

# Development Log

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# Dev Log 0: Hello World

(Week1, Monday, 8/26/19)

## Introduction

For my senior project I will be working on a VR research project with Dr. Herbert Cecotti. The project seeks to explore any change in students learning between three learning mediums. The three are traditional textbooks, a computer screen and a VR application. I am tasked with creating a VR museum, with the hopes that, students will learn artworks more effectively while being immersed in a virtual museum stylized after the time period in which the painting was created. I will also be working closely with an art history professor to complete this project.

## Project overview

The goal of the project is to see if there is a noticeable difference in the way that students learn via VR as opposed to a more traditional means. To maximize the effectiveness of VR, it is important to utilize all of the strengths of VR technology.

With my background in VR development, I believe that VR will have a significant advantage in experiencing a media. The immersive qualities of VR seems to heighten the focus of the user. I've also found that VR can be overwhelming for audiences that have not experienced it before, and this can lead to them being distracted or lost easily if not directly guided.

# Dev Log 1: Project Planning

(Week 1, Sunday, 9/1/19)

## Introduction

This week I was tasked with planning out the project. I met with Dr. Cecotti on Monday and discussed the project's high level features. These include: Locomotion, a Quiz System, Realistic Lighting, Shaders for the paintings and a Gaze Tracking system. I will also have to create the layout for the experience, as right now it is a large warehouse.

## What was Done:

I completed a timeline of what I believe can be feasibly built in this semester. I have also included some optional features that can be added on if time allows. I also reviewed the project's initial proposal. This gave me a much better understanding of the parameters of the project.

## Roadblocks

1. I still need to meet with the art department to discuss the Rooms/ museum layout.
  - a. This is scheduled for 6 am on Tuesday.
2. Find out how many students are working on the project / Who (if any) will I be working with.

## What Needs to be Done

1. Learn VRTK



# Dev Log 2: Dev Tools

(Week 3, Monday, 9/9/19)

## Overview

Today I worked on creating a fps counter and a framework for adding more dev tools. I also spent some time laying out a mock up for the quiz system UI. Tomorrow I will create the assets for the Quiz system UI and I will mock up the back end of the quiz system. I'd like to be able to hook up the VR >< UI interaction tomorrow as well if I have time.

## Goals for Tomorrow

1. Create UI Assets
2. Mock up Quiz Backend
3. Hook Up VR><UI interaction

## Tasks for Week

- ~~1. Meet with Cecotti~~
2. Meet with Art Dep
3. Source Quiz questions
- ~~4. Build Quiz system~~

# Dev Log 3: Quiz system / Employment paperwork

(Week 3, Tuesday, 9/10/19)

## Overview

I worked on the quiz system. I first built the GUI elements within unity. Then I built a quiz script that takes questions and displays the appropriate text information on the prompt and answer buttons. This generates the buttons according to the question (ie. true false questions generate 2 buttons and multiple choice generates as many as needed)

Actual as I'm typing this I think it might be easier to build an answer prefab and generate the answers dynamically that way. I'll try it tomorrow.

I also filled out the employment paperwork. I still need to bring in my passport for the I9 but it should be good otherwise.

## Goals for Tomorrow

1. Dynamically generate answer buttons?
  - a. Might help with sizing issue
2. Create quiz structure
3. Create quiz generation algorithm

# Dev Log 4: Quiz system, Shuffle and Score

(Week 3, Wednesday, 9/11/19)

## Overview

I started by building a Quiz class that could shuffle the questions and answers and interface with the quiz system. Then I reworked how the quiz system handled questions to better work with the new quiz framework. Afterwards I added a quick script to the buttons that would make them toggle. It's not pretty but it will work for now. I finally added in the score tracking system. It checks when the submit answer button is pressed and then checks the toggle status of each button against its expected value. I cleaned up the code a bit after that.

## Goals for Tomorrow

1. Figure out a better data collection method
2. Make the UI look more clean
3. Design how quizzes will attach to pictures
4. Look into dynamic text box scaling

# Dev Log 5: Quiz system, Jsons and ADTs

(Week 3, Thursday, 9/12/19)

## Overview

Today I started working on bridging the gap between my quiz system and the legacy json/painting prefab system. I spent most of the time structuring the new json layout. I also diagrammed the phases of the experience to help design the Experience Manager and respective handlers later. At this point instead of cobbling something together to make jsns work with my quiz system I'm going to take the time and design a better super system that will be easier to work with and extend later. I also want to run my ideas past Dr. Cecotti before I jump to deep into this idea.

