

BSc Computer Science for Games Programming

Honours Stage Project

Interim Report

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(Not Including Literature Review Draft)

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Project Overview

Introduction

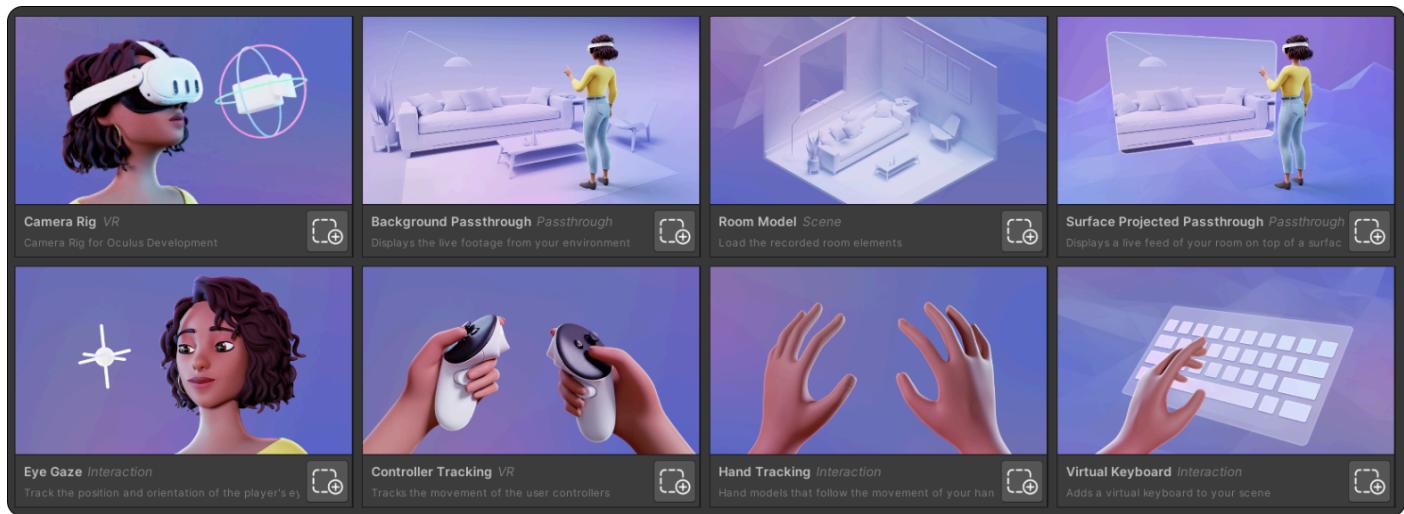
My project, developing a mixed reality training tool for crime scene investigators, focuses on creating mixed reality interactive experiences to provide training and skills development. My aim is to simulate realistic crime scenes around the user in any environment. This project is designed to bridge the gap between theoretical learning and hands-on fieldwork that can strengthen learning for evidence identification, collection and analysis, thus helping users improve their accuracy and reliability in real-world situations.

My primary objectives for the CSI tool comes down to the following: develop suitably realistic simulations, design intuitive user interfaces, incorporate real-time feedback, and align the tool with official crime scene investigation protocols (As close as I can possibly achieve). I also plan to include randomised scenarios/narratives and evidence placements to provide diverse and challenging experiences, just like in real situations, that adapt to the needs of different trainees.

Since choosing this project and completing my Project Definition Document (PDD), I've faced significant challenges during development. Meta's developer restrictions caused major delays, not only for this project but for all my assignments. I also encountered major issues in successfully building and deploying the application to the Meta Quest 3. These technical issues completely halted my progression, which required me to seek help from multiple sources, including the IT technicians at the University. It was Jack Thompson who eventually resolved my deployment issues just before we broke off for Christmas, allowing me to finally proceed with my project's development. I have learned the hard way the importance of tenacity & resilience when seeking support and the value of expert collaboration.

Throughout these complications, I have continued to refine the project scope based on feedback. To my project plan, I have added safeguards to ensure user safety, reduced the emotional intensity of the crime scene scenarios to avoid causing distress, and emphasised pilot testing to ensure the tool is accessible, scalable, and user-friendly. These adjustments ensure that the tool remains focused on its core purpose: to provide an engaging, immersive, and effective training experience for the police and academic institutions.

