Master's thesis 2025

Design of Engaging Community-Centered Cooperative Multiplayer Sandbox Games with Wide Demographic Appeal

What are some of the most important factors when designing appealing mechanics to encourage community-centered cooperative role hierarchies in sandbox environments?

ANDREJ ERDELSKÝ | ALEXANDRE MONTEIRO

UNIVERSITY OF
GOTHENBURG

CHALMERS
UNIVERSITY OF TECHNOLOGY

Department of Computer Science and Engineering
Chalmers University of Technology
University of Gothenburg
Gothenburg, Sweden 2025

Design of Engaging Community-Centered Cooperative Multiplayer Sandbox Games with Wide Demographic Appeal
What are some of the most important factors when designing appealing mechanics to encourage community-centered cooperative role hierarchies in sandbox environments?
ANDREJ ERDELSKÝ, ALEXANDRE MONTEIRO

Supervisor: Pauline Belford, Computer Science & Engineering
Advisor: Joakim Höglund, FunRock & Prey Studios
Examiner: Michael Heron, Computer Science & Engineering

Master's Thesis 2025
Department of Computer Science and Engineering
Chalmers University of Technology and University of Gothenburg
SE-412 96 Gothenburg
Telephone +46 31 772 1000

Cover: Description of the picture on the cover page (if applicable)

Typeset in LaTeX
Gothenburg, Sweden 2025

Design of Engaging Community-Centered Cooperative Multiplayer Sandbox Games with Wide Demographic Appeal
What are some of the most important factors when designing appealing mechanics to encourage community-centered cooperative role hierarchies in sandbox environments?
ANDREJ ERDELSKÝ, ALEXANDRE MONTEIRO
Department of Computer Science and Engineering
Chalmers University of Technology and University of Gothenburg

Abstract

This thesis explores the design of cooperative multiplayer sandbox games that foster community-centered engagement and appeal to a broad demographic of players. In collaboration with **FunRock & Prey Studios**, the research focuses on identifying key mechanics that encourage the formation of organic role hierarchies within player groups, without explicit direction from the game. By combining theoretical analysis with an iterative design and playtesting process, a functional prototype was developed to observe and evaluate player behavior in a large-scale cooperative environment. The study draws from game design theory, psychology of player motivation, community dynamics, and empirical playtest feedback to develop design guidelines that balance complexity, accessibility, and player agency. Findings reveal that ambiguous mechanics, interdependent gameplay systems, synchronizable player tasks, diverse mechanical complexity, and scalable role structures are critical to promoting emergent leadership, group cooperation, and engagement across casual and hardcore players alike. The resulting insights contribute to both academic research and industry practice in the design of socially driven multiplayer games.

Keywords: Game Design, Multiplayer Sandbox, Community Engagement, Role Hierarchies, Emergent Behavior, Casual and Hardcore Players.

Acknowledgements

We would like to express our sincere gratitude to our supervisor Pauline Belford, for the guidance, feedback and support given throughout our thesis. Her knowledge and experience were key for the completion of this research.

We are also extremely thankful to Joakim Höglund, Simon Goldgrab and all the staff in **FunRock & Prey Studios** for their insightful suggestions and assistance provided to us before and during the research conception. Their feedback was instrumental for the conception of the prototype and their participation in the third playtest session gave us valuable information that significantly contributed to the research.

Finally we would like to thank all the playtesters that joined the sessions and gave us important feedback and data.

Contents

1

Introduction

1.1 Context

Our goal with our thesis was to conduct research alongside a company in the gaming industry. We decided early on that this would be ideal for us, as we wanted to work and obtain experience in a professional environment while also being surrounded by experts who would give us insightful knowledge to aid with our research question and contribute to the industry with our work.

After extensive searching, we decided on collaborating with a company called **FunRock & Prey Studios** located in Stockholm. The studio requested our assistance in researching a novel game concept they are interested in developing. The main focus of said game would be to leverage community engagement by putting large amounts of players in a sandbox environment, with very little information and indication of what to do aside from an over-arching goal they as a group need to achieve. These players would then need to discover game mechanics and concepts out by themselves and work together as a community by organizing themselves into a hierarchical structure to optimize their functioning as a team.

For the studio, there is also an important incentive factor of wanting both avid gamers and more casual players to have fun and feel rewarded regardless of the time investment they would put into this theoretical game. This is paramount because such a game designed around having a reliably large community of players lives and dies by the number and size of in-game groups that new potential players can join into, meaning this potential game concept needs to appeal to as many player demographics as possible by design.

We saw an opportunity in this idea; it would be a major design challenge to create a multiplayer world with deep mechanics while not telling players what to do and how to interact with said world but rather incentivizing them to explore, work in groups, and organize themselves around the achievement of their own group goals that would otherwise be borderline impossible if done alone. Together with **FunRock & Prey Studios**, we believe that such a game design space hasn't been truly explored before and can potentially give players a unique sense of satisfaction and pride from belonging to an in-game community and being part of something bigger than their

own individual actions.

Even if some popular games have already ventured into similar design territories focusing on the aforementioned concepts, we are confident that the combination of satisfaction stemming from deep community engagement above individual actions and incentivized organic player cooperation requiring optimized player organization in a truly free sandbox environment allows us to create game design recommendations for a game concept that can result in a unique player experience capable of resonating with demographics of players ranging from smaller friend groups to large pre-existing communities of players that migrate from other games.

1.2 Research Problem

This ambitious goal presents numerous challenges due to a variety of factors that arise from the complexity of designing and implementing our planned game concept.

Firstly, for this concept to work, it needs as many players as possible to create large in-game communities, meaning its design needs to maximize accessibility and appeal to all available demographics of potential players. In practical terms, we need the game to appeal to what we define as casual players (people who only play games once in a while for short amounts of time) as well as to avid gamers (people who enjoy spending multiple hours on games on a daily basis). In order to achieve this we need to design systems that realistically engage both groups and make them feel rewarded no matter their time investment and provide replayability to keep the community count healthy for long periods of time.

Secondly, our goal is to design a game concept that aims to create an emergent behavior in player groups that will lead them to organize themselves into specific role hierarchies, which can only be successfully created by designing gameplay systems, mechanics, and in-game player goals that interact with each other in just the right ways to elicit such a behavior in players. This is, of course, a very challenging task, since it is impossible to force players into certain behaviors directly, especially considering how much freedom and trust we want to give them through the sandbox systems of the game. This goal can therefore only be achieved by carefully researching, designing, experimenting with, and tuning gameplay systems with the hopes of achieving this player behavior.

Lastly, designing and creating an online multiplayer game with scalable systems that are capable of supporting large amounts of players and also being realistically testable in small environments for practical play-testing purposes is an immense technical challenge unto itself. It is therefore crucial for us to define a realistic scope for this prototype in order to design and implement as many researched concepts and game mechanics as we possibly can in a time frame of 4 months (January to May 2025) while also maximizing play-testing and having a playable software demo as soon as possible, capable of giving us valuable feedback from players, which is invaluable in this project.