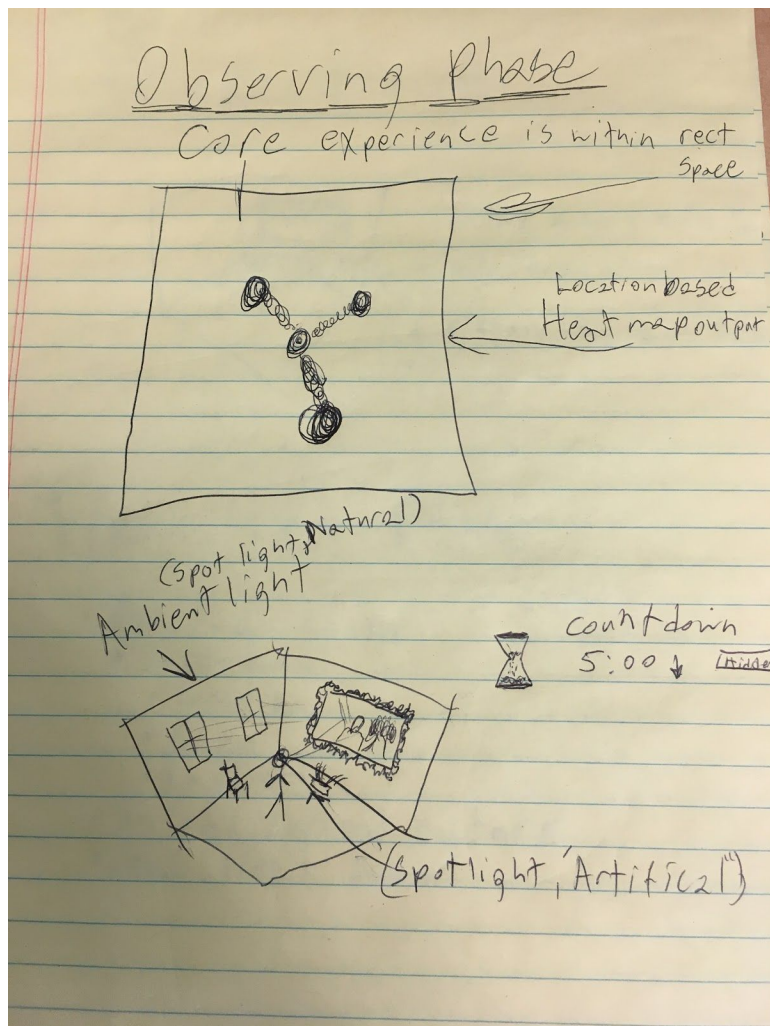


Fig 5.1 Observation phase hand drawn diagram

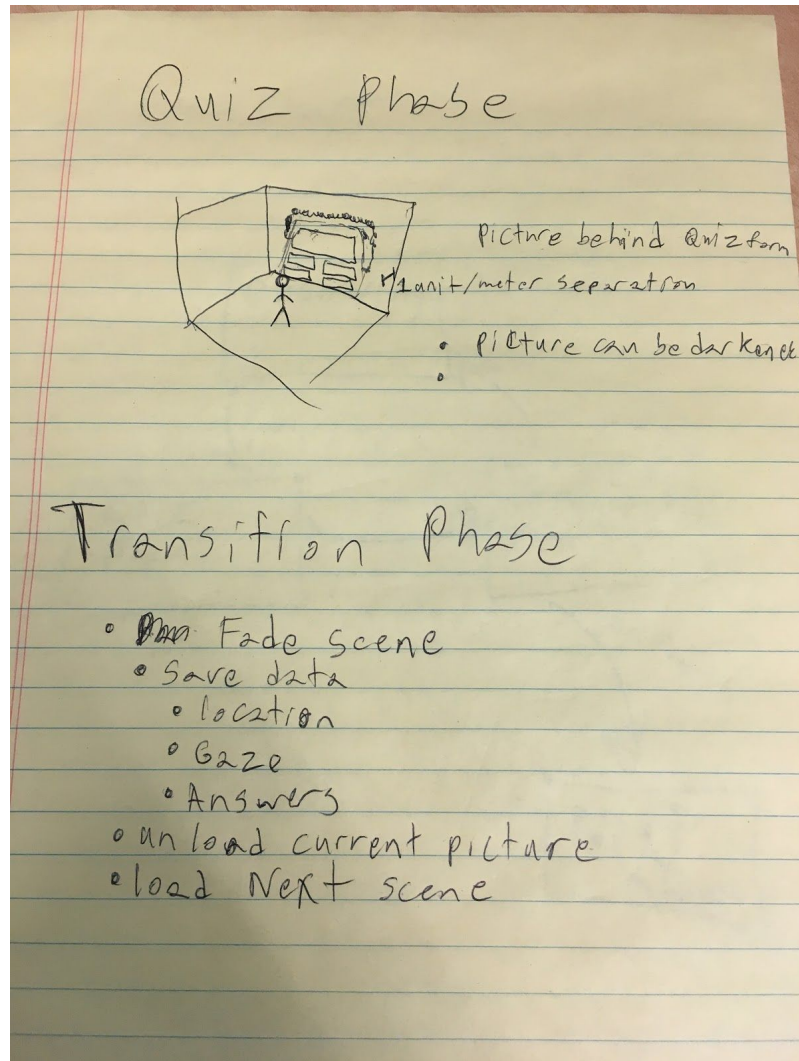


Fig 5.2 Quiz phase hand drawn diagram and Transition phase flow/reqs

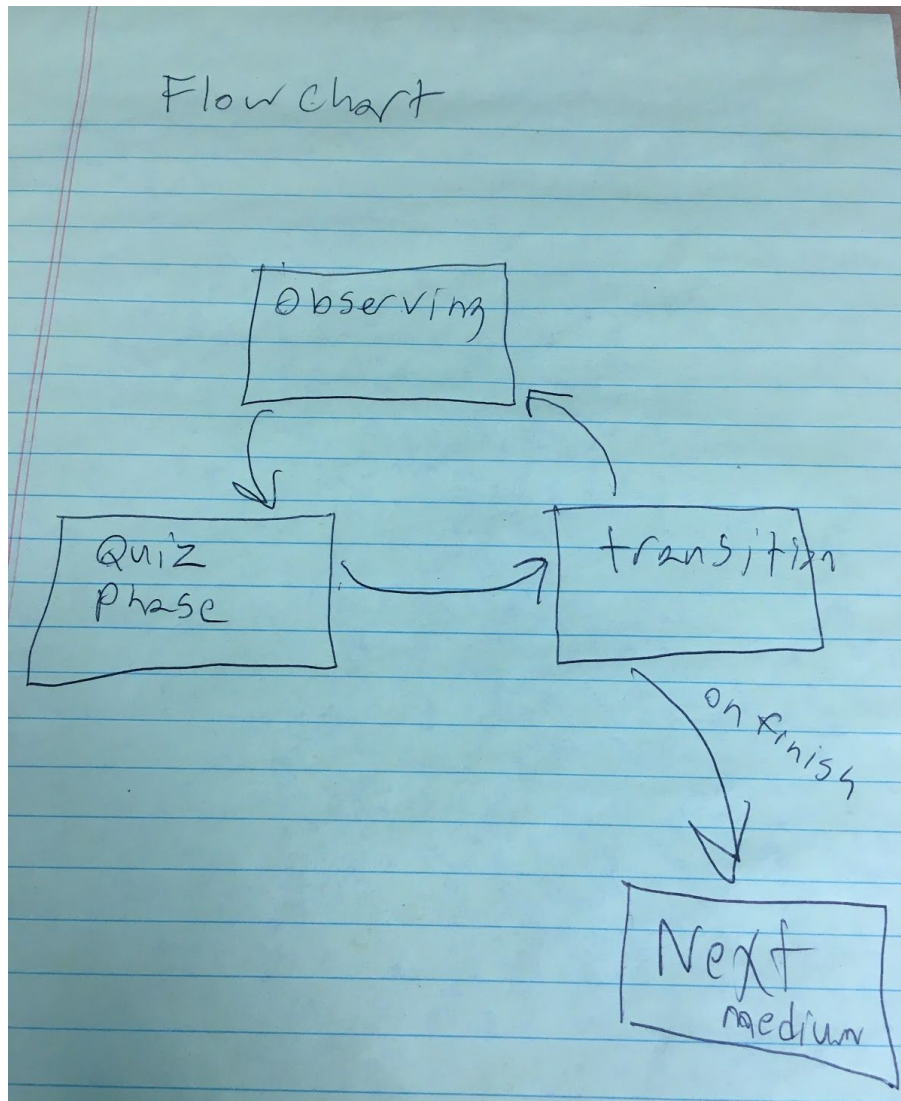


Fig 5.3 Phase flowchart hand drawn

```

{
  "Picture": {
    "filename": "The_Death_of_Socrates.jpg",
    "title": "The Death of Socrates",
    "author": "Jacques-Louis David",
    "ratio": 1,
    "light": "dim",
    "size_y": 1.295,
    "size_x": 1.962,
    "Quiz": [
      {
        "Question": "Liverpool is the greatest football team in the world!",
        "Answers": [
          {
            "Answer": "True",
            "Correct": true,
            "TimesChosen": 0
          },
          {
            "Answer": "False",
            "Correct": false,
            "TimesChosen": 0
          }
        ]
      },
      {
        "Question": "The sky is red",
        "Answers": [
          {
            "Answer": "True",
            "Correct": false,
            "TimesChosen": 0
          },
          {
            "Answer": "False",
            "Correct": true,
            "TimesChosen": 0
          }
        ]
      },
      {
        "Question": "Click all of the buttons",
        "Answers": [
          {

```

*Fig 5.4 Proposed new Json picture centered format*

## Goals for Tomorrow

1. Design Class structure for Exp manager and handlers
2. Mock up class diagrams
3. Mock up scene for meeting on monday
4. Explore current json loading method

# Dev Log 6: Probuilder and Parsing

(Week 4, Friday, 9/20/19)

## Overview

This week has been slow moving. I haven't been able to get into the lab very much this week due to having to job hunt. I did sit down today and tried to work more on the rooms system though. I spent about 4 hours working today.