This project represents a unique opportunity to combine modern technology with occupational education. I aim to develop a tool that 'sets a new standard' in forensic training, offering novice investigators an adaptable and cost-effective way to learn, repeat, and prepare for real-world challenges.



(Source: [Meta's Building Blocks | Develop Mixed Reality Apps lightning fast](#))

Project Progress

Project Technical Progress

Since the submission of my Project Definition Document (PDD), significant technical progress has been made for the back-end of the CSI tool. This progress is particularly focused on laying the foundation for the system's core functionalities, including room geometry scanning, controller and hand recognition, and basic object interaction. These achievements represent critical milestones that validate the feasibility of the project and establish a solid base for implementing more advanced features, such as evidence randomisation and interactive narrative systems. Ideally, I would have been much further ahead with development if it were not for technical obstacles, however, I am just grateful that I eventually resolved the issues, and that I could continue in Mixed Reality rather than the substitute, Virtual Reality.

Tools and Technologies

For this project, I used Unity 22.3.38f1, which is ideally suited for creating immersive experiences in mixed reality (MR). I did use other versions, but none had the compatibility and robustness of 22.3.38f1. Once I had a working published scene, I firstly used Meta Building Blocks to facilitate MR development by providing pre-built objects for indoor scanning, object connections, and environmental awareness. This tool contributed significantly to the Quest 3's ability to recognise indoor geometry, track hand and controller positions, and support dynamic interaction with virtual objects.

I faced many difficulties during the integration process. Early in development, I had significant challenges with Meta's developer limitations, and successfully executed a build to the Quest 3. These issues, which included SDK compatibility and device portability, as I have said, temporarily slowed and then halted progress. Resolving these issues required collaboration with external support resources such as publicly available technical documentation and online development communities. Ultimately as I spoke of above, I had to receive support from the University's IT support, which eventually led to the resolution of these technical issues. While it was time-consuming and tedious (as stressful), this experience provided useful insights and lessons into usability which underlined the significance of remaining flexible while working with proprietary software and hardware.

I decided to use Unity's XR Interaction Toolkit because It is regarded as an important role in creating seamless interaction mechanics. There are alternatives (Microsoft's Mixed Reality Toolkit [MRTK], VRTK [Virtual Reality Toolkit], Oculus Interaction SDK, XRTK [XR Tool Kit a community-developed form of MRTK]) but this is the most widely used. XR Interaction Toolkit has been integral for integrating fundamental interface structures and allowing smooth hand and controller tracking. On top of this, the toolkit has laid a scalable framework for future scenes that will allow me to include greater advanced features like improving the entire project's capability and ability for growth.

Risk Analysis

The challenges I encountered during the initial deployment phase outlined the critical importance of the risk mitigation strategies outlined in my PDD. Delays imposed by Meta's restrictions showed the need for flexibility in project timelines and the potential risks associated with future SDK updates or hardware changes. To ensure similar problems don't happen at a later level of development, I will ensure to leave myself with 'padding', which will be added time for development in case issues arise.

Overcoming these early challenges has highlighted the need of adhering to an Agile development style. By dividing the project down into segments, I am able to constantly polish and improve each component. This strategy has proven helpful in solving the technical challenges faced so far, and I'm sure it will continue to, throughout the development process as the project moves forward.

Anticipated Challenges

As the project moves into its next stage, the primary goal is to improve interaction mechanics for complicated objects, such as pieces of evidence with unique attributes or objects with multi-step needs. To ensure routine testing and use, these methods need to be reliable and easy to use, especially for forensic investigators who may not know their way around a VR headset. It will be a challenge to design all aspects carefully, for user-friendly and simple interactions with the headset and CSI tool. I realise that the user experience design is critical.

The addition of randomisation and marking systems are two significant problems. These elements are vital for creating compelling and diverse training scenarios, however, their successful deployment will require careful planning. Finally, I'm planning to make use of Unity's scripting features and AI integration to generate unique scenarios. Using crime scene and narrative algorithms powered by AI, my CSI tool will be able to generate a limitless number of training instances, ensuring longevity.



(Source: [VR Meets AI: Introducing Unity Sentis](#))

Progress and Milestones

Despite the project's issues, I have accomplished a number of significant milestones that show the project's technical progress.

Room Geometry Scanning

One of the first major achievements I was able to implement was a scene that adapts to real-world geometry using the Quest 3's room scanning capabilities. This feature allows the CSI tool to recognise walls, floors, and table-like surfaces, resulting in a dynamic virtual scene that matches the user's surrounding environment. From the beginning planning stages of this project, this feature has always been critical for ensuring that the CSI tool may be utilised in numerous environments, without needing any setup.

