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Milestone 2

1. Background

1.1. The Problem

Modular home manufacturers build houses inside factories rather than at the site of the property. These factories are set up as assembly lines of multiple stations, each of which is responsible for different parts of the manufacturing process–one might build the floor, another may add plumbing. Companies making these modular homes want to optimize the design of their factories to make these assembly lines as efficient as possible. They are also increasingly looking for ways to automate parts of the manufacturing process.

As it stands today, experimenting with factory design and automation is an expensive and uncertain business endeavor for these modular home companies because they need to modify their actual manufacturing facilities to evaluate the outcomes of potential changes. Furthermore, there is the added cost of training existing workers to work alongside those changes. Thus, modular home manufacturers need a more cost-efficient method to model and experiment with factory changes and to train workers to adapt to those changes.

To that end, manufacturers are interested in adopting virtual reality to quickly prototype factory designs and the operation of those factories' assembly lines. Rather than changing their actual facilities, these companies want to create interactive, virtual environments that mimic the layout of real factories and the processes that occur along an assembly line.

1.2. Project Partner

The partner for this project is Joseph Louis, an assistant professor of civil and construction engineering within the College of Engineering at Oregon State University. He is doing research on the use of virtual reality in designing factories for the modular home manufacturing company Ritz-Craft.

1.3. Stakeholders

The modular home manufacturer Ritz-Craft is a stakeholder. The project partner's research is being conducted for this company. All of the virtual reality models created in this project are based on the actual design and processes of Ritz-Craft's current factories. The company will use the virtual reality program created by this project to aid in the development and optimization of their real factories.

The primary users of this project will be Ritz-Craft employees. These include designers and engineers tasked with creating and optimizing the company's factories. They will use the virtual reality tool to experiment with factory changes. Employees working on the factory floor will use the tool for training, in order to adapt to those changes.

Other stakeholders for the project are the capstone team members Jason Chen, Zachery Thompson, and Nathaniel Mohr. They will be responsible for developing the virtual reality environment and some of the 3D models that will be used.

2. Vision

Once the problem is solved, the cost of modeling changes to and redesigning modular home factories will be significantly reduced as virtual reality allows experimentation without making costly changes to real-world facilities. Additionally, the speed of experimentation will increase because all assets in the virtual environment can be quickly created on a computer, requiring no physical materials to change the factory. The combined cost and speed benefits mean design teams can quickly iterate on factory changes with little expense.

Workers will become productive with factory design and process changes faster. Because the factories are modeled in virtual reality, workers will quickly adapt to changes in real-world facilities since they can be trained in the same virtual environment. Training employees in a virtual reality that mirrors the actual factories they work in will reduce potential expenses from workers making mistakes on the actual factory floor.

2.1 Central Hypotheses

Growth Hypothesis

With increasing automation taking place, modular home manufacturers will seek additional ways to automate the processes in their factories. These companies will look for solutions that are inexpensive and effective. The virtual reality approach to designing factories is a solution that will appeal to them because it is largely risk-free, does not require a lot of upfront investment, and allows them to very accurately mimic their real-world factories.

Value Hypothesis

By using virtual reality to design their factories, companies can save money, resources, and time by testing their design and processes in a virtual environment before making significant investments to their real factories. Companies can experiment with various design ideas without needing to pay for physical resources and construction within their facilities. It allows them to take an iterative approach to design, with each subsequent design improving on the previous, without committing to any real changes.

2.2 High-Level Requirements

Functional Requirements

Some of the functional requirements for the project are listed below.

1. Users should be able to add pre-designed assets to the virtual environment.
2. Users should be able to use virtual reality headset controllers to move objects around in the virtual environment.
3. Users should be able to interactively complete predefined tasks. These tasks may include operating machinery using headset controllers and moving materials from one station to another.
4. Users should be able to run the virtual reality environment on various headsets, including those from Oculus and HTC.

Non-Functional Requirements

Some of the non-functional requirements for the project are listed below.