The first task I worked on was getting Probuilder to work. The project seems to be stuck in a CS 3.x when the latest version of Probuilder uses CS 4.x. After some time I decided to go with an older version of Probuilder that worked in CS 3.x.

After that I started modeling a test room. This was working, except I couldn't transport all of the VR controllers to the new scene. It seems like the VRTK and custom scripts we've built aren't very portable between scenes. After a while I gave up and started building test rooms in the main scene. This however caused the framerate to plummet when inside the room. Frustrated, I decided to take a walk and came back to work on the json parser for the gamemaster.

The parser came together much easier than expected. The picture object seems to contain the metadata, texture and Quiz object correctly. The Quiz object seems to initialize properly. This should give me a good starting point for next week.

All together I didn't get much done this week. I had other work things going on that distracted me and therefore wasn't able to work as much as I would have liked. Next week should be better. I worked roughly 6 hours this week, most of which was at a lower efficiency than my normal.

## Goals for Next Week

1. Build a picture prefab that works with the new data structure
2. Build a generic room prefab that can be populated with the picture and quiz prefabs
3. Work on transitioning rooms
4. Finish laying out picture\_Quiz json
5. Research Museum Architecture and lighting



# Dev Log 7: Json Loading, Picture Initialization

(Week 5, Monday, 9/23/19)

## Overview

Today I finished setting up the experience manager -> painting initialization. I've got all of the basic components to initialize properly but there is an error that is making the paintings disappear.

## Goals for Next Session

1. Debug the painting disappearing
2. Fill out the json day

# Dev Log 8: Picture Initialization Bug fixes

(Week 5, Wednesday, 9/25/19)

## Overview

I started today by trying to debug the Painting disappearing bug. I found that the Gamemaster was calling the update painting function in its start method before the painting object called its start method. So the default values were not initialized, thus giving the weird error. After fixing that I moved on to finding the paintings for the exam. I was only able to find #2 the double portrait. I started to fill out the json of it's metadata, but I was stopped due to not knowing what measurement the x\_scale and y\_scale values are in. It seems like they might just be a ratio but I'm not sure.

## Goals for Next Session

1. Test ratio for painting
2. Set-up full painting loop
3. Test painting loop
4. Set-up for multi painting loop

# Dev Log 9: Pomodoro Style

(Week 5, Thursday, 9/26/19)

## Overview

### Round 1: Check 1, 2

Tested the ratio value in the paintings json. Found out the size\_x/y values are in meters.

### Round 2: iE(D)M

Built experiencemanager interface and implemented it in building the VRExperienceManager. Implemented the LoadPictures method and built a wrapper class for room data. I used that room data to implement the LoadRoom method. Some other work was done but forgot to document

### Round 4: Refactory

Refactored the GM for better encapsulation. Set up a generic LoadPictures method to load as many pictures evenly into as many IEMs as there are attached to the GM gameobject. I then built a ArrayShuffler utility class that should return a shuffled array using the same optimised algorithm I have been using in the Quiz system. Generics are complicated but pretty cool.

### Round 5: Testing

I tested the shuffler and it seemed to work for the quiz. However, I ran into an issue with the GM (i think). Every time I start the application the first painting to get posted is the last painting in the json. I'm going to explore this further next round.

### Round 6: Shuffled

I accidentally found out that the PlacePlayer method is working. Still debugging the shuffling bug. Tested the Shuffler on the quiz system again. It seems to work for that, which has

me confused. So far I have the problem isolated to the `ShuffleEXMandPaintings` method in the GM. I'll work on it tomorrow. Unit tests might be in order.

# Dev Log 10: Rooms, Randoms and Refactors

(Week 5, Friday, 9/27/19)

## Overview

Today I will be working more on the rooms system, with the goal of having a build that can run through a full experience loop with multiple room loops. I will be using the Pomodoro technique again as it worked really well yesterday.

## Round 1: Phaser

I built a new LoadQuiz function so that the EXMs can load their quizzes to the framework. I then refactored room initialization to make it more generic. This will be useful later when custom rooms start becoming a thing. I then worked on the update loop for the VR EXM. I started with a switch block to take advantage of the phase enum.

## Round 2: All the Single Room Loops

I finished the core loop of a single room/painting/quiz combo. There are some bugs with picture scaling, Quiz data being maintained and spawning the player. But all in all im making good progress.

## Round 3: 3 is a crowd

I finished the core loop for the entire VR EXM. The core loop supports any number of paintings and quiz questions. I currently am only testing it with 3 paintings, however I am confident it will scale nicely. There is only support for one standard time to view all paintings, but that can be extended later if needed. Future features include Blocking out the picture for certain quiz questions and a better spawning system.

## Round 5: Bug Squash'n

I Fixed the scaling bug with the pictures and fixed the quiz data persisting bug. I then extended the Json/Quiz system to be more scalable with future features. Specifically I did it to add the True false flag and the canseepicture flag

## Round 6/7: transform.Y Wont You Work

I attempted to fix the pictures clipping through the floor bug. I think I have the solution, I just need to tweak some values. But I ran out of time. Should be able to sort it out early next week.

# Dev Log 11: Quickie

(Week 6, Wednesday, 10/2/19)

## Overview

I don't have much time to work for this session so I am just going to focus on preparing for the next session. If I can get the documentation done for the next big systems it will make the next session more productive.

### **Targets for this session:**

1. Identify the targeted metrics
2. Mock up position tracker

# Dev Log 12: Help I'm Alive

(Week 6, Thursday, 10/3/19)

## Overview

Today I am going to try to work for an extended session. The goal is 6 hours. I want to complete the metric system by the end of this session. With the planning I did yesterday, I think that it is an achievable goal. I will be using the pomodoro technique with targeted goals for each 25 minute round.

Tech debt acknowledgement:

1. I understand that the project needs to be ported to the newer version of Unity and more importantly on to the better render pipeline LWVRRP. I also understand that the longer I wait to do this the more work it will be to port up when I finally get around to doing it.
2. I understand that the naming conventions for the expMans are inconsistent and that they should be fixed.

### **Targets for this session:**

1. Adjust UMLs to match current ideas
2. Build the super structures of the Metrics system
3. Build the concrete implementations of the:
  - a. VrRecorder
  - b. Utilitys
  - c. File output
  - d. Personal Info
4. E: Design and prototype the intro form screen

## Round 1: Prep work

I started today by recreating the UML diagram that I came up with at work last night. The structure makes more sense to me and isn't trying to force a design pattern that I am not familiar with into the mix. I then did a bit of file management and admin work.

## Round 2:

Goal: Create high level interfaces



## Conclusion:

After learning more about json structures and creation, I decided to go with a more direct and embedded solution. It is a stacked object strategy that should allow for decent scalability however the implementation is pretty scattered. I would like to refactor it out if I have time at a later date.

# Dev Log 13: Plans Mean Nothing, but Planning is Everything

(Week 7, Monday, 10/7/19)

## Overview

Today is a sprint review/planning day. I think for this week, I should work on:

1. Finishing the json writer
2. Creating the location tracker
3. Create timer for recording system
4. Converting/porting the project to the new render pipeline
5. Creating the FPS controller

## Change of Plans:

So I met with Dr. Cecotti and he has given me a new task for this week. I now need to extend the paintings json to handle answers that can contain actions. For example, there could be a question that asks which lighting is best, and when each answer is selected the lights in the scene change to match the answers set up.