Controller and Hand Recognition

Another important milestone was the effective implementation of hand and controller recognition. Using Unity's XR Interaction Toolkit and Meta Building Blocks, I was able to accurately detect user input, allowing trainees to interact with virtual objects using their hands or controllers. This ease of choice offers a straightforward and immersive experience, allowing users to concentrate on the training objectives rather than navigating complicated controls.

Basic Object Interaction

Finally, I included basic object manipulation capabilities like physics-based interactions. Users may pick up, move, and throw virtual objects in the scene. This is the foundation of the whole CSI tool for in-game objects, tools and more. This milestone shows the technological capability for realistic and engaging training solutions that mimic real-world crime scene investigation.

Foundation for Future Development

These core milestones not only illustrate the project's potential, but also serve as a strong platform for developing more complex features. The room scanning capabilities, for example, will be expanded to accommodate the randomised placement of evidence objects within the scene. In addition to these, I'm currently working on another much more complex feature which will be the selling point for my CSI tool. I will be developing a framework for creating realistic crime scenes with various structures, as well as narrative frameworks, which respond to user actions and choices. These aspects are vital to the CSI tool's educational usefulness as it will allow students to practise their skills and get real-time feedback to improve. This also presents multiple choice narratives to help students build wider research capabilities.

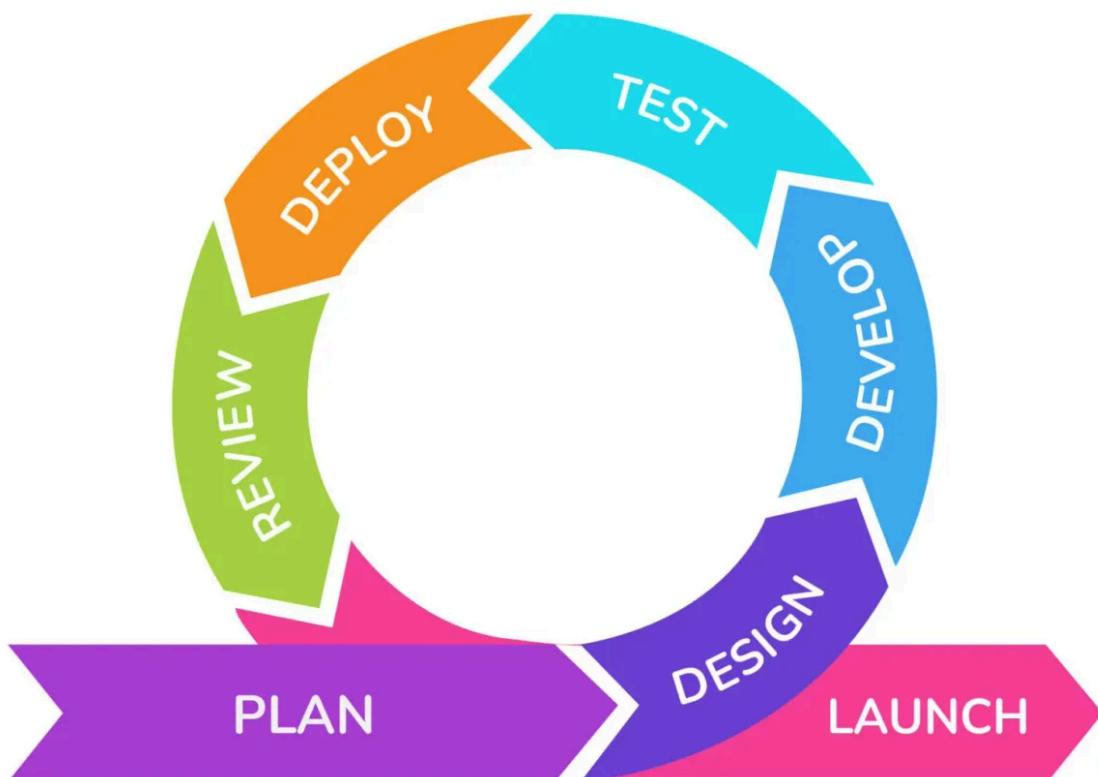
Project Management

Development Progress and Management

For this project, I decided to follow the Agile technique, which helped me to respond quickly to the challenges I did face, and to be able to dynamically prioritise objectives. To reinforce this, I decided on using Monday.com at the start of my project. Monday.com was a great piece of software, which was free and ticked all the boxes I needed. However it is now a paid subscription, so I will be creating my own Gantt Chart whilst I research the possible adoption of the widespread tool, Jira. The Gantt chart will serve as the primary work planning and tracking tool, providing clear and simple documentation of progress. I also decided on GitHub to store my project files, as it offers extensive version control and communication capabilities. This was essential for when I requested help and needed to share my files on the fly. This combination, in my opinion, allows for an efficient development approach.