1.3 Aim

The goal of our thesis is to research, design, and implement a unique multiplayer game concept that we believe, together with our partners at **FunRock & Prey Studios**, has never been fully explored before, and in doing so effectively create design recommendations on how games trying to leverage similar concepts can be designed. The uniqueness of this idea stems from the gamification of the concept of letting players organize themselves organically into distinct role hierarchies without the game explicitly forcing players into any predefined behavior. We want to give players the freedom to succeed and fail on their own terms as an in-game community, engaging them in a sandbox game environment filled with systems and mechanics that they need to discover on their own, only giving them the necessary information to interact with the game without spoiling any game systems. However, the game would provide players with a major overarching goal, a goal so monumental that it will naturally incentivize players to effectively cooperate by dividing themselves into specified roles based around in-game functions they serve in their player group as a whole.

Our hypothesis is that designing such an environment will provide players a fulfilling experience on a different level of enjoyment, where they can feel proud about their achievement on an individual level but, most importantly, about being an integral contributor to their in-game community. We strongly believe that the feeling of pride an individual gets by contributing to and being part of a larger community of players inside a game is immensely powerful and is not utilized enough in games. Humans, as a social species, naturally seek a sense of belonging within a larger community [1]. Each person tends to find their own strengths and unique contributions, which not only support the progress of society but also bring meaning and fulfillment to their lives [2]. By creating a game that leverages and gamifies this primal concept of inherently human behavior found in all of us, we are convinced that it is possible to create a satisfying gameplay experience that transcends the minutiae of in-game tasks and taps into a meta-level of enjoyment that comes from being part of an experience with other people.

1.4 Research Question

What are some of the most important factors when designing appealing mechanics to encourage community-driven cooperative role-hierarchies in sandbox environments?

1.5 Stakeholders

The different stakeholders include those who will benefit from the findings derived from our research. Each stakeholder stands to gain a unique insight regarding game mechanics that encourage the establishment of role hierarchies in multiplayer settings.

1.5.1 Game Designers

Relevance: Game Designers, specifically those who plan to create multiplayer games with cooperation in mind for a larger target demographic, will benefit from the design recommendations and mechanics that we will explore and determine in this research. This can help them design mechanics better suited for this behavior to occur, both as the result of a technical implementation and also as an emergent behavior.

1.5.2 FunRock & Prey Studios

Relevance: The insights of this research can be used by **FunRock & Prey Studios** to determine the necessary mechanics needed to be put in place in order to create a game capable of appealing to different types of players and promoting cooperation between them in a sandbox environment.

1.5.3 Academic Community

Relevance: This research aims to analyze existing games and papers relevant to the topic and contribute new knowledge to the game development field, which then can be utilized in an academic setting as a learning tool.

1.6 Ethical Considerations

To ensure the integrity of the research conducted, its value to the partner company, and the well-being of the prototype playtesters, it is important to us to take into account the ethical concerns that might arise. This section highlights the measures taken to address topics such as business practices, business confidentiality, testers well-being, testers consent, testers privacy, and a reflection on potential impact.

1.6.1 Testers consent and privacy

Whilst conducting playtesting sessions, participants will be briefed on the data collection process, which includes the type of data that we will gather, its purpose and the rights regarding data privacy. In addition, prior to the playtesting session, participants will be explicitly asked to concent to the data collection and the degree of data sharing. This includes decisions regarding disclosing their personal information and sharing materials such as screen recordings from the playtesting session.

1.6.2 Testers well-being

During the playtesting, measures will be taken to ensure that participants well-being is a top priority. This includes an environment that is non-judgmental, respectful, and considerate of the different backgrounds of the participants. We will also make sure to conduct the session in a suitable room with good and comfortable conditions.

1.6.3 Business practices and confidentiality

As this research is a partnership with a company, it is of utmost importance to use it to make sure that we follow the proper business practices and respect the confidentiality of certain information provided by the company. Any sensitive data and competitive insights will be kept confidential and used merely for academic purposes.

1.6.4 Reflection on potential impact

This research will include a reflection on the potential ethical impact that could be caused by our findings in the game design and development space, both in the short and in the long term.

2

Theory

2.1 Background

In order to get a better understanding of the design landscape we want to explore, we can investigate papers that were written about adjacent topics.

The core of the research relies on multiplayer, so we can start by investigating the techniques that multiplayer games employ [3]. We also want to create something that is appealing to a wide demographic, and so we need to understand what exactly people find appealing in games [4] and what games manage to succeed in this field.

Furthermore, there is the whole aspect of cooperative play [10], which we hope leads to people creating hierarchical groups [5] in order to organize themselves and increase efficiency in gameplay. This psychological behavior can be seen in various games, so we can study how people develop communities in them [6], as well as how to create that feeling of being part of something in general [7].

Additionally, there is the aspect of rewarding players and making them feel satisfied regardless of their time commitment; for that we can look into how rewards in games are usually done [8] and also how they impact the game and its players [9].

After researching these topics and analyzing what conclusions other researchers got to, we can get a better understanding of what to design and specifically design something that will contribute to the game development space and fill a knowledge area that has yet to be delved into. On top of that, we can also get a better understanding of what we can test with a prototype and what is outside of our control.

Taking all of this into account, we segmented the Theory chapter into four sections that represent each main topic we want to research.

2.2 Community Engagement

2.2.1 Definition

As Gavin, Kenobi, and Connor [10] define, the term "community engagement" in video games refers to the ways players actively interact, collaborate, and contribute to gaming communities, both inside the game environment and beyond it in the physical world. The individual player's involvement can take various forms, such as taking part in social play areas, in-game guilds, online forums, and user-generated content. By showing how interactive digital settings inspire players to create deep social relationships, the authors also stress the importance of shared play experiences in creating a feeling of community.

Additionally, community engagement in video games also refers to the active interaction of game developers with their player base within a game's ecosystem [11]. This is frequently made possible by developers setting up forums, social media accounts, or dedicated community servers where players can exchange strategies, offer suggestions, and keep up with game updates. Players feel more included as a result of this interaction, which motivates them to work together, exchange stories, and support the game's continuous development [12]. In addition to improving the gaming experience, developers foster these communities and build an ecosystem for players that sustains the game's popularity and longevity.

For example, Mega Cat Studios [11] highlights how keeping an active community through events, giveaways, and direct interaction can greatly increase player loyalty and retention. The idea of "collective intelligence," which was first proposed by Pierre Levy [13], also emphasizes how well online communities can cooperate and share knowledge, creating a more engaging gaming experience.

For the purposes of our research and prototyping implementation, when it comes to the factor of community engagement, we aim to create game mechanics and systems that encourage active interaction and cooperation between players in the hopes of leveraging this sense of community as the main source of enjoyment for the player. Instead of relying on satisfying and finely tuned moment-to-moment gameplay, we aim to leverage the sense of belonging and pride that a player can possess with regard to their respective in-game community and their shared achievements as a group [1], [2] instead of their individual contribution. In other words, the goal of this game design experiment is to try to maximize the feeling of engagement and enjoyment in the player from the fact that they are contributing and not from the minutiae of the contributing activity itself.

2.2.2 Motivation and Psychological Aspects behind Gaming Communities

Gaming communities are motivated by a multitude of psychological concepts such as social identity, shared experience, and belonging [14], [15]. Players often develop

close bonds within their community since its members are more likely to have similar interests to theirs, fostering a sense of collective identity and unity [1]. Social Identity Theory claims that people get some of their sense of identity from the groups they are a part of, which in turn explains why gamers have the tendency to create strong emotional bonds with their gaming communities [16]. Platforms such as online forums, competitive esports teams, streamer comment sections, or a raiding guild in an MMORPG (massively online multiplayer game, i.e., World of Warcraft) give players validation and a sense of belonging [17].

