3 Design

3.1 Design Context

3.1.1 Broader Context

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

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

Area	**Description**	**Examples**
Public health, safety, and welfare	How does your project affect the general well-being of various stakeholder groups? These groups may be direct users or may be indirectly affected (e.g., solution is implemented in their communities) Our project will help inform club members and students on how 5G works and how it can be applied to farming. A better understanding of 5G can lead to smarter farming which can improve food production.	Increasing/reducing exposure to pollutants and other harmful substances, increasing/reducing safety risks, increasing/reducing job opportunities Increase in food production, Increase in knowledge. More overall success in farming.
Global, cultural, and social	How well does your project reflect the values, practices, and aims of the cultural groups it affects? Groups may include but are not limited to specific communities, nations, professions, workplaces, and ethnic cultures. Our project is accurate to the wants and views of affected groups. The project is written by students, for students. Since the project is a mod for a videogame, it also reflects what many students enjoy and use frequently.	Development or operation of the solution would violate a profession's code of ethics, implementation of the solution would require an undesired change in community practices Instead of filling out a worksheet, students will now be able to play a game over the same topic.

Environmental	What environmental impact might your project have? This can include indirect effects, such as deforestation or unsustainable practices related to materials manufacture or procurement. Our product does not have any environmental impacts since our product is an open-source game so no materials are required for this.	Increasing/decreasing energy usage from nonrenewable sources, increasing/decreasing usage/production of non-recyclable materials N/A. This is software, and not resource intensive software at all.
Economic	What economic impact might your project have? This can include the financial viability of your product within your team or company, cost to consumers, or broader economic effects on communities, markets, nations, and other groups. An economic impact our product can have is the financial viability of our product and its costs to our consumers. We had a budget in mind and we have been making decisions towards our product in order to stay consistent with our budget goal for both the team and the users.	Product needs to remain affordable for target users, product creates or diminishes opportunities for economic advancement, high development cost creates risk for organization Our product needs to be affordable for our users since we want our product to be easily accessible for students and teachers who want to utilize it.

3.1.2 User Needs

List each of your user groups. For each user group, list a needs statement in the form of:

Students need a fun and interactive way to learn about 5G broadband in rural areas

Teachers need a simple, fun tool for introducing students to the next generation of farming

Farmers need a way to see how a 5G broadband connection can increase the quality of their work

Wireless Companies can use the simulator to see where a wireless tower could improve general signals

Investors can use the simulator to understand the impact the scale of the next generation of farming

User group needs (a way t0) to do something (i.e., a task to accomplish, a practice to implement, a way to be) because of some insight or detail about the user group.

3.1.3 Prior Work/Solutions

Include relevant background/literature review for the project

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

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

– Note that while you are not expected to "compete" with other existing products / research groups, you should be able to differentiate your project from what is available. Thus, provide a list of pros and cons of your target solution compared to all other related products/systems.Detail any similar products or research done on this topic previously. Please cite your sources and include them in your references. All figures must be captioned and referenced in your text.

There is no similar product in the market. Although there are many other mods in the market such as farming tools, the field we are trying is completely new.

The advantage of our project is the ability to combine agriculture with STEM for education.

The disadvantage of our project is that we are simulating in a game. It is not exactly the same as reality.

3.1.4 Technical Complexity

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

1. The design consists of multiple components/subsystems that each utilize distinct scientific, mathematical, or engineering principles –AND–

   We will build mods for cell towers, satellites, and cell phones. All these components will build a communication system. The fields involved are programming, graphic design, and signal transmission.

2. The problem scope contains multiple challenging requirements that match or exceed current solutions or industry standards.

   Since we are exploring new areas, there's no current solution or industry standard.

3.2 Design Exploration

3.2.1 Design Decisions

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

We have decided to use Minetest as the game we will be modding.

The main 5G features we want to implement are Cell towers, Satellites, and Cell Phones.

We are going to be combining other mods with our own for farming and animals.

Obstacles and weather will be the main setbacks for the player that they have to work around.

3.2.2 Ideation

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

For one of the design decisions - using Minetest as the game we will mod, we identified potential options based on budgeting. We wanted our product to be easily accessible for its users so finding an open source game where they did not have to pay in order to download the game was important. Minetest is a free open-source game.

Five options we considered were:

1. Minecraft
2. Terasology
3. Roblox
4. TrueCraft
5. Terraria
6. Minetest

3.2.3 Decision-Making and Trade-Off

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

Pros:

- We will generally try to add as much detail as possible into each part of the mod, because that will increase realism. This applies except in the case of the following con.

Cons:

- Some things that happen in real life would not make any sense in a game. We will have to intentionally leave out some functionality in order to prevent user frustration. For example, the chance of random component failure. In real life, you may get unlucky and be shipped a dud or defective product, but if we were to implement that in the game, players would think the mod is not working right or that the failure is the programmer's fault, not an intended feature.