This shouldn't be that difficult. I think the best way will be to use the same dictionary action system that I used for the spell casting in the VRRPG. I should also create an answer button manager to control the buttons and their respective actions.

I also brought up the porting up to the newer version of unity and the new render pipeline. He seemed pretty against it. I asked about trying it at home and he gave me the go ahead.

### Porting to new Unity and Render Pipeline

#### Potential risks:

- Ruining all current shaders
- Possible C# dependency issues moving from a 3.x to a 4.x compiler

#### Potential gains:

- Greater lighting control
- Much easier shader programming
- Possible greater control over rendering performance

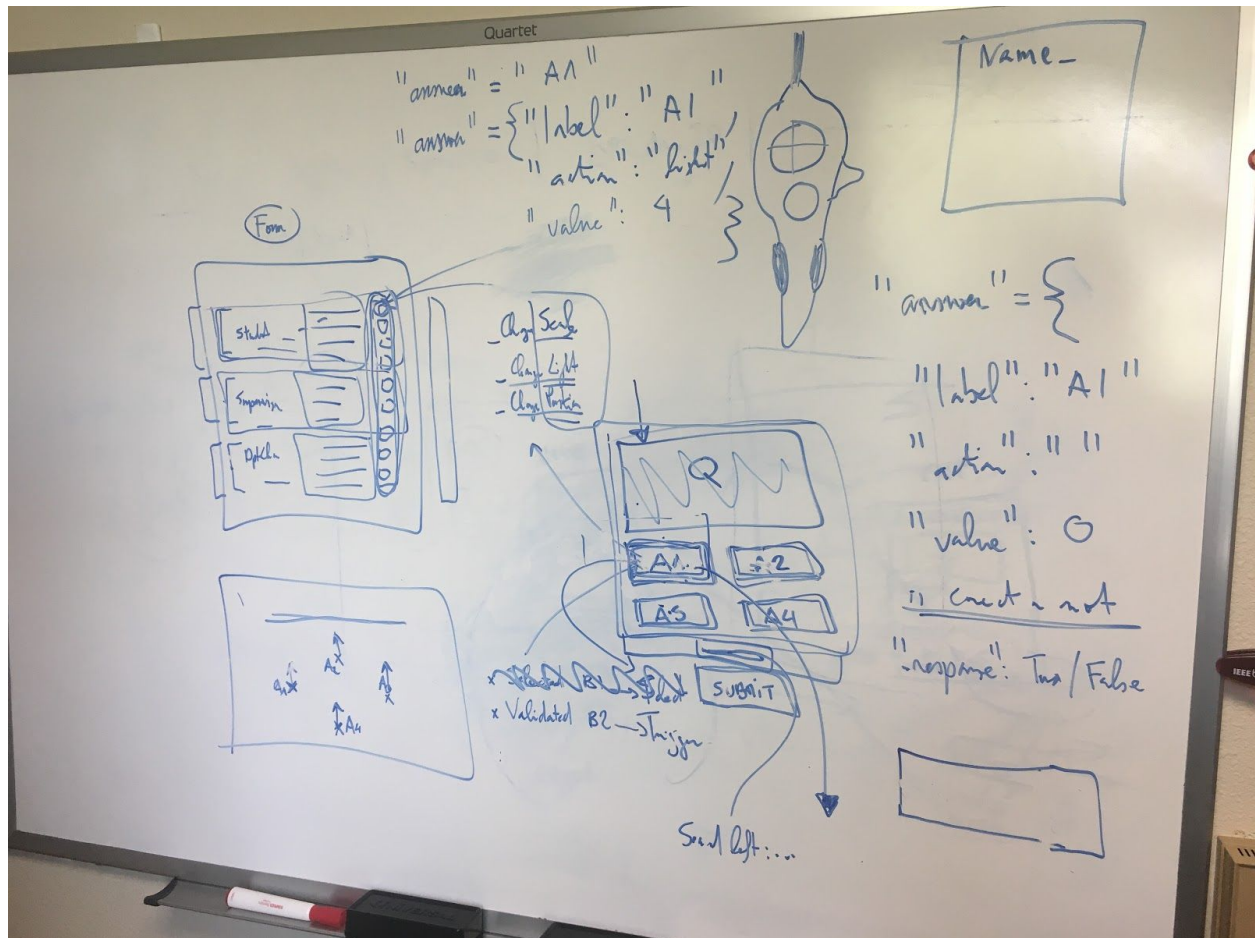


Fig 13.1 Meeting diagrams, answer action system, 10/7/19

## Sprint Goals:

1. Quiz is displayed in a convenient location near player
2. Find exact amount of characters can be comfortably displayed in quiz prompt boxes
  - a. Question
    - i. Ideal: < 100
    - ii. Max: 130
  - b. Answers
    - i. Ideal: < 45
    - ii. Max: 60
3. Action buttons do their intended actions
4. Recorder outputs json files
5. E: Intro screen

# Dev Log 14: Let's Play COUNTDOWN!

(Week 7, Monday, 10/7/19)

```
UnauthorizedAccessException: Access to the path 'F:\Zach\VR art gallery\Reports\Gen1Untitled.json' is denied.  
System.IO.FileStream..ctor (System.String path, FileMode mode, FileAccess access, FileShare share, Int32 bufferSize, Boolean anonymous, FileOptions options) (at /Users/builduser/buildslave/mono/build/mcs/class/corlib/System.IO/FileStream.cs:259)  
System.IO.FileStream..ctor (System.String path, FileMode mode)  
System.IO.FileStream..ctor (System.String path, FileMode mode)  
(wrapper remoting-invoke-with-check) System.IO.FileStream..ctor (string System.IO.FileMode)  
MasterRecordKeeper.WriteToFile (System.String fileName, System.String json) (at Assets/Scripts/Zach/Metrics System/MasterRecordKeeper.cs:88)  
MasterRecordKeeper.SaveCurrentExperience () (at Assets/Scripts/Zach/Metrics System/MasterRecordKeeper.cs:67)  
VrExperienceHandler.TransitionToNextPicture () (at Assets/Scripts/Zach/Managers/Experience Managers/VrExperienceHandler.cs:139)  
VrExperienceHandler.Update () (at Assets/Scripts/Zach/Managers/Experience Managers/VrExperienceHandler.cs:172)
```

*Fig 14.1 Error Code upon trying to write json file on experiment completion.*

## Overview

For this session I will be working on:

1. Making the quiz canvas follow the player.
  - I think the first stage of this will be to find the best position for a standing player to view the quiz.
2. Then If I have time I would like to make the quiz disappear unless the player is looking at it.
  - I think that will add a nice bit of polish and will be a decent challenge to develop

I will be using the pomodoro technique again.

## Phase 1: Getting Handsy

I started by trying to get the quiz to track the player's body. However, VRTK hides collider generation. So while I was looking for where it was instantiated, I thought it might look nice to have it on the hand, similar to how Rec Room has their main menu. I attached the quiz to the left controller with a child wrapper Gameobject. I then adjusted this Gameobject to set the appropriate transform for the quiz prefab. Now I should be able to attach any quiz prefab to the hands with ease.