Cooperation and competition are two other psychological aspects that can have major effects on gaming communities. Teamwork is often leveraged as a design choice by developers in many multiplayer games, which encourages players to cooperate effectively and requires their mutual support in order to be successful inside the game environment, in turn strengthening social bonds [18]. On the other hand, competition in games is used as a tool to motivate players, pushing them to further their skills and in-game knowledge, in addition to making them desire the recognition within their community [19]. Multiplayer games are therefore shaped by the dynamic balance between cooperation and competition. These social circumstances then allow players to create friendships, rivalries, and mentorship connections. Self-Determination Theory shows that video games fulfill the psychological demands of their players, such as autonomy, competence, and relatedness, all of which are enhanced by interactions within gaming communities [20].

Moreover, gaming communities serve as platforms for emotional support and identity refinement. Players utilize these platforms to connect with similarly minded people with common interests and tastes, express themselves freely, and decompress from everyday life in general [21]. Online gaming communities also provide a relaxed environment for individuals who struggle with social anxiety that helps them develop confidence and social skills [22]. Players can meaningfully engage with like-minded individuals thanks to the relative anonymity of online interactions, which further promotes self-expression and identity experimentation [23]. Ultimately, gaming communities serve not only as hubs for entertainment but also as complex social ecosystems that satisfy fundamental psychological human needs for their members [1], [2].

2.3 Casual and Hardcore Players

2.3.1 Definition

As once said by Bob De Schutter and Steven Malliet [24] "Games are no longer played only by hardcore players who were typically male adolescents, but by a diverse group of players from children to elderly people in a variety of ways (...)", the market for games has expanded and now reaches a wider audience, but before we dig further into this topic, we must understand what a casual or hardcore player is.

Player in this context is used to described those who engage in digital and physical

games, but despite that, we'll be referring as "players" the ones that specifically partake in digital games. The term "hardcore" can be characterized by traits such as being extremely explicit, intensely loyal or stubbornly resistant [25], whilst "casual" tends to be the opposite, a more ordinary, less intensive and relaxing approach to this things.

In regards to describing types of players, however, the terms "hardcore" and "casual" may have different meanings regarding the person or community it relates to. Generally speaking, hardcore players are typically more loyal towards the gaming industry, have a higher level of game literacy, play games as a lifestyle preference and are enthralled by challenge, leading them to go the extra lengths necessary to become better at the game they're playing [26]. On the other hand, casual gamers have little knowledge about game conventions and usually play games as means to relax and have fun without caring much for the neither the competitive or challenging aspects of games [26].

In "21st Century Game Design" [27], casual players are even divided into three main types: the lifestyle gamers, characterized by not wanting games to be challenging as it prevents them from progressing the game they're playing. The family gamer, which usually includes parents who purchased games for their children and so are looking for simple control schemes and entertaining yet not complex mechanics. Finally, there's the testosterone gamers, described as those who are "in the middle between casual and hardcore" [27]; these types of players are fixated on specific game elements such as player versus player functions and high-action games. They often share some characteristics with hardcore gamers but are unwilling to go to the same lengths hardcore gamers go in order to become better at a specific game.

There are multiple factors of measurement used to distinguish hardcore and casual players, but upon diving into the different research conducted on the topic, we realized a pattern in the factors used to determine the types of players. Typically around 5 to 6 factors are used, which are:

- Time played per week
- Time played per session
- Time researching games
- Decisions per minute
- Games owned
- Games purchased in the last six months

In a 2005 study on hardcore and casual players [28], similar measuring factors were used to distinguish these two types of players, the requirement being that an hardcore

player had to fulfill at least 5 of the 6 requirements to be eligible.

But are all of these factors valid? Well, not necessarily. Taking for example the time played per week of a specific game, if said game has challenging components to it, a hardcore player might spend 10 hours a week preparing for the challenge, optimizing the aspects of the game geared towards the challenge, and finally taking it on. A casual player, however, can also spend 10 hours in a week on the same game, but simply experience a different side of it, partaking in easier and relaxing tasks [29]. Nevertheless, there are other factors we can take into account other than the already mentioned, such as player difficulty and designer difficulty.

Player difficulty is self-imposed by the player, it goes beyond the challenges created by the developers, for example wanting to fight a tough enemy without any weapons. This type of difficulty is more typically employed by hardcore gamers, who are always on the search for a new challenge and test to their skills [29]. On the other hand designer difficulty is set by the game designers, this means different levels of game difficulties that affect things such as game pace, enemy health, enemy movement, etc.; this type of difficulty usually allows players to choose preset options in order to adapt the game to their liking, so a casual player can tone down difficulty making the experience more comfortable whilst an hardcore player might do the opposite.

Although not all factors mentioned necessarily cover all the possible traits of hardcore and casual players, they help researchers and us, understand the differences in these players. So, for the purpose of this paper, we'll define hardcore players as those who are most interested in the challenge a game can provide, as long the preparation needed for it and the dedication and time necessary to complete it. Casual gamers are those who enjoy a more relaxing, less intensive experience that still is entertaining and fun in its own aspect.

2.3.2 Motivation and Psychological Aspects behind Player Categories

Now, having a better idea of what defines casual and hardcore gamers, it is important to also understand what motivates such behaviors in the first place.

Hardcore and casual players possess certain attributes that can categorize them with specific identities [30]. So, for example, "The Storyteller" are players, usually on the casual side, that derive the most pleasure from the stories the games tell, and that's the main reason why they engage and have fun with games. On the other hand, "The Competitor" enjoys competing against other players or NPCs [31], this identity is more commonly found within hardcore players.

Identities are not the only factor that describes the motivation players demonstrate in games; however, in SDT (Self-determination theory [14])), there is a distinction between autonomous motivation and controlled motivation. Autonomous motivation can often be seen as intrinsic [32], so a player voluntarily engages in an activity because

they find it interesting [33]. Whilst controlled motivation is extrinsic [32], which relates to a player engaging in an activity due to pressure or feeling a responsibility towards it. Both of these motivations can be seen in hardcore and casual players but are usually more prevalent in a particular type. Casual players tend simply because they like the experience making it autonomous motivation; hardcore players can feel a sense of pressure or responsibility towards as challenge, there's a psychological aspect of "I need to clear every hard challenge in this game" that comes into play, making it controlled motivation.

Improvement over time can also be an important source of motivation. There have been studies in cognitive psychology that indicate enhanced basic visual attention in more experienced players [34], which also correlates with their ability to multi-task and ability to play at a high level after long periods of gaming. This type of ability is something that hardcore players sought to obtain, something that is only achievable by practice.

Studies on levels of stress when compared to the level of experience a person has on a particular skill have also been conducted [35], these studies observe less cognitive demand when performing a skill for a second time or after multiple times. People who dedicate more time to their craft tend to stress less when faced with adversity in that field, and this is also a factor that motivates players to spend so many hours in a particular game, to get this level of cognitive state.

Finally, there's also some research conducted on hardcore and casual players, taking into consideration their genders. In general, the casual and hardcore female gamers played mostly single-player games, thereby requiring no help or interaction from others [36]. In contrast, casual male players didn't care much for social interaction and challenge in games, but hardcore male players preferred ranked matches, game statistics, and achievements [36].

To conclude, there are multiple factors that can influence motivation when it comes to casual and hardcore players, from wanting to improve their cognitive skills to wanting to reduce stress, each factor being more closely related to one of these two particular types of players.