Current Status of Tasks

The evidence randomisation system and checklist interface are currently in early development. These components are vital for achieving the CSI tool's primary purpose. The evidence randomisation system is very important to ensure constant learning and improvement for the students, rather than playing lets say 5 predictable scenes over and over. The checklist interface will be piggy-backing off the evidence randomisation system, to ensure that the user can get accurate and instant feedback.



(Source: [eFile is agile](#) please note, this source is only referenced for the image)

Adjustments to the Plan

Delays caused by deployment issues with the Meta Quest 3 meant logically I needed to review my original project plan. To ensure I have a deliverable product I am proud of, I have had to pull back my expectations within the new timeframe. Non-critical changes, such as aesthetic improvements and sophisticated functionality, have been postponed until substantial progress has been made in the back end of the tool.

My new Gantt chart in the Appendix of this document represents this re-prioritisation. I have tried emphasising repeated development cycles with a focus on usability testing and improvement. Using Agile's flexibility, I have been able to overcome my previously stated obstacles without sacrificing the project's ultimate goals, only by re-prioritisation.

Supervisor Collaboration

Regular meetings with my supervisor have been crucial in guiding project development. These sessions have allowed us to examine my progress, discuss issues, and organise extra support when needed. The constant line of support and feedback helped me refine my task management and keep the project on track to meet its objectives. Mostly, I have found these sessions great for socialisation and for showing me what working with a manager would be like in a real-world career.

Testing and Refinement

The first implementation test will take place along-side the end of the first development phase. These tests will assess the CSI tool's functionality, usability, and ability to accurately simulate a real-world crime scene. These results will offer valuable data for guiding the future of this project and guarantee the finished product satisfies the needs of the client, Humberside Police.

Next Steps

My upcoming goals include finishing the checklist interface and evidence randomisation process, as well as conducting early usability testing with some of my family and peers. This will be critical for evaluating the effectiveness of my tool and help me plan future enhancements. In addition, after the SDK building fiasco, I will keep a close watchful eye on any potential risks and alter my strategy accordingly to mitigate any negative impact.

Literature Review Draft

Crime Scene Investigation Training

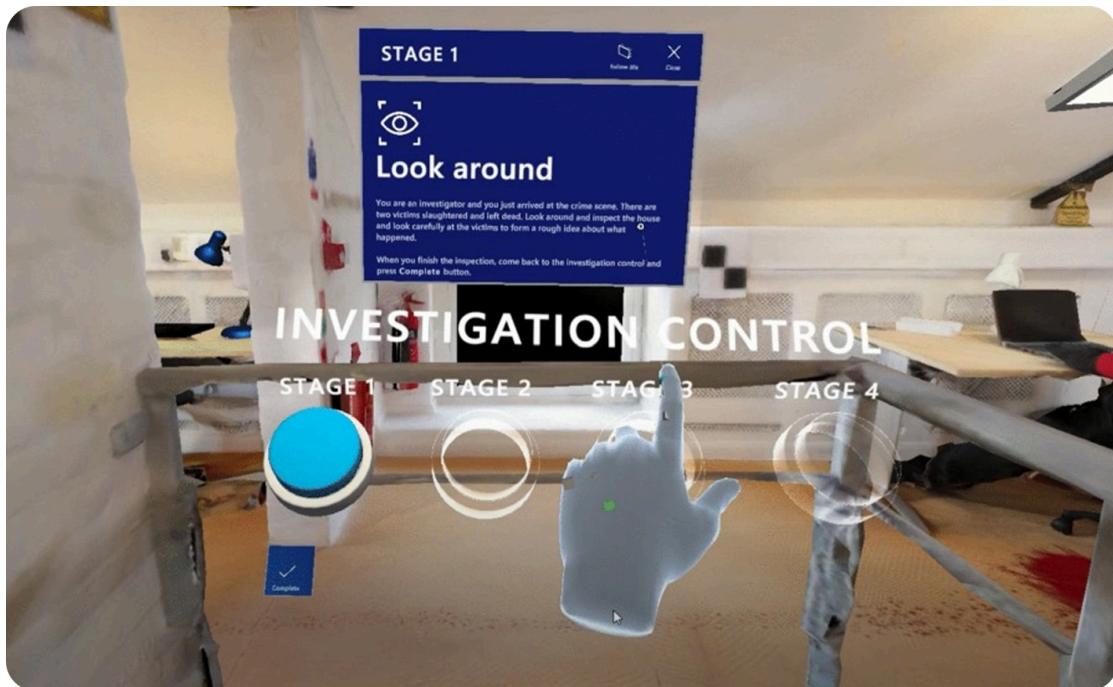
Crime Scene Investigation (CSI) training has typically used a combination of real-world experience, classroom education, and costly well-made simulations to educate novice forensic investigators. Real-world practice, where students experience hands-on experience by working at crime scenes, is considered to be the 'gold standard' in forensic training. The firsthand experience with evidence collection, analysis, and crime scene management provides great learning opportunities. They watch and engage with seasoned professionals, improving their skills in the real-world settings which in turn increases their practical grasp of investigative procedures.