1. The virtual reality environment needs to be built using the Unity game engine.
2. The virtual reality program needs to be developed using a headset-agnostic tool, such as SteamVR.
3. The virtual reality program must be compatible with the controllers from all supported headsets.

3. Prioritized Project Constraints

Time

The entire project needs to be completed before the expo at the end of the year. The group has allotted two times during the week for stand up meetings as well as a longer time frame to get together once a week and work on the project together. We will work in sprints to ensure we are making consistent progress on the project. Time is the main constraint on the project.

Resources

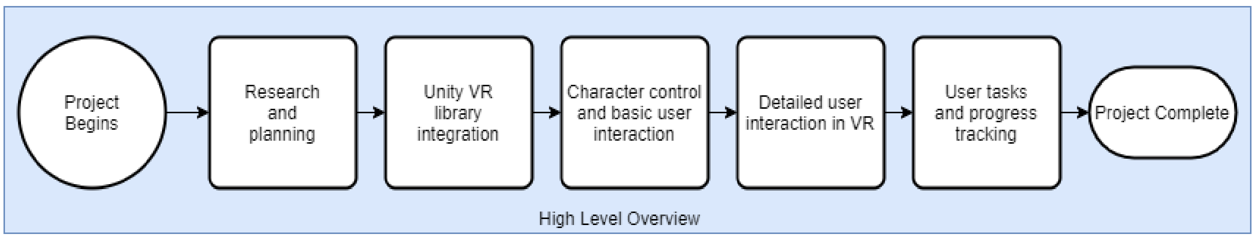
As this project deals with creating an interactive environment in virtual reality, we will need a virtual reality headset in order to see that our environment is working properly. Our project partner has a headset that will be available for one of us to have during the duration of the project for the purpose of testing the environment.