2.4 Role Hierarchies in Games

2.4.1 Definition

In this thesis, when we discuss role hierarchies in games, it is a shorthand used to efficiently refer to the distribution of effective role responsibilities between members of a player group inside multiplayer cooperative games and the hierarchies that result from this distribution. Research has shown that cooperative video games encourage players to develop structured teamwork dynamics, often leading to the emergence of distinct roles within a group [37]. In simpler terms, when a group of players engages with a game that requires cooperation, in order to tackle their common goal optimally,

they will organically organize themselves based on the tasks they need to accomplish, giving themselves and each other "roles" that they ideally adhere to in order for the group to effectively function as a unit in-game [38]. Depending on the game, the complexity of the game mechanics and the magnitude of the interdependence between player roles can result in the necessity of an additional leadership role that is not based on moment-to-moment gameplay interaction but rather on managing other players and assuring team success [39]. This is where the "hierarchy" aspect stems from.

Rather than being explicitly imposed by game mechanics, role hierarchies in video games frequently emerge from player behavior and their interaction with the game mechanics themselves and the cooperative aspect of the game [40]. Considering this, some games still opt to provide pre-defined roles to their players based on their in-game character choices, such as "tank," "damage dealer," and "support" in role-based multiplayer games such as World of Warcraft [41] or League of Legends [42]. While these roles tell players what they are specifically efficient at doing in a gameplay sense and give them a sense of direction within the context of the player group, this role is not enforced mechanically, and players still have the freedom to make their own choices. In other words, developers use this structured method of role assignment as a tool to help players find their place in group composition and guide them through the cooperation process instead of creating a binding mechanical contract that the player cannot break out of [38].

Even in these scenarios, players frequently develop additional layers of role specialization that evolve beyond the formal definition of roles provided by the game itself [40]. To illustrate, in tactical shooters for instance, certain players may naturally assume leadership positions by giving strategic guidance, while others may focus on resource management, cover fire, or reconnaissance. These emergent role hierarchies stay fluid, in-game circumstances and player experience can cause players to shift responsibilities and leadership positions depending on the task at hand [39]. Moreover, the degree of hierarchization within a team and the number of layers in it can be influenced by the game's complexity, the level of competitiveness and the level of cooperation required [37].

While the aim of our research and implementation is to create game design recommendations for mechanics that will hopefully lead to the creation of such emergent role distribution hierarchies in our prototype, we also endeavor to create systems that are suited for easy adoption by preexisting social hierarchies in gaming communities and otherwise. In simpler terms, we believe that if the mechanics in a game are properly designed to create an organic hierarchical role structure, preexisting communities, such as a streamer's fan base, for instance, can easily assimilate into the game systems and organize themselves as a team optimally in a shorter time span than individuals that have no preexisting social ties. In this example, the streamer in question and other community moderators can naturally gravitate towards leadership roles while fans can organically take up the more direct in-game mechanical interaction roles. Our hypothesis is that if a game can deliver on such a promise, it can create a niche

for itself on the market and be an attractive proposition for such communities to create engagement for its members.

2.4.2 Motivation and Psychological Aspects behind Role Distribution

Role hierarchies in multiplayer games are not only influenced by in-game mechanics but also by several psychological and social factors. Hierarchies are established by players based on perceived in-game skill, past experience in a group setting, and communication ability [39]. Certain individuals tend to gravitate towards leadership roles while others willingly follow the guidance of more experienced players and support their decisions. This mimics real-world organizational structures, where group dynamics and job complexity frequently cause leadership to emerge [23].

Furthermore, the development of hierarchies in video game cooperative environments is also influenced by social and cultural conventions [23]. Some player groups, for example, have a tendency to form more equal team arrangements in which players share comparable levels of responsibility, while others might decide to employ a more rigid chain of command team structure in which some people have clear leadership roles and others depend on their direction [43]. Players of multiplayer cooperative games profit by obtaining knowledge of these social aspects concerning role hierarchies, in turn increasing their success as a group by utilizing more effective role distribution and general collaboration.

Finally, role hierarchies in multiplayer games are also shaped by the competitiveness of the game and the pressures exerted by the community surrounding it [44]. High-stakes competitive game environments, like ranked matches or esports tournaments in games like League of Legends [42], encourage players to create rigid role structures that try to maximize team performance as much as possible [45]. In contrast, casual multiplayer experiences have more fluid and adaptive hierarchies where players exchange responsibilities and leadership roles thanks to the lack of competitive pressure to perform better than an opposing group of players [39]. The presence of a competitive environment often creates a pressure for players to conform to community-dictated norms, influencing players to adopt individual roles and predefined team structures based around community-supported meta-strategies. Even though these roles are not directly enforced by the game itself, playing the game not in accordance with the community-agreed cooperative standards is scrutinized and can lead to toxic social interactions [46].

2.5 Sandbox

2.5.1 Definition

Sandbox is a term that holds different meanings depending on the setting, but regardless of the setting, it always alludes to an environment that can be freely explored with lax rules.

In the context of games, sandbox is a genre in which very little limitations are placed on the player, allowing to explore the world at will [47]. Contrasting progression-style games [48], sandbox games emphasize roaming and give players the ability to select and create their own tasks. Typically, instead of featuring segmented areas or levels [49], it gives players access to the whole world right from the start. Furthermore, these games usually provide a certain level of scalability, making the world scale with the players needs and progression status.

There is, however, a degree of limitations that these games need to have in order to avoid nonviable portions [50]. Frequently in the form of some kind of resource (such as the natural resources in Minecraft [51] or zoning policies in Sims [52]), these limitations empower creativity [53], as constraints are a great way to make players think "outside the box.".

Sandbox is a genre often combined with other game genres, that build upon the open-ended design philosophy with extra features. Distinct Sandbox games will offer different stages of freedom, some allowing players to alter the world itself while others might only allow to add certain elements to the world.

To sum up, Aleksander Lyngstad makes a great analogy to describe these types of game genres: "A good analogy for the virtual sandbox is the physical sandbox: what can be made will depend on the tools and materials available in that sandbox. While in a physical sandbox, a child might bring their own toys; a virtual sandbox allows bringing in 'outside toys' in the form of modifications or add-ons (...)" [47].

2.5.2 Motivation and Psychological Aspects behind Playing Sandbox Games

Sandbox games offer a space that allows players to foster creativity [54] but being a medium for this is not the only reason why so many players choose to engage in these games.

There is a plausible, yet still rather unexplored, therapeutic aspect of playing sandbox games [55], these games that allow such degrees of freedom [56], offer escapism, a place where players can direct their negative emotions [57].

Due to the level of agency allowed to players, giving them the ability to both create and destroy the world around them, it served as a form of stress relief [55], letting them manage stressful situations and tasks at their own pace. Nonetheless, there's another side to this argument, as these games can also be the source of "griefing" [58], due to the feeling that might manifest if a player sees a construction or task that they spent a long time on being destroyed without their consent.

In the context of stress relief, studies have been conducted where comparisons are drawn between popular game genres and sandbox games. A common conclusion in this research was that sandbox players tended to exhibit the lowest levels of stress

after a gaming session [55].