## Phase 2: Where is Joe Wilkenson?

I mocked up the ui elements for the countdown feature in the quiz system. I then hooked the UI up to the back end system and coded a simple countdown (up) feature that updates the image mask and text. I haven't tested it yet but it should move on to the next question once time has been completed.

## Phase 3: Times Up

I finished the countdown feature. The countdown feature works as intended. If a `timeLimit` is present then the `elapsedTime` will count up to it. The `countDownTime` will display the time remaining and the `countDownClock` will graphically represent it. If the player doesn't pick an answer by the time limit, then the submit button is pressed and any answers selected are recorded. If there is no `timeLimit` value in the json, then it is assumed to be unlimited time. At the moment this makes the clock white and displays a 99 for the text. I might change that to be blank.

# Dev Log 15: Actions Speak Louder Than Words

(Week 7, Wednesday, 10/9/19)

## Introduction

HoP Pk is closing tomorrow. I found out via text yesterday. This means I am now unemployed, sans this. I bring this up because it is affecting and will continue to affect my work for a bit until I can find another job. I will continue to try to put in as much effort to this project as possible but I have to find a job soon to be able to pay rent.

That being said I did come in and work an hour yesterday. I fixed a couple small bugs with the quiz timer and started planning the action button system.

Today I'm looking to have the entire action button structure done. Ideally I'd like to have all functionality done asap so that I can continue to work on the core loop. I would like to do some usability testing in the next week or so. I will be working for 3 hours today starting at 10:33am and ending around 1:33pm.

## Session goals:

Duration: 3 hours

Milestones:

1. Develop single answer mode
2. Add action button system
3. Test action button system
  - a. Lights
  - b. Position
  - c. Scale
4. Review work completed at the end of the session

## Phase 1: Fly Away Little Controller

I began today trying to get a reliable solution to having to manually assign the quiz to the hand controller. It caused a lot of headaches and weird bugs like sending the controller far away from the body. I don't even know why I started working on that. I'm going to try to reset and get back on task.

## Phase 2: Pick One and Deal With It

I expanded the functionality of the button manager. I think the naming is all over the place but it works as intended. Currently all action answers and T/F questions will default to one answer at a time. All others must be specified.

## Phase 3-6: Lights, managers, ACTIONS!

I started by working on the actionbuttonmanager. I tried to isolate it from other systems because the project is starting to get coupled. I structured it in a similar manner to how my voice activated magic system is, with a dictionary of possible actionTypes and several dictionaries for the specific actions that can be taken within that action type. It scales beautifully. Currently only the lights action system works. The workflow for adding more lights to the system is easy.

1. Create the light(s) in Unity
  - a. If multiple lights are going to be used for a single light group, wrap them in an empty gameObject and continue as if the wrapper G.O. was the only light.
2. Name it a unique name. (I've been using paintingname\_light\_n naming conventions)
3. Attach it to the lights array on the actionbuttonmanager component in the gamemaster gameobject.
4. Fill out the json as normal
  - a. Question object must have an "ActionButton" field set to "Lights"
  - b. Answers must have an "Action" field set to the name of the light in Unity
  - c. If either of these are missing the question will not work, however the quiz should work normally.

## Review:

Today I worked on the action buttons system. I started immediately off track by trying to make the quiz system attach to the players hand in a "better" way. After failing at that I moved on to what I was supposed to be doing and finished the single answer toggle option. It works well unless there is more than one Quiz prefab in the scene. Then I worked on the action button system. I first built the super structures of the system, mainly the manager and a helper in the buttonSelector. Then I hooked up what I could to the existing systems. I then created lights in Unity which was fun because I have barely touched the lighting system in Unity. I created some quick spot lights for demonstration and loaded them into the system. After some minor bugs and a couple tweeks it works as expected.

### **What went well:**

1. Action system seems to be able to scale nicely

2. I worked consistently
3. I didn't overplan, I worked on the problem at hand

**What could be improved:**

1. I started pretty scatterbrained for the first phase of the pomodoro
2. Naming is getting less consistent
3. Should've brought snacks and water.

**Session stats:**

Duration: 3.4 hours

Milestones:

- ~~1. Develop single answer mode~~
- ~~2. Add action button system~~
3. Test action button system
  - ~~a. Lights~~
  - b. Position
  - c. Scale
- ~~4. Review work completed at the end of the session~~

LoC: ~250



# Dev Log 16: Harder Better Faster Stronger

(Week 7, Friday, 10/11/19)

## Overview

Today I came in for a short session. When I got to the office, Dr. Cecotti was upgrading the desktop with an RTX 2060. The improvement was insane! The pictures were significantly less jittery and the frame rate was more consistent.

I showed him what I've worked on this week and he seemed happy with the improvements. We agreed that the quiz menu could be a bit more intuitive but I think I'm going to wait until the Index comes in and try to incorporate it's finger tracker in the new design.

Afterward I worked on making the json writer work. After a lot of troubleshooting I think it is working properly. Some of the issues were inaccurate pathing and naming, not equipping the record classes to be serializable and inaccurate type matching. I ended up working on that for too long and haven't finished the action buttons. I should be able to knock that out this weekend or monday before the meeting.

## Session stats:

Duration: 2.05 hours

Milestones:

1. Upgraded pc (Dr. Cecotti)
2. Tested system with new graphics card
3. Fixed json writer
4. Fixed record creation

# Dev Log 17: Moving and Shaking

(Week 7, Saturday, 10/12/19)

## Introduction

### Overview

Today I will be finishing the initial implementation of the Action answer buttons mechanic. I would like to have Painting Scaling and Player position done today and a couple of test cases for both. If I can finish those then I will move on to the metric system features. Namely the player info collection system. That should take a while so it will likely take me until

the end of today. I am pretty tired today, and have had a stressful week so I feel like my productivity is at like 70%. I'm going to push through and try to use the breaks in the pomodoro to move and get the blood flowing.

### **Session goals:**

Duration: 3.24 hours

Milestones:

- ~~1. Develop action buttons for Player position~~
2. Develop action buttons for Painting Scale
3. Design Player info collection system

Workflow Methods

- Pomodoro

## **Pomodoro Logs**

### **Phase 1: Location, Location, Location**

I started with reviewing the old code and checking a play through of the system. I then programmed the position action system methods and created a generic debugger that should catch most errors in the action system. I haven't tested the position action yet but It should work.

### **Phase 2: You Didn't Think This was Going to be Easy, Did You?**

After finishing the initialization scripts I tested the system. This was fruitless as I forgot to add the action fields in the json. After some head scratching I fixed the error and found out that, WAIT , I just thought of something.

### **Phase 3: Testing**

The issues were that I wasn't calling the do action function properly and that there was a typo in the ActionTypes initialization.

### **Phase 4-6: Forms and Forgetting to log...**

I tested the position a bit more. Then after deciding that the scaling might not be used, I moved on to setting up the initial form for players to fill out before starting the experiment. I've

set up a simple form using TMP elements on a unity canvas. It should do the trick, at least until an artist joins and breaks it. Next steps are finalizing those player data questions and hooking it up into the main scene.

Then I'd like to work on the fps controller a bit. I feel like the longer I don't include it the harder it will be to develop. After that should be sourcing all of the paintings and modeling/populating the rooms.

