group if you will be unable to attend.
6. Expected equal workload shared across each individual.
7. When presenting, each group member will participate in the creation of slides and presentations.
8. Proper documentation will be expected from each individual or group, using the google drive folder we all have access to.
9. Communicate with both the advisor and client on a monthly basis with updates and progress updates.
10. With the work being divided among groups, it is the responsibility of that group to communicate the progress of the project and notify the group of any delays.

Goal-Setting, Planning, and Execution

1. General schedule provided by the client

Sep 2022: Research and basic plan of action
October 2022: plan for each major part (controls, display, audio, and code for UI)
November 2022: general design modeled (inventor, CAD, or other)
December 2022: list of all parts, basic UI code running on laptop
February 2023: building and starting documentation of project
March 2023: finish building and documentation of project
April 2023: testing, presentation, and reporting

Strategies for planning and assigning individual and team work:

1. Split the work into teams of two, then get together and join ideas together when together.
2. As a group discuss plans of action, what will be needed from each group, and how parts should interact (group one may design the holder for the display, but group two needs to know where is will be placed for wire routing purposes).
3. If a group member repeatedly fails to show up for meeting time without a notice beforehand, repeatedly fails to achieve their required work, or fails

to help in the powerpoints, they will be expected to bring snacks for the next group meeting. (pizza, wings, sandwiches).

Individuals skill and responsibilities

Brad Yenger (EE)

- Soldering experience, 3D CAD design, carpentry skills, along with project experience

I will aid in the creation of the wooden frame, the connection of devices like speakers and displays. I will also be able to create a 3D design for prestations as well as for planning for wire routing and attaching devices. Finally I will help in the creation of the powerpoints and presentations.

Liam Tureaud (EE)

-Soldering experience, carpentry, PCB design, electrical work

I have a solid understanding of what is needed for the project as I have done something similar. I am able to help Brad with the frame and electrical devices which are needed for the project. I can create the needed circuits and wire all of the electrical parts and solder if/when needed. Finally I will help in the creation of the powerpoints and presentations.

Alexander Glass (SE)

-Capable coding in Java, HTML, JavaScript, willingness to learn a new skill during the course of this project

I will mostly be involved in the coding aspect of the project. Implementing the games so they can run on the game cabinet. Depending on how we want the final product to look, I could work on a front end component to get a quality UI. I can also help with the creation of the cabinet itself while learning several skills that come with that side of the project. Finally I will help in the creation of the powerpoints and presentations.

David Helmick(SE)

-Worked with many different computer programming languages in many different aspects (simple games, UIs, websites, embedded systems, databases, etc.). Taken both CprE and SE courses so I have lots of knowledge about computers from a hardware and software perspective.

I can help work on the UI as well as any backend components needed to make sure the software works properly with the hardware. Finally I will help in the creation of the powerpoints and presentations.

Jeffrey Marsh(SE)

-pretty talented programmer also well versed in video game emulation

I expect to help with getting the cabinet to interface with the emulators running on the PI or PC, but will help wherever else the team needs me as well. Finally I will help in the creation of the powerpoints and presentations.

Mark Gores(SE)
-proficient in multiple coding languages. Good understanding of operating systems. Good understanding of computer engineering.

help designing the code for user interface, creating the code to run on startup, and will be very interested in helping and learning any of the EE portionions. Finally I will help in the creation of the powerpoints and presentations.

****

a) I participated in formulating the standards, roles, and procedures as stated in this contract.
b) I understand that I am obligated to abide by these terms and conditions.
c) I understand that if I do not abide by these terms and conditions, I will suffer the consequences as stated in this contract.

1) Bradley Yenger_____ DATE _____9/17/2022_____
2) Mark Gores_____ DATE _____9/17/2022_____
3) Jeffrey Marsh_____ DATE _____9/17/2022_____
4) Liam Tureaud_____ DATE _____9/19/2022_____
5) Alexander Glass_____ DATE _____9/19/2022_____
6) David Helmick_____ DATE _____9/19/2022_____