Sandbox games have also been proved to be a great tool in the context of teaching and enhancing skills and literacy amongst users; Minecraft [51], for example, has been used in the past to help students visualize writing ideas [59]. Furthermore, in 2022, Chung and Lin [60] used a three-dimensional Sandbox game called "Creativerse" to construct a 3D gamification problem-based learning model, which aimed to improve motivation and satisfaction amongst students who tried it.

To conclude, there are multiple incentives, from a psychological aspect, to play sandbox games, whether it be to relieve stress, learn/teach, or even a place to redirect negative emotions. These genres of games offer a plethora of benefits to those who choose to engage in them.

2.6 Relevant Games

Whether it is because they incorporate sandbox elements, appeal to casual and hardcore gamers, are especially good at community engagement, are known to encourage role hierarchies in-game, or have a mix of these elements, the following game examples will provide different benefits and value that will guide us in the right direction and help us understand the extent of what we can develop in our prototype.

2.6.1 Final Fantasy 14

Final Fantasy 14 is an MMORPG [61] released by Square Enix [62] in 2010. The game has been receiving expansions and continuous content updates ever since; it has one of the biggest MMO communities of modern times and has consistently been praised for the quality experience it delivers.

As with many other MMOs, Final Fantasy 14 has systems in place to promote cooperation and player interaction within the game. For the sake of this thesis, we will focus on the Free Company (or FC for short) system and the group raids, both the eight-man raids [63] and the twenty-four-man raids.

FCs are the equivalent of guilds [64] in the game. They are made of groups of people that structure themselves in a hierarchal fashion, with a leader, one or more sub-leaders, and normal members. Leaders are more proactive players that tend to log into the game with high frequency and are tasked with managing the FC and moderating its members. Likewise, sub-leaders support the leaders but also recruit new members into the FC. The FC system allows for these roles to be distributed, where the person who created the FC becomes its leader or alternately can also abdicate that role and give it to someone else. Depending on the role, the player will get different access within the FC, such as being able to recruit other players, control the FC chests, and so forth.

FCs don't have other built-in roles apart from the mentioned ones, meaning that players are free to raid or just do casual content. This provides an environment that allows both casual and hardcore players to share the same space and enjoy each other's company while also having the freedom to play the way they want. Furthermore, some casual content gives players the chance to farm and craft gear that the hardcore players can purchase and use in end-game raids, allowing the casual players to make a profit but also empowering the hardcore players, creating a symbiotic relationship within the FC members and promoting the general mentality of wanting different ranges of player types in the same FC.

Raids in Final Fantasy 14 take many forms. Firstly, the 8-man raid, as the name suggests, requires 8 people to enter the content. The raid always asks for at least two healers [65], two tanks [66], and four damage dealers (or DPS for short [67]), but having a specific type of tank, healer, and DPS is not mandatory. This means, for example, that you can have the same class of DPS on all 4 members, but there is a catch: although not mandatory, if the party consists of an even distribution of classes, so melee DPS as well as long-range damage DPS, and a similar deal with tanks and healers, then the party receives a global damage buff. This damage buff is not that noticeable on casual-level content, but on high-level raids, it is mandatory to clear the raid. The bosses on these raids also possess specific mechanics that can only be cleared by tanks, healers, DPS, or a combination of these, so everyone in the party has equal responsibility and a sense of contribution.

In addition, a raid leader is not a built-in system, but something that tends to always happen and emerge from players wanting someone to call boss mechanics and plan out raid sessions, a topic we discuss in the role hierarchies section on the need for a leader.

24-man raids function similarly to 8-man raids but on a larger scale; instead of 1, there are 3 groups of 8-man parties working simultaneously to clear the raid. Each group has their own internal chain of command, but, in addition, there tends to be someone, or a small group of people, that give global instructions to all 24 players to promote coordination.

The main takeaways from Final Fantasy 14 are: creating a community system that allows both hardcore and casual players to have a meaningful role as well as being able to support each other; having specific set rules for group content that requires certain roles of players but allows for a certain level of freedom; and having a way to communicate with the group, regardless of size, in order to promote either coordination, teamwork, or perhaps conflict amongst enemies.

2.6.2 r/Place

r/Place [68] is a recurring collaborative project and social experiment organized by the website Reddit [69], that started in 2017.

The way r/Place works is the following: a massive blank canvas is made available at the start of the event; all Reddit users can then pick a color and place one pixel down on this canvas every 5 to 20 minutes. A single pixel being put down in this period of time might not seem like much, but when taking into account the thousands of people that join each time it takes place, and the fact that people organize and coordinate themselves to draw a specific thing on the canvas, it results in a digital painting with hundreds of drawings. These drawings can range from famous paintings to flags of countries and even niche references that only the community that drew them understands.

For the context of this thesis we will focus on the community aspect of this event and role hierarchies that emerge from it with the common objective of drawing a certain image.

Each time r/Place happens, a behavior pattern occurs: at the very start of the event, it is mostly disorganized chaos with people placing random pixels anywhere or trying to draw personal sketches. However, after a while, we start to see organized groups; these groups usually coordinate using third-party software and have a common goal in mind. Structuring themselves this way unlocks the door to more intricate drawing designs. As time progresses, more of these groups show up and claim a portion of the canvas for their drawing. Typically in these events, some streamers show up; they act as the leader and order their viewers in order to create a cohesive drawing of their choosing.

The canvas is not infinite, however, so at some point the blank space runs out. When this happens, people start to draw over other pre-existing drawings. Upon reaching this point, the users start realizing the importance of organization and structure, and it goes from simply wanting to coordinate drawing something to, on top of that, defending your space in the canvas. The roles within a group are then divided into a leader managing the entire group and deciding what to draw, where to do it, and if it is time to create something new or to defend a pre-existing drawing; those who are solely focused on creating art; and those who are solely focused on defending their space.

It is easier to understand why people react like this when taking into account what was discussed in our role hierarchies section. In there we mention how certain individuals gravitate towards leadership while others prefer to be guided. Not only this, but when your space is in danger of being occupied, or when you want to occupy someone else's space, a competitive side of the event arises, and as we previously mentioned, this leads to people wanting to optimize their strategies in to beat the opponents and complete their goals, which results in a high level of engagement by these groups.

The main takeaways from r/Place, therefore, are that within a constrained environment, people will first explore their options and then naturally start to gravitate towards others with similar ideals; when groups start to form, they structure them-

selves into categories to become more efficient; and finally, when faced with adversity such as having an opponent trying to claim your territory, a competitive side emerges in users, leading them to try to maximize their potential as a group by both defending and attacking others while working on their personal goal.

2.6.3 EVE Online

EVE Online [70] is an MMO space sandbox game developed by CCP Games [71] that was released in 2003.

EVE Online is renowned for the amount of freedom it offers players; in this game, trades, mining, PvE [72], and PvP [73] combat, building ships, exploring the galaxy, and crafting weapons can all be done. There are no set goals for the players, they create them for themselves based on the resources the game provides. For the sake of this thesis, we will be focusing on the groups, hierarchies, and tasks that players create and explore how EVE Online promotes these behaviors.

Eve Online has no set roles established for players; however, they do promote the division of labor in the form of different ships. There are various types of spaceships players can build in the game; these ships can be categorized depending on what their use is.