# Dev Log 18: Getting the Finger

(Week 8, Tuesday, 10/15/19)

## Introduction

### Overview

The Vive Index came in yesterday! The project is only kind of broken with this new tech. Push comes to shove I can always just revert to the older controllers and ignore the knuckles. This might be the smartest option as changing control scheme halfway through the project to something you aren't used to seems like project suicide, but I really want to play with this new toy! I think this week might be a good week for reflection. It is the midway point in the semester, so I think it would be good to sit down and look at where the project is right now. Then I can better plan for the back half of the semester and the next phases of the project.

### Weekly goals:

Duration: 10 hours

Milestones:

1. Sprint Review
  - a. Demo if current build
  - b. List finished features
  - c. List backlog
2. Sprint Retrospective
  - a. Liked
  - b. Learned
  - c. Lacked
  - d. Longed for
3. Project Plan
  - a. Reorganize/prioritize backlog
  - b. Estimate story points
  - c. Develop weekly plan
  - d. Throw weekly plan into garbage
4. Test Knuckle features (estimate development risks)
5. Test HDRP project port (estimate risks)

Workflow Methods

- Agile/Sprint

# Dev Log 19: Yeah, No... Write TPS reports

(Week 8, Wednesday, 10/16/19)

## Introduction

### **Overview**

Today I will start the sprint review. I'm thinking that I might create a new document for the sprint review and retro.

# Dev Log 20: Overkill on backups is Underrated

(Week 8, Friday, 10/18/19)

## Introduction

### Overview

I started today in response to 3 emails I got yesterday from Dr. Cecotti. I was worried because in my attempts to port up to the latest version, TMP caused some issues. These issues caused the application to not even start. I think it might be best to not try to change versions mid stream. Even though I was the one pushing for it.... I bring this up, because I think that I confused Dr. Ceccotti with my intentions for the port, and when he tried to demo the project, he bricked that copy of the project. Luckily, I had a backup.

This means priority 1 today was getting a stable demo build built. This took me about an hour as there was a bit of weird issues with pathing in deployment builds as opposed to editor builds. That being said, it was easier than expected. It is nice to have a stable build as a benchmark. I think it would be smart to incorporate demo/dev builds into my weekly workflow.

Now that the demo build is complete, I am going to continue my sprint review.

### Plan for Tomorrow:

1. Set up demo for Tuesday meeting
2. Investigate Quiz question bug
3. Sprint Retro

# Dev Log 21: Demo Crunch and Meeting

(Week 9, Tuesday, 10/22/19)

## Introduction

### Overview

To do (Mind like Water)

- Better controls
- Better navigation
- Room scaling
- Best position question
- Better quiz menu position
- Texturing

# Dev Log 22: Getting in Shape

(Week 9, Friday, 10/25/19)

## Introduction

### Overview

Tonight I worked on getting the painting placement right and the rooms to auto size. I was asked by Dr. Cecotti to have this finished by next meeting.

I started with the painting placement. My plan was to center the painting on (0,y,0) and build the world around it. So I started by zeroing all of the transforms of virtually everything. Then I tackled the issue of the painting spawning code. This clean up lead down a rabbit hole that ended up fixing some major bugs with painting sizing. The code is now much cleaner and works as expected. The paintings will check if the height is to big to fit within the ideal center position while leaving at least a minimum buffer distance between the bottom and the floor. If so then place it, otherwise place the painting  $\frac{1}{2}$  painting height + buffer.

Then I worked on the room resizing. I first normalized the room cube to make resizing easier. Then I worked out the equations for the algorithm (fig. 22.1). I left all of the buffer sizes, field of view and minimum room size variables exposed to the editor for easy adjustment. Then I hooked it up with the vrHandler. It works, however I believe there is a race condition that I haven't found yet that is causing the room to resize to the previous painting. I will look into it further later.

Next steps will be to:

1. Fix the race condition / resizing to the last painting bug
2. Scale the texture tiling
3. Dynamically set the player spawner
4. Fix the player spawner bug
5. E: Add fade transitions between paintings



# Dev Log 23: Getting in Shape 2: Electric Boogaloo

(Week 10, Monday, 10/28/19)

## Introduction

### Overview

Today I plan to finish the Room resizing feature. I still have to investigate the VRhandler race condition. After that I need to set the player respawn point and rescale the rooms texture.

I have set up a basic player spawner. However the next step for it will be to make the player spawner move in relation to the size of the painting and the size of the field of view.

After meeting with Dr. Cecotti I believe I have a better idea of the scope of the project. He explained that the program is meant to be able to adapt to any properly structured json file that is given to it. Therefore the entire system needs to be more dynamic. With this I am going to restructure my plans and try to refocus the project towards that goal.

(Mind Like Water)

Vibrate the hand to signal quiz start

# Dev Log 24: Ticking Boxes

(Week 10, Thursday, 10/31/19)

## Introduction

### Overview

Happy Halloween! Today I worked on the backlog given to me by Dr. Cecotti. I knocked out a large portion of them. I started by working on the teleportation feature. I set up the teleport controller and adjusting the values to be more appropriate. Then I worked on the player controller interfaces. I slowed down the walking movement and made sure that the entire player object is moving with the play area object. I cleaned up the tool tips so now they look more streamlined. Then I made it so that the pointer is always activated. Then I added a placeholder info panel. It gets instantiated and populated below the painting.

After the meeting Dr. Cecotti explained how writing the report will work. It seems like a bit of a learning curve but pretty powerful.

# Dev Log 25: Room Renovations

(Week 11, Monday, 11/4/19)

## Introduction

### Overview

As I only have a short time to work today, I am going to try to polish the features I have working. Ideally I'd like to get the texture scaling properly fixed.

### EOD

I got the tiling to be consistent for the floor. I beveled the ceiling so It looks a bit nicer. Then I added some base textures and materials to the scene. I would like to spend more time polishing the look of the scene. I may use Wednesday for that entirely.

There will be another all hands meeting next Tuesday. For it I must have the teleport bug fixed. I also would like to have the scene polished more and the quiz experience reworked.

# Dev Log 26: Try not to Telefrag

(Week 11, Wednesday, 11/6/19)

## Introduction

### Overview

I plan on spending a lot of time today preparing for a demo tomorrow. With that I'd like to polish the room and fix the Teleporting bug.

### Second Pass

I came back and tweaked the teleporting code. I tried several different fixes, but ended with a switcher that changed which pointer is being used at a time. I think it might be too complicated, but it's the best solution I can come up with at the moment. I scheduled a testing session on Friday from Noon to 3. So far 2 people have said they can come. I need to write up the questionnaire and finish the demo tomorrow to prepare for the QA testing.

# Dev Log 27: Coordinated Breakings

(Week 11, Friday, 11/8/19)

## Introduction

### Overview

I held testing today. Before the testing I updated the tooltips and added a tool tip swapping mechanic. I then updated the ABA lightings to work with the new scene layout. Then I held testing.

Christian was the first tester. He had zero VR experience and struggled a bit with the controls initially. His first reaction to the quiz was to try to poke it with the other controller. By the second painting he was using the walking feature. He was hesitant to move his body and I didn't notice until late in the experience. By the 3rd painting he was able to use the ui menus proficiently. By the fourth painting he had tried the teleport mechanic. While he had some trouble figuring out the shoot and confirm controls, he became proficient later.

He wanted there to be a diagonal mechanic for the walking. Felt that the forward/sideways movement was jerky. His favorite painting was Mona Lisa. Info was small.