However, this method is often restricted by the availability of crime scenes, which means that not all trainees will have the same exposure to diverse cases or scenarios. Furthermore, real-world crime scenes are chaotic, and can be emotionally shocking for students who are not yet climatised to those sights.

Classroom education is more effective when combined with real-world experience, as it provides core understanding of forensic scientific principles, legal standards, and ethical issues. Lectures, case studies, and other forms of learning are essential, but they lack the real-time application and hands-on learning.

Simulations, like scenarios or constructed crime scenes offer a compromise for experiencing these necessary skills. These simulations usually lack the ability to breed the emotional depth or unpredictability of actual crime scenes. On top of this, simulations don't always provide appropriate narrative diversity, resulting in trainees missing out on exposure to some types of situations or evidence.

Conventional approaches are limited. Real-world crime scenes are restricted, and while simulations provide controlled environments, they sometimes fail to capture the broad range of obstacles that forensic investigators encounter in real life. As a result, there is a growing interest in technologies such as Mixed Reality (MR) to provide a more immersive, flexible, affordable, and diverse educational route.



(Source: [Designing and evaluation of a mixed reality system for crime scene investigation](#))

Mixed Reality in Law Enforcement Training

Mixed Reality and Virtual Reality technologies have changed law enforcement, first responder, and forensic investigator training. Mixed reality technology enables students to interact with digital objects in real-time, within their real-world environments. This eliminates the need for replicated crime scenes, and reduces the hazards associated with traditional training techniques, allowing for constructive, realistic and repeatable learning experience.

Notable mixed reality training hardware and software programs had been created recently, and some even for crime scene investigation. For example, "CSI VR: Crime Scene Investigation," offers three-D reconstructions of crime scenes, allowing students to walk around and study the scene, improving their abilities. However, this developer treats it more like a game and less like a training experience, and while these kinds of tools seem promising, in my opinion they face challenges such as simulation accuracy.

AI in Training and Evidence Randomisation

Artificial intelligence should significantly improve my CSI tool by adding the timeless feature of randomising scenarios and creating narratives for crime scenes, each time a new training session is launched. This AI-driven technique ensures that trainees are exposed to a wide range of investigation circumstances, reducing overfamiliarity that can occur when a user experiences the same pre-programmed scenarios again and again.

For example, my AI system will place evidence in random locations within a crime scene, modify witness testimony, as well as change between property crimes, violent crimes, and fraud. Students can also re-play a specific randomly generated scene, if they feel like they want to revisit, master, or understand further if they didn't the first time.

Existing Tools and Technologies

The development of mixed reality applications relies heavily on Unity, a leading platform for game development. Unity is an ideal tool for creating immersive, dynamic simulations due to its advanced physics engine, rendering capabilities, and compatibility with mixed reality hardware like the Meta Quest 3. Its flexibility and ease of use enables developers to build highly detailed and realistic 3D environments, which in my case will help me more closely replicate actual crime scenes. Additionally, Unity boasts a seamless integration with various virtual and mixed reality devices, including the Meta Quest 3, making it the perfect choice for this project. The Meta Quest 3, is an excellent headset, especially for mixed reality. This makes it another essential piece for immersive crime scene investigation training.