Firstly, there are ships that specialize in combat; these come in two big subcategories: bigger ships that hold great firepower but are slow and smaller ships that can't deal massive blows of damage but are much faster. The larger fighting ships are typically preferred as the big hitters in armies, with capabilities that allow them to destroy even planets. The small fighting ships, on the other hand, are preferred by pirates that loot slow cargo ships with their swift movement and speed. As mentioned, there are ships that hold cargo; these ships tend to be massive in size but very slow, often accompanied by fighting ships to act as their defense against looters. Finally, there are mining ships, specifically designed to mine ores from planets and asteroids.

Taking into account these types of ships, it is easier to understand how the game uses them to promote different roles in the game, but why would these roles even be formed in the first place? Well, within the game there are multiple rival companies, all run by players; these are divided into hierarchies and are fueled by competitiveness and profit, both factors that we mention in our previous role hierarchies section about being stimuli for these behaviors. In addition, there is also a sense of loyalty to one's company; even the rogue pirates who simply aim to steal resources from big company cargo ships take pride in their crime syndicate.

This game has a certain appeal to both casual and hardcore gamers as well, as some people enjoy the stress-free activity of just mining while others enjoy actively partaking in combat; both these behaviors can be explained from the conclusion we derive in the casual and hardcore players section of this thesis. As we talk about in the sandbox section, the level of freedom in sandbox games allows players to get

creative, and in Eve Online we see just that: pirates will create strategies to hide themselves in big cargo routes and create openings to steal resources in the form of different traps. This is but one example of what takes place every day in this world that allows for all types of player behaviors and plans.

In order to make a profit and be more efficient in combat, players create tasks and overarching goals for their companies; usually, they want to construct large ships capable of wiping entire enemy fleets, which protects their mining territories and their trading facilities. Nevertheless, these large ships are a massive undertaking; they require millions of materials that would take a single player years and years to obtain. This is another way in which EVE Online promotes group work: the tasks are so monumental that, to achieve them faster than the enemies, players must work together and in parallel to optimize their progress. By having different groups within the same company perform different tasks at the same time (some mining, some carrying cargo, some offering protection, some invading enemy territory, and so expanding the company's domain), players are capable of outperforming their opponents and claiming bigger rewards.

The main takeaways from Eve Online are: creating tools that are made for a specific role/purpose; having the powerful weapons/actions locked behind enormous tasks that are only capable of being completed as a group; giving players the freedom to just profit over others but at a high risk; having mechanisms more simple and relaxing in nature set in place for casual players whilst having systems set in place for hardcore players; and having both of these be dependent on each other and be able to be done in parallel.

2.6.4 Helldivers 2

Helldivers 2 [74] is a cooperative third-person shooter game, developed by Arrowhead Game Studios [75], released in 2024.

In this game, squads of up to 4 players land on various alien planets in their galaxy that are controlled by different enemy factions comprised of giant insects and cyborgs and eradicate them. They do so by utilizing various weapons with different damage properties along with a plethora of customizable equipment, like grenade consumables and "stratagems," powerful abilities that can be called in from orbit by inputting specific input sequences. In order to succeed at their mission, players need to cooperate to effectively fight back against waves of enemy hordes while also fulfilling various objectives that spawn around their landing area. Once all objectives are fulfilled, you have to survive until evacuation, which concludes the current play session. Squads can then upgrade their gear on their spaceship, which serves as a player hub, and then choose to start a new mission on the same planet or a different one entirely. The aspect of cooperation is additionally reinforced by the fact that the game has unnegotiable friendly fire activated, meaning that players need to always pay attention to their squad members at all times in order to prevent them from dying form their own projectiles and explosions, requiring additional team

coordination.

While most gameplay aspects of Helldivers 2 are not pertinent to what we are trying to achieve in this thesis, one aspect that is immensely relevant to us is the way this game creates community engagement. While the actual gameplay of Helldivers is contained within a player squad of a maximum of 4 members where moment-to-moment cooperation emerges, community engagement is created through a community-wide collective war effort that is tracked inside the game's menus or through third-party websites [76]. To put simply, every planet in the galaxy with missions is associated with a percentage that represents the scale of control that a specific enemy faction has over it. Each time a player group successfully finishes a mission on a certain planet, the percentage decreases by a specified amount, meaning that if a sufficient number of squads do missions on that planet, it is possible to fully eradicate a threat from said planet. This causes the planet to be saved from the current threat, either causing a different faction to newly attack the freed planet, changing the types of enemies and missions players can encounter, or for the planet to cease to be a contested location of the galactic war. In some cases, motivated by community wide in-game objectives, when all planets in a specific galactic sector are freed from the influence of war, different sectors with new planets were attacked, adding new content (e.g., biomes, enemies) to the game through completely diegetic means motivated by the collective in-game efforts of the community as a whole.

In practice, this system of diegetic community engagement through in-game player activities proved to be immensely successful [77]. It gives each player the feeling that they make an impact on something bigger than themselves when playing, that their actions have consequences that influence the community and the game itself. According to Alice Jovanée from Polygon [77], creating this sentiment of contribution inside players can have a profound psychological impact, which equates to deep engagement in the game's community. Players have to not only cooperate within their squad but also coordinate efforts as a community, leading to a truly unique and unprecedented experience that took the gaming world by storm in 2024, still thriving to this day.

We believe that there is a lot to learn from Helldivers 2 and how it manages to capture the attention of individual players through community engagement and how it masterfully weaves into the game's systems in an organic way that is not intrusive while fitting the game's themes and narrative perfectly. Even though our game prototype cannot realistically simulate or try to test similar levels of engagement, we find it imperative to incorporate systems akin to the ones found in Helldivers 2 that are tailor-made to give community-wide goals and an overarching mission to players, in order to ideally give them a sense of belonging to something bigger than themselves, no matter the size of their group.

2.6.5 Minecraft

Minecraft [51] is a sandbox survival game developed and published by Mojang Studios [78], originally released in 2009.

In this game, players explore a procedurally generated voxel-based world. Players gather raw materials by destroying blocks and objects in the environment, which they can use to craft various tools in order to acquire even rarer materials. While exploring, players need to survive by managing their hunger and health by finding food sources and fending off enemies that spawn in the world, especially at night. A hallmark feature of Minecraft is that the game lets players be endlessly creative by allowing them to build structures to their liking with their accumulated gathered blocks, ranging from necessary shelters to survive the night to complex structures utilizing rudimentary electronics and railway systems. The game itself has no set objectives, other than surviving, which means players can do whatever they want to in the sandbox environment the game provides them with. Minecraft also supports multiplayer, allowing any number of players to explore and survive together by cooperating. It is this specific type of cooperation that is relevant to our research.

Since players are not given any specific goals or roles when cooperating in the sandbox environment of Minecraft, it is up to the player group to decide on how to effectively divide the task necessary to achieve their collective goal that they themselves have agreed upon. This creates an organic role distribution where players decide what their role in the group is based on personal preference, previous experience, or imminent necessity, for example. In Minecraft specifically, some common roles that manifest in groups are players that explore and discover cave systems to gather rare materials to advance their whole team's tool quality, players that build and organize structures and shelters for the group, players that gather building materials to be used by the construction players, and players that create and manage farms to grow crops and breed animals to sustain the group's food supply, just to name a few.

Some groups prefer to optimize their shelters and build visually pleasing structures as much as possible, while on the other side of the spectrum, there are groups that want to explore the world as much as they can by being nomadic, while crafting the best possible equipment in order to take on the game's hardest challenges, such as dragons. The necessity for certain roles therefore varies depending on the groups tendencies, while also staying fluid at all times since the current goals are ever changing and are decided by the players themselves and not the game. For example, when a group runs out of a certain resource, a player that designate themselves to be in charge acquiring it as soon as possible, while others concentrate on expanding their camp in the meantime.