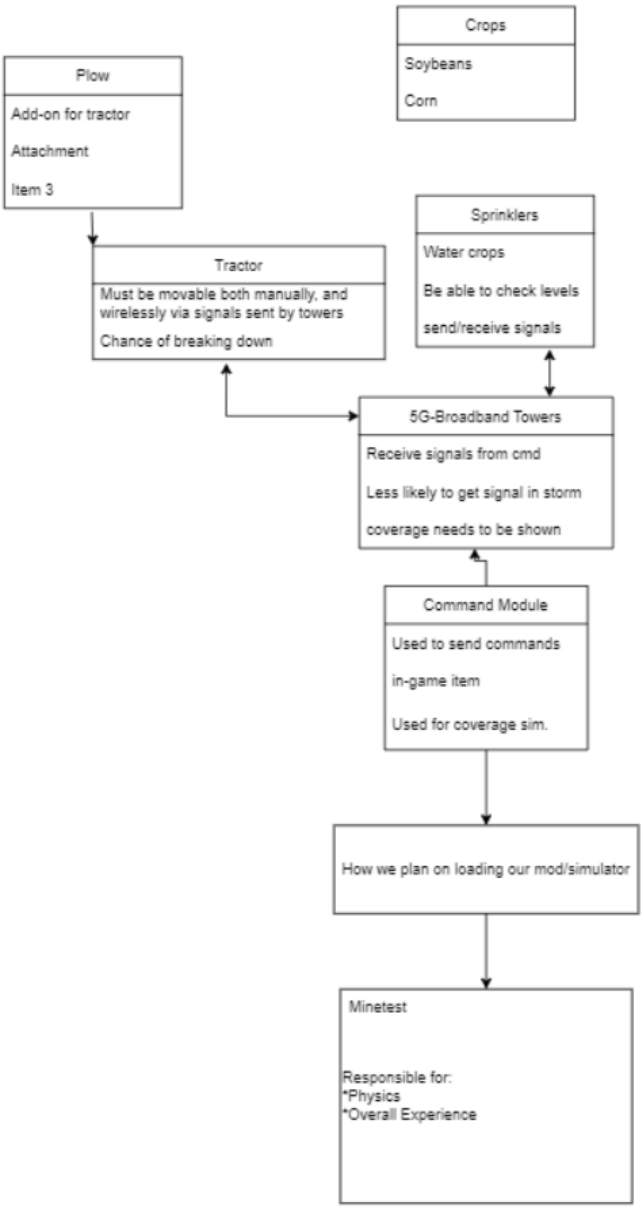
3.3 Proposed Design

Discuss what you have done so far – what have you tried/implemented/tested?

We have tried several different videogames to see which would be best to use as a foundation. Minecraft was tested and discarded because it would cost a large sum, and the source code is obfuscated. All the other games except for Minetest were tested and discarded due to lack of features.

3.3.1 Design Visual and Description

Include a visual depiction of your current design. Different visual types may be relevant to different types of projects. You may include: a block diagram of individual components or subsystems and their interconnections, a circuit diagram, a sketch of physical components and their operation, etc.



Describe your current design, referencing the visual. This design description should be in sufficient detail that another team of engineers can look through it and implement it.

This is our current design of what we want to implement, we will likely add to it as we continue working on the project. Each item will have some interaction with another. All the farming equipment will have some 5G tied to it like with the Tractor and sprinklers.

3.3.2 Functionality

Describe how your design is intended to operate in its user and/or real-world context. This description can be supplemented by a visual, such as a timeline, storyboard, or sketch.

How well does the current design satisfy functional and non-functional requirements?

In the real world, our project will run on a person or school's personal computer, by launching an .exe file. This satisfies the requirements very well, since it will be easy to set up, easy to transport to clients, and requires no physical products.

3.3.3 Areas of Concern and Development

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

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

Some concerns we have when delivering our product based on our requirements and needs of both users and clients is the overall functionality of the game. We want the game to be working at full functionality and also have all the components needed in order to provide the best learning experience for our users. We also have concerns about issues with our 5G connectivity for rural broadband. If this is not working, then the game would not be useful.

Our plans for developing the solution to address these concerns is to make sure we create and utilize all current mods that are relevant towards our project. This includes farming since our target users are 4H students. If our game for some reason is not functioning properly, the solution to this is to know how to troubleshoot any issues for Minetest. A solution for 5G connectivity would also be to gain the knowledge of troubleshooting in this area, although any connectivity issues can be out of our reach since it is for rural broadband.

NOTE: The following sections will be included in your final design document but do not need to be completed for the current assignment. They are included for your reference. If you have ideas for these sections, they can also be discussed with your TA and/or faculty adviser.

3.4 Technology Considerations

Highlight the strengths, weaknesses, and trade‐offs made in technology available.

Discuss possible solutions and design alternatives

3.5 Design Analysis

– Did your proposed design from 3.3 work? Why or why not?

– What are your observations, thoughts, and ideas to modify or iterate over the design?

3.6 Design Plan

Describe a design plan with respect to use-cases within the context of requirements, modules in your design (dependency/concurrency of modules through a module diagram, interfaces, architectural overview), module constraints tied to requirements.