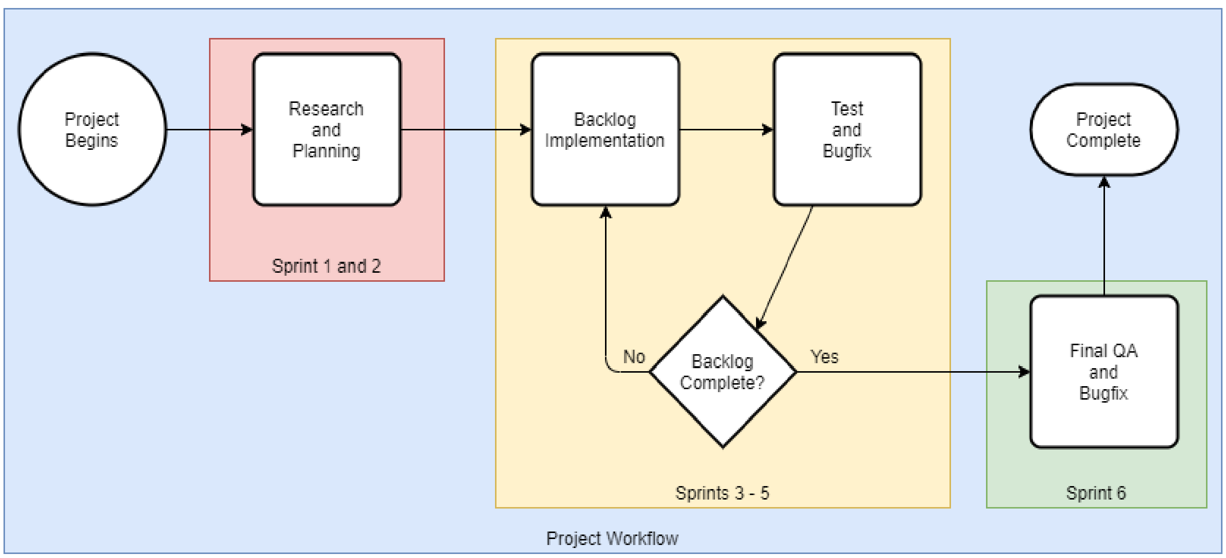
Scope

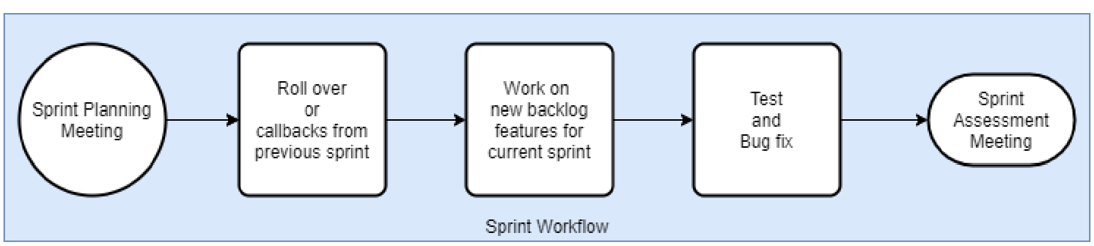
Our scope will mostly be restricted by the time allowed for the project. Other restrictions to our scope come from the models that we have available to us. The models we are using come from a specific factory, so we would only be able to implement parts of the factory that we already have the models for.

4. Scope

4.1 Process Flows







4.2 User Stories

1. As a user, I need to be able to move around in VR so that I can move between tasks.

2. As a user, I need to be able to interact with virtual objects so that I can work on an assigned task.
3. As a user, I need to be able to pick up/put down different tools so that I can perform different aspects of assigned tasks.
4. As a user, I need to be able to track my progress on tasks so I can learn the task.
5. As a user, I need to be able to move between workstations so that I can learn new tasks.
6. As a warehouse manager or designer, I need to move equipment in virtual reality so that I can see the effect of changes without disrupting the real factory.

5. Iteration Plan and Estimate

All work for this project will happen in 6 distinct sprints. Each sprint will last 3 weeks and cover specific aspects of the project. Each sprint will begin with a planning meeting to assess any outstanding work not completed in the previous sprint and to determine which items in the backlog are critical to the sprint. At the end of each sprint will be a retrospective meeting that highlights what work was done and what work still needs to be done. The retrospective meetings will help prepare for the next sprint and allow us to determine if we need to change or adapt the current iteration plan.

Sprint 1 (Oct 26 - Nov 13): Sprint 1 covers familiarization with the project and pre-planning. This sprint will consist primarily of communication between us and the project partner to determine high level goals and expectations. This sprint will also give us time to familiarize ourselves with the tools necessary to complete the project.

Sprint 2 (Nov 16 - Dec 6): Sprint 2 will cover the initial research and planning for the project. Research will be done on what VR library to use and how to integrate it into Unity for use in this project. Other research will be done to determine what other libraries or external tools may be necessary. In this sprint the initial backlog will be groomed and prepared for development in the following sprints.

Winter Break (Dec 7 - Jan 3): As of this time we will not be working over winter break, and this time period is reserved for personal life.

Sprint 3 (Jan 4 - Jan 24): Sprint 3 will cover development of the building blocks and low level foundations of the project. This sprint will cover VR integration with existing project files and low level character control and interaction in a VR environment. This sprint will cover any backlog items that are essential to later development to provide the building blocks for the rest of the project.

Sprint 4 (Jan 25 - Feb 14): Sprint 4 will begin to use the building blocks created in Sprint 3 to build intermediate functionality described in the back log. This sprint will enable the user to begin interacting with the simulation in VR and with the environment as well. At the beginning of this sprint any items left over from Sprint 3 will be assessed. Critical items will be carried over into this sprint, and we will decide if any non-critical items should be dropped from the backlog.

Sprint 5 (Feb 15 - Mar 7): Sprint 5 will cover structured interaction between the user and the simulation. This sprint will tackle direction intervention by the user and allow the user to progress the simulation by their interactions. This will be the last development sprint and all critical backlog items should be completed by the end of the sprint.

Sprint 6 (Mar 8 - Mar 28): Sprint 6 will be the final sprint and consist primarily of testing and quality assurance. During this sprint any existing bugs and defects will be corrected and the project will be thoroughly tested for the presence of any unknown bugs or defects. At this stage all major systems should be in place, and no major changes should occur.