According to our research and goals with our prototype, our main takeaway from sandbox survival games such as Minecraft is that giving players the freedom to explore and experience the game's environment on their own terms without giving them any required goals motivates them to find their own meaning in their actions and gives them the agency they need to form cooperative role structures by themselves. We

also think that the survival genre is an effective vehicle for the game concepts we are planning to research and implement. Based on the immense popularity and beloved status of games such as Minecraft, it can be easily assumed that survival games have the tendency to effectively create engagement and possess wide demographic appeal across all ages and player groups.

2.6.6 Overcooked

Overcooked [79] is a cooking co-op simulation game, developed by Ghost Town Games [80], that was released in 2016.

In Overcooked, players control various chefs in busy kitchens filled with hazards; they must balance this chaotic environment with the borderline overwhelming amount of dish requests that come from customers. To succeed in this game, players must be capable of organizing themselves under time pressure in the co-op mode; this leads to divisions of tasks that are not necessarily imposed by the game itself but rather are found to be the most optimal way to clear the levels by the players. This type of player behavior, as well as the mechanics the game provides to empower it, is what we will be focusing on for this thesis analysis.

What we find most interesting about the cooperation Overcooked offers is that all tasks that players can assign themselves to are by nature mechanically dependent on each other and demand set amounts of time. This means that players need to cooperate on a different elevated level, where they need to sequence their tasks optimally between each other in a time-sensitive manner, requiring additional administrative management of different tasks. For example, if a pizza is requested by a customer, players need to cut tomatoes and cheese and knead the dough separately, put it on a plate, and then bake it before serving. If players were to divide the work based on meals, it would take too long because of the amount of steps required for each meal and the quantity of meals required at all times. In order to optimize their cooperative work and succeed, they need to identify which tasks can be parallelized, such as cutting the tomatoes and cheese, and do it at the same time, ideally while another pizza is baking, etc.

The main concept that we can take away from this game is that when players are under time pressure, creating different tasks that are directly reliant on each other creates an engaging and intense cooperative experience. The optimization of such tasks and managing their ordering invites players to create managerial positions in addition to gameplay roles inherent to in-game actions, in turn making role hierarchies within player groups more complex. Based on these findings, we intend to incorporate a timed overarching goal in our game concept where players are inherently required to parallelize various tasks and divide roles accordingly to succeed.

3

Methodology

3.1 Wicked Problem

Wicked problems are composed of 10 characteristics listed in [81]. Our research question poses to contain various wicked problems due to the multiple intertwined factors that make it seem impossible to solve as well as the context of the knowledge that is unknown at the start. Only when we begin working on the thesis will these issues become more apparent, which will complicate our path to find a perfect solution.

In order to tackle this design issue, we will need to decompose our question into more digestible and researchable topics. This approach allows us to understand each and every associated factor involved in the research question, analyze it, understand its dependencies, and understand the theory behind it.

Each time a wicked problem is encountered in our research journey, we will make use of the mentioned segmented strategy to make it easier for us to find solutions for these issues.

3.2 Workflow Methodology

The workflow of our research will dictate the how we organize ourselves during development and the amount of progress we will be able to achieve withing the time frame that we have for the thesis, it is therefore pivotal that we chose a workflow that best suits our needs and gives us the best results.

One potential workflow we are planning on using is Agile [82]. The reason for this choice is due to the benefits that Agile can provide to the project. Agile is a flexible methodology, allowing for changes and alterations in the project. Changes are bound to happen as the research progresses, so our workflow must be capable of handling and integrating these changes. For that matter, Agile provides an iterative process, meaning that we will be able to rework and improve our previous finds as more data becomes available.

Agile focuses on dividing the bigger project into smaller tasks, which each of us can take, allowing us to collaborate in parallel. These tasks are usually done in set periods of time, more commonly known as sprints; each sprint will have a goal that we must complete by its end. During sprints we will also take advantage of another characteristic of Agile, vertical slicing, so instead of working on a feature out of time, we will be working on many at the same time that will be iterated over time as sprints get completed.

Within Agile, there is a more specialized methodology that is worth looking into for this research, Scrum [83]. Scrum is a more structured approach to Agile with distinct roles: the project owner, the developer, and the Scrum master. By taking different roles each sprint, we get a better grasp of the project as we are capable of viewing it from multiple angles.

In Scrum we can also work in sprints, with each sprint having a set of user stories [84] that we must complete instead of a more general goal set by ourselves. Furthermore, we could also make use of a Scrum board [85], in which we divide tasks into three categories: development, testing, and evaluation. Each task would need to clear these three stages before being considered as completed, ensuring that the testing is fully operational by the time it is considered as completed. Finally, we would also be conducting user testing, so creating multiple prototypes over the different iterations of the projects and testing them with users to try to understand what the project lacks or what needs to be changed.

All in all, it will be beneficial to us in the long run to adopt one of these workflows, as it will make us more structured, organized, and efficient.

3.3 Ideation Methods

To help us get a concrete idea of what we should research and explore in this thesis, we will be making use of ideation methods. Below we list the methods that are going to be explored as well as a brief description of each one. The process of choosing these methods came from past experience with them, personal taste, and what we thought would produce the best results for the specific topic we are researching.

Ideation is the very first step in our thesis journey, so we wanted to make sure that the methods chosen would yield results that would lay a sturdy foundation for the rest of the research.

3.3.1 Brainstorming

Brainstorming is an important step towards finding solutions for the wicked problem. We plan on conducting multiple brainstorming sessions, and the objective of each one is to produce as many ideas as possible for a possible solution within the time constraint of the meeting.

Within each session, we will make use of different brainstorming approaches to explore different angles that might produce more or fewer ideas. Such methods could be sketching and Six Thinking Hats [86]. When sketching, we will be utilizing a whiteboard or a paper and draw any ideas that come to mind; this is a great way to visualize the concept and make it easier for the other group member to understand it as well. Six Thinking Hats is a method in which we will write ideas on paper, and place them on six different hats, each representing different perspectives to consider of the idea, this can help us get a better understanding of the scope of the project as well as help us narrow down our approach.

3.3.2 Company Meetings

Due to our close partnership with **FunRock & Prey Studios**, meeting with them periodically will be a crucial method of elicitation for the thesis. During these meetings we will discuss ideas from both sides, try to understand everyone's perspectives, and find the right solutions. The thesis aims to be useful in the academic field but also for **FunRock & Prey studios**; therefore, their output holds significant influence in terms of concepts that we will explore.

3.3.3 Mind Map

Mind mapping [87] is a tool that will help us organize and visualize ideas during the ideation phase, as well as their interconnections and dependencies. Our process of mind mapping will consist of: defining a core concept, branching out from it, so scouting the depth and breadth of the core concept, and finally highlight the themes that we deem of highest value to research.

This technique provides a comprehensible visual aid to analyze different ideas, identify connections, organize them, and discover clever solutions.

3.3.4 SWOT Analysis

SWOT analysis [88] is a method we will use to map the strengths, weaknesses, opportunities, and threats of our thesis. This will allow us to have a broader look at the project as a whole and identify potential problems or benefits with the ideas we have in mind right from the beginning.