Next was Bryce. He had some experience with Google Cardboard but none with a full VR system. Bryce moved a lot. From the first time he put on The Vive, he moved around the room in the physical space. He got the answering mechanic down right at the buzzer for the 60 seconds. He stated multiple times that the walking felt laggy. I'd like to investigate this further but didn't have the time. He also stated that the paintings looked "real" and not like they were digital. He really liked the Napoleon painting, he wanted a "flying" feature to look at the whole painting. He was the first to look through the walls. Everyone afterwards would look through the walls at some point. Bryce felt that the painting was see through. This was due to the chaperon boundary box displaying because he was too far back. He constantly backed up. I believe this was due to him feeling too close to the paintings.

He didn't like having to switch between teleport and menu pointers. His favorite painting was Napoleon, due to the size of the painting and room.

Next was Mehesh. He tried it first without his glasses but felt it was too blurry. He started with teleporting. He was fairly proficient however he had trouble switching to the menu pointer. He seemed to like the dynamic lights ABA system. The light objects were a nice touch. Click all the buttons didn't work as intended due to the last button not being blue. He wanted the teleporter to shoot farther. He expressed the need for a quiz announcement, he later suggested that the menu pointer be automatically brought up when the quiz starts. His favorite painting was the Mona Lisa and his preferred method of navigation was teleporting.

Finally Michael tested the experience. He somehow answered a question without having the pointer displaying. He also immediately teleported outside of the room. He hated the walk feature and almost fell over. His favorite painting was the Glass of Beer. He stated that the answers would flicker occasionally. He also was able to get the laser to point on the tool tip. For having minimal video game and VR experience, he was able to pick up the controls really quickly.

Next time I should print out test sheets to fill out to increase efficiency. Overall I gathered great data and will be able to use it for this and future products.

# Dev Log 28: Be Kind, Don't Rewind

(Week 12, Friday, 11/15/19)

## Introduction

### Overview

I have been sick all week so I have only briefly been in the lab. Today I plan to make up for that with an 8 hour session (5/3 split). I started by listing out the current tasks that need to be finished. Then I assigned them all values based on the time it will take to finish them and the importance of each item. I think this has helped streamline my thought process. I'm going to try pomodoroing again as well. Dr. Cecotti might be coming in around 5:30 today so I'd like to have as many bugs ironed out as possible by then.

### Round 1:

I completed the player position tracker. It should now record where the body of the player is at the time of hitting submit for each question. Most of the leg work was done in QuizSystem.cs Might want to format the data better. Next im going to start working on the teleport rework.

### Round 2-5:

I've been tackling several teleporting bugs all at once without realizing it. The current build has a fix I believe. There was a script attached to one of the VRTK objects called Position Rewind. I believe it's entire function was to break things specifically for me in unpredictable ways. It almost got me too, but after going through and looking at the code for a lot of VRTK scripts I found it. Disabling it hopefully will fix several headaches.

As for functionality, I added some art/design features to the teleporter to hopefully make it easier to understand what the player is actually doing. I limited the teleport to only being able to teleport the play area within the room. Before they were teleporting themselves and could exploit this to get out of the room. I also added a temporary play area boundary marker to the scene to let the player know how much room they have.

The goal was to do an 8 hour day, but being sick and with that teleporting bug giving me as much trouble as it did I'm going to call it 2 hours early.

# Dev Log 29: Ready? Start!

(Week 13, Monday, 11/18/19)

## Introduction

### Overview

This week I plan to tackle the backlog. There are a couple key features still missing from the project, not the least of which is the FPS controller. If I can put a big enough dent in the backlog this week it will make the rest of the semester run smoother.

Today I will work for a couple hours. I am going to start with the quiz question start event.



# Dev Log 30: Chip Damage

(Week 13, Tuesday, 11/19/19)

## Introduction

### Overview

I'm still tackling the backlog today. I got the Quiz events finished yesterday. I'm still feeling sick and yesterday was difficult to stick to work.

## Review

### Overview

I got quite a bit done today. I started with the auto swap feature. It didn't take very long and it helped develop a design pattern I used later. I initially didn't think that the auto switcher would be very impactful to the project, but after it was implemented I realized how nice it is to have. If time allows I may implement a full rework of the right hand to utilize context aware input handling.

I then worked on the Smooth walking task. This was born out of so many people having trouble with the walking feature. I haven't ever had an issue with the controls so this was a difficult problem to visualize. I ended up assuming that the issue is stemming from the large deadzone in the touchpad. I feel like players might be pressing conservatively (to mean closer to the center). This may lead to them pressing with no result or pressing on the border of the dead zone and getting a "jerky" motion. I shrunk the dead zone considerably. From 1.5 -> 0.3 on both the x and y axis.

Finally I worked on an Endgame state. I set up the framework for the endgame state and switching between IEMs but I am going to wait to see what info Dr Cecotti wants to display at the end before designing anything. I then worked on the end state for the VR IEM. I settled on a simple text box that says that the experience is over and add a fade effect to hopefully grab the players attention.

### Next Steps

1. Answer button rework
2. FPS controller

# Dev Log 31: When You Can't Create, Delegate

(Week 13, Wednesday, 11/20/19)

## Introduction

### Overview

Today I will begin the FPS handler. It has been bothering me for a while so if I can knock it out then it will be a huge win for me and the project.

I started by refactoring out the room generation system to make it accessible for the other handlers. Now the handler calls the room loader class to do all of the room generation logic. This had the side effect of removing some coupling issues with the quiz system. I implemented an observer pattern based delegate system for the GameMaster. The quiz will now call this delegate event in the GM when it has finished. The GM then notifies which ever IEM is running at the time. This will be useful later too as it will (hopefully) make hooking up the FPS handler easier.

I worked on clean up from the refactoring. I had to reconnect a few prefabs. Then Dr. Cecotti came and checked out the project. He liked the walking improvement and the boundary on the floor.

After he left I had dinner and then worked on the new quiz layout. This way allows for up to 5 answers. It wasn't that difficult but it's also not the cleanest looking design. If time permits I would like to rework it.

Then I got an idea for having the Quiz json creation within the app. After some cursory research I don't think it will be very difficult.

I worked on the Quiz json creation UI. I designed a simple menu system and started implementing it within unity. I made the paintings creation, deletion and scroll view work properly. They are currently just UI shell but I think that adding the data to it should be easy enough.

I could keep going at this all night but I'm calling it after 6.25 hours. I just noticed that I have passed 100 hours worked on this project. Woo! I'd like to do a retrospective later if possible.

# Dev Log 32: WB

(Week 15, Tuesday, 12/3/19)

## Introduction

### Overview

It's been a while. It's crunch time. I'm stressed.

# Dev Log 33: Framed

(Week 15, Friday, 12/6/19)

## Introduction

### Overview

Yesterday I held some usability tests with Michelle and Brian. I'll transcribe their experience later but they helped me identify a bug with the start quiz button.

Today I'm hoping to start and finish the dynamic frames. I only have 2 hours so I need to get to work!

### Review

I completed the first pass on the frames. In its current state I would be ok with shipping it. I'd like to add some better materials to it and adjust the sizings of the steps. Dr. Cecotti seemed to like it. He also suggested to add some crown moldings to the base boards. To add some flair. Time to call Joe!