(Source: [CSI VR: Crime Scene Investigation on Steam](#))

Ethical Issues and Considerations

Developing a training tool for the police requires careful attention to ethical and legal aspects to ensure compliance and safeguard user well-being.

- **Privacy Concerns:** This is not applicable, but if for a 2.0 and more polished version, the game could collect and track trainee performance data to provide personalized feedback and assess training outcomes. However, collecting personal data poses privacy risks. To address this, all data would be anonymized and securely stored to prevent unauthorized access.
- **Legal Considerations:** Any external datasets, 3D assets, or other materials incorporated into the tool must be properly licensed for educational or commercial use. Rigorous documentation and verification of all external resources will ensure compliance with intellectual property laws.
- **Emotional Distress:** Crime scene simulations may evoke emotional discomfort or distress in trainees. Psychological support systems will be integrated into the training program. Trainees should have access to counseling sessions to reduce any negative emotional impact, but that is up to the organisation using the tool to organise.

Gaps in the Literature

There are still a lot of unanswered questions, despite a great deal of study on the possibilities of virtual and mixed reality technology, especially in law enforcement and crime scene training techniques. Also, the adoption of AI-driven randomisation in MR training for forensic applications has not received much attention. Although there are some ethical issues with immersive simulations, there aren't many polished frameworks for controlling user's emotional reactions to actual crime scene situations. The goal of my project is to close these gaps by providing a cutting-edge mixed reality teaching platform.

Risk Matrix

5x5 Risk Matrix

		Severity →				
		1 Insignificant	2 Minor	3 Moderate	4 Major	5 Death
Likelihood →	1 Rare	1	2	3	4	5
	2 Unlikely	2	4	6	8	10
	3 Possible	3	6	9	12	15
	4 Likely	4	8	12	16	20
	5 Certain	5	10	15	20	25

Technical Challenges:

12

Developing my game involves technical elements, such as precise tracking and real-time rendering. I know that bugs and performance issues can and will arise.

User Safety:

6

Since my game encourages players to move around in real-world environments, I need to be mindful of user safety. Accidents can happen if players aren't aware of their surroundings.

Privacy Concerns:

4

Collecting data from users is important. I'll need to ensure compliance with data protection laws and be transparent about how I use their information.

Market Competition:

15

The VR/MR space is competitive, so I understand that my game needs to offer something unique. However I have not seen anything that comes close to what I want to do.

User Experience:

8

Balancing engaging gameplay with MR elements can be challenging. Poor user experience can lead to negative reviews and low retention rates.

Emotional Distress:

9

As we will be dealing with real-life crime scenes and scenarios, I will need to take into consideration how these environments will affect people, and take the necessary steps to ensure they have support.

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Appendix

Gantt Chart

After the very emotional downfall of Monday.com, I decided to create and revise my own Gantt chart, mimicking what Monday.com did well.

- **Task 1:** Research and define requirements for crime scene simulation.
- **Task 2:** Design the game's mechanics, crime scene scenarios, and interaction models.
- **Task 3:** Develop 3D models and environments for crime scene simulations using blender.
- **Task 4:** Integrate game mechanics with VR/MR hardware.
- **Task 5:** Conduct pilot testing.
- **Task 6:** Finalise game development, incorporating feedback.
- **Task 7:** Produce user manuals and supporting documentation.

Honours	Owner	Status	Start date	End date	Tr	Notes
Tr	Owner	Status	Start date	End date	Tr	Notes
Task 1	Samuel Lawrence	Completed	30/09/2024	13/10/2024	-	Notes
Task 2	Samuel Lawrence	In progress	13/10/2024	28/04/2025	Task 1	Notes
Task 3	Samuel Lawrence	In progress	03/03/2025	28/04/2025	Task 2	Notes
Task 4	Samuel Lawrence	Completed	01/12/2024	29/12/2024	Task 3	Notes
Task 5	Samuel Lawrence	Not started	28/04/2025	11/05/2025	Task 4	Notes
Task 6	Samuel Lawrence	Not started	11/05/2025	19/05/2025	Task 5	Notes
Task 7	Samuel Lawrence	Not started	19/05/2025	30/05/2025	Task 6	Notes

Prototype Screenshots