# Dev Log 34: Going Full Troddle

(Week 15, Sunday, 12/8/19)

## Introduction

Tonight I worked on the frame again and the baseboards. I threw together the baseboards pretty quick but I think they look nice. They add a bit more color to the scene. They unfortunately scale with the room so hopefully there aren't any massively tall paintings... Minor touches to the frame to get it fitting properly over the painting. There was a float rounding error that while the error rate was small, the impact was very noticeable in VR.

Tonight is technically my last night before the project is supposed to be turned in. I compiled it to have a solid backup exe incase my crunch rush tomorrow breaks something. Push comes to shove this version of it works and I'm proud of it. If this is the last I get to work on the VR museum project, I'll be ok with its current state. There are still a ton of features I'd like to add and some features I think could be ironed out a bit more. That being said, I was able to deliver on all of the tasks assigned to me and then some. I've learned a ton working on this project about VR, Unity, programming, design, working with other people from other disciplines and software production. I'm grateful to have gotten to work on this project.

# Dev Log 35: One Final Effort

(Week 16, Monday, 12/9/19)

## Introduction

Today is the last meeting of the semester. I spent the time before polishing the project. I opted to not fire in the text to speech feature as I was worried my haste would only add more bugs. Instead I added a couple questions to the intro bit from the art department and polished the fps controller. I also applied a new highlighting method to the buttons that should help players differentiate when they have clicked a selected button or not. Finally I have added the normal-mapped perlin noise shader to the paintings. I decreased the intensity (0.13 -> 0.1) and the results are nice. It is much more subtle.

After meeting with Dr. Cecotti we worked to fix the frames to make them look better. It was a lot of small tweaks and ultimately it's pretty jimmy rigged. But it works. I also refactored out the info panel out of the prefab. This helped make the small placement and rotation changes much easier.

# Dev Log 36: Music & Narration

(Week 16, Thursday, 12/12/19)

## Introduction

I worked on the text to speech feature today. I started by trying to implement the code that Dr. Cecotti sent over but unfortunately it didn't work. I guess it has something to do with unity only allowing select parts of the .Net framework into the engine to maintain portability between the mobile devices. So after some research I found a new library that does basically the same thing. I implemented it and then created some test descriptions for the paintings. The effect is quite nice and it will allow for the paintings to be explored further past the surface level info box.

Afterwards I decided to add background music to the experience. I thought it would add a nice ambience to the scene and immerse the players further. I created a base music manager to hold the background music. I then created a method that would randomly choose a song from the list and play it. The result worked well.

# Dev Log 37: Anti Anti-Aliasing

(Week 16, Thursday, 12/23/19)

## Introduction

Today I came in to help take some screenshots for the project. While we were discussing the screenshots we decided to try to fix the anti aliasing issues. The resolution of some of the paintings were at the wrong ratio for many positions around the room. To fix this we implemented a mipmap solution with dynamic swapping between the maps. I'm not fully sure how it works, honestly I was working on another solution when the dynamic swapping just kind of happened. Happy accidents and an early Christmas present from the Unity gods.



# Dev Log 38: Breaking Stuff and Looking Tough

(Week 19, Thursday, 1/16/20)

## Introduction

I started today by setting up a new weekly trello board in my templated style. It has been pretty productive in other projects so it should work here too. The main goal at the moment is getting the FPS controller to work as intended. I spent some time earlier this week tinkering with the quiz system, but in the 2 hours I worked on it, I wasn't able to find a solution. That lead me to work on a different aspect of the project today.

I started working on the VR/FPS controller choosing feature. I spent most of my time exploring the VRTK\_SDKManager script. I think I have a decent grasp on it to be dangerous. My plan is to have 2 separate prefabs of the controller set up and use a scriptable object to load the choices made in the menu to the initialization of the scene. This also allows me to add in the load different runs feature at little cost.

I started to work on it by first splitting the controller prefab into two specific prefabs. It went smoothly for the most part, but in practice I am finding coupling issues that need to be addressed. Namely in the VRExperience handler. I had set it up to cache several different elements from the master controller so that I could use whatever I needed at the time. Now that there is no master controller, this is an issue. I think that resolving these issues will only benefit the code base so I'm happy to work on them. Im hoping to be done in 1 more 2 hour session.

# Dev Log 39: Switch-a-Roo

(Week 19, Thursday, 1/25/20)

## Introduction

This week I have tried to come in multiple days to program, but I keep getting side tracked and end up having to hold usability tests for the entire time. Today I'm coming in stealth and locking the door to hopefully get some actual work done.

## Review

I set up the controller choosing gui and the run selector input functionality. I also spent some time working on cleaning the code after the big controller decoupling session. I added a method to the walking switcher and the tooltip hiding components that will find whatever controller is needed.

# Dev Log 40: Snap Back to Reality

(Week 20, Friday, 2/7/20)

## Introduction

I came back from my trip down south confident but tired. I want to work the full 10 hours this weekend and ideally finish the controller choosing mechanic. Stretch goal will be for finishing the FPS quiz interaction as well.

I started today reviewing the project and onboarding Mahesh. I then began decoupling the player placing system. A simple fix just checks what objects are in the scene based on the tags preset and then iterates through them and places each. Could be done more clean but it's not bad.

Then I began work on attaching the controller functions at runtime. This was a bit more difficult but I believe it works consistently now. After that I worked on getting the quiz to attach to the VR controllers hand. It took a bit of tinkering but in the end it helped decouple some of the roomLoader scripts.

Next steps:

1. Design FPS Quiz functionality
2. Attach quiz to FPS
3. Implement FPS Quiz functionality

# Dev Log 41: Sick Time

(Week 21, Saturday, 2/15/20)

## Round 1:

The goal was to get the Sim fully functional. I started by making a new quiz prefab that would be specifically for the sim version. It now renders in screen space and scales with the monitor. Then I added an auto mouse lock/unlock function. It currently auto locks when the quiz starts and doesn't unlock until the quiz ends. I'd like to add in the ability to hide the quiz and allow the player to view the painting again mid quiz. Then after that was completed I worked on getting the rest of the systems to recognize the new quiz locations. After that I worked to fix some of the bugs with the VR version that appeared in the original prefab controller split. I believe I now have all original functionality back with the VR controller. The only modifications might be to the look of the quiz. I think I might need to tune the transform a bit to bring it back to its previous state. The whole program seems to work closer to as intended now. When I get back from lunch I am going to polish and build. Maybe I'll take a crack at the mid quiz movement scripting.

# Dev Log 42: Quarantine Debugging

(Week 23?, Sunday, 3/15/20)

I came in today to work on the project. The goal was to start experiments next week, but we are pretty sure that is not going to happen because of the quarantine. I still wanted to make the project as ready as I could just in case.

I completely disabled shuffling functionality because even though all of the code looked as though there was no way it should get shuffled, the answers were still being shuffled. I then built a cleaner way for the program to be exited. The user can press escape at any time during the experiment. There is also a time out feature at the end of the experiment. I fixed some small visual inconsistencies and added more music. I also reworked the way that json files are chosen. It now searches through the root folder and finds all json files. Then it populates a dropdown component with the options. This is much more clean and makes testing significantly easier. I also added a collider to the SIM controller so that it can no longer walk out of the walls.

Finally in testing I found a bug in which the VR controller's walk and toggle tooltips functions are not working in the build version of the app. In editor it works fine. Need to do some research to see what needs to be fixed.