3.3.5 Game Research

Our thesis, although novel, is based on other concepts that exist and have been implemented. In order to get a grasp of how others implementations of these concepts worked, we will research games that make use of the concepts.

The goal with this is to understand what the games that succeed using our research concepts did well, understand what the games that fail did wrong, understand what sort of mechanics and systems were in place to make use of such concepts, and help us understand what is capable of being tested within the limitations that we have.

We will try to understand, for each game, if what made it succeed/fail is something that we can test for ourselves or not, so, for example, if its success/failure came from specific mechanics or systems that could be feasible to implement, we could try it in our prototype. In contrast, if the reason for success/failure came from a sociological phenomenon or an external factor that we can't replicate or control, then we will know to stay away from it.

To aid us with this research, we will be making use of techniques such as formal analysis of gameplay and studying games from the viewpoint of information [89].

The idea with this game research is to help us narrow down and truly understand what will be testable and worth researching in our prototype phase.

3.4 Prototyping

This section presents the methods we are employing for the development of our prototype. The objective was to effectively and swiftly evaluate key game design decisions that prove the validity of our game concept and collect input for additional improvement. In order to gather as much data from user feedback, we opted for a rapid iterative prototyping strategy with strategically prioritized requirements that would allow us to playtest as soon as possible with the possibility for further refinement based on feedback.

3.4.1 Rapid Prototyping

Rapid prototyping is founded on the concept of iterative development, where developers create scaled-down prototypes of applications to test and validate concepts instead of committing resources to develop fully-fledged products [90]. Instead of trying to incorporate every feature imaginable, prototypes need to concentrate on the essential features of the application while being flexible enough to refine and improve the initial design based on user feedback. By developing prototypes early in the development process, development teams can save time and resources by spotting possible failures before the become problems.

3.4.2 MoSCoW Prioritization

The MoSCoW method is a requirement technique used to rank software features according to their relevance to the project as well as to the stakeholders involved [91]. This approach will be utilized in conjunction with rapid prototyping to make sure that the prototype's key components are prioritized while also taking into account possible improvements that, if time permits, may be made. The MoSCoW method divides requirements into following 4 categories:

1. **Must Have**: The project wouldn't achieve its goals if these elements weren't included. These requirements are non-negotiable and have to be included.

2. **Could Have**: Crucial but not essential high-priority items. If at all feasible, these features should be implemented since they greatly advance the project's goals.

3. **Should Have**: Desirable but non-essential requirements. Although adding them would improve the final work, if time or resources are limited, they are typically left out.

4. **Won't Have**: Features that are deemed potentially pertinent to the project but have been specifically left out of the present development cycle because of a number of limitations.

Since our project consists of implementing a prototype instead of creating a valid commercial game, our MoSCoW prioritization specification will reflect only the most essential elements instead of concentrating on polish and quality of life features. In other words, all must-haves will be based around proving researched concepts and experimenting with them while implementing the simplest supporting game systems as possible.

3.5 Evaluation Methods

This section presents a list of the evaluation methods used to objectively determine the quality of our game prototype. This thesis seeks to determine the advantages, shortcomings, and possible future developments of our prototype as well as the design choices it was based upon. We chose methods that assess the prototype's player experience and its overall effectiveness in achieving its intended design goals described in previous chapters.

3.5.1 User Playtesting

Since our research revolves around the emergent behavior created by game mechanics in players and the engagement created by them, it is imperative for playtesting to be part of our prototyping process. By gathering the impression data from our prototype playtesters, we can gain actionable insight and feedback on how we can improve our game concept and alleviate its shortcomings.

3.5.2 Participant Selection Criteria

For the evaluation of our prototype, our plan is to maximize the number of possible simultaneous playtesters while also selecting participants that differ as much as realistically possible in these following criteria:

1. **Gaming Casualness**: Players that are either casual or hardcore gamers and everything in between to see how engaging the game concept is to different gamer demographics.

2. **Experience within the genre**: Players who have experienced a similar game before to see if they tend to gravitate towards leadership roles and if experience is a factor for role decisions in this context.

3. **Familiarity within the group**: Individuals that have varying levels of familiarity between each other to gauge how effective the game mechanics are at causing the players to organically cooperate.

3.5.3 Playtesting Procedure

Each prototype playtesting testing sessions will be carefully planned and carried out in this manner:

1. **Preparation**: In this step, we will prepare a thorough plan for the session, which includes choosing which and how many participants will be grouped together as a team and formulating a list of questions to be asked after the experience while also creating a structured form to be sent to the participants.

2. **Testing**: Testing will be conducted in a controlled environment where playtesters are given an explanation of the game's controls in addition to an overarching goal they need to achieve as a team to succeed in the play test. The session will have a predefined time limit that will be transparently communicated to the testers.

3. **Feedback Collection**: Feedback will be collected by observing and writing down the behavior of individual players and the team as a whole, by asking premeditated questions after the experience, as well as by the form of the data gathered from a digital questionnaire sent to each participant.

3.5.4 Surveys

In addition to gathering feedback from our testers during play test sessions, we want them to also fill out forms to describe their experience after the session. Since our plan is to create a scalable multiplayer game prototype, we want as many possible simultaneous playtesters in each session, meaning that spending time with each of them personally and equally to gather worthwhile data after the fact is realistically impossible. In order to properly examine feedback from all of our playtesters, we have opted to provide them with an additional form that asks them relevant questions for our research.

3.6 Possible Software

We explored several software options for various elements of the project. The listings below provide brief descriptions of each program under consideration. Firstly, in order to communicate effectively between us and our supervisor, as well as with the representatives at **FunRock & Prey Studios**, we need to consider several

communication software tools. Secondly, we need to examine available options of productivity software tools that allow us to formally write down our research findings, organize and prioritize our tasks, and conduct surveys. Thirdly, we have a necessity of sharing digital files and keeping track of versions of our prototype codebase, thus requiring the use of file-sharing program along with various version control solutions. Moreover, since we are designing and implementing video game prototypes, dedicated game development software tools are also paramount to our work. Last but not least, we plan on creating art assets for our prototypes, therefore necessitating computer graphics program tools, individually specialized in 3D model creation, vector graphics editing, 2D pixel art, and rasterized drawing.

Choosing the right software depends on personal tastes and the benefits it offers. These examples vary in discipline they are specialized in as well as the complexity and user-friendliness of their features. While we may not end up using every single software tool listed below, we have considered all of them equally.

3.6.1 Communication

- **Discord** [92] is a free software that allows users to communicate by texts, audio, or video. It is based around a customized server structure, and it is commonly used for casual interactions with friends, for gaming community hubs, and for discussing hobbies.

- **Slack** [93] is a program commonly used in the professional work environment. However, calls are only possible between two individual users, and messages are deleted after 90 days on the free plan.

- **Zoom** [94] is an application that enables virtual meetings with audio and video support commonly used in the learning and work sectors. Text messages can be sent during meetings, but they are automatically saved after their conclusion.

- **Microsoft Teams** [95] is a team collaboration application offering workspace chat and video conferencing. It also offers file storage options and is commonly used in professional and educational environment

3.6.2 Productivity Tools

- **Overleaf** [96] is an online collaborative writing editor for LaTeX and rich text. It provides a streamlined way to write, edit, and publish scientific papers with proper formatting while supporting multiple users writing at once.

- **Google Forms** [97] is a survey administration tool that allows users to easily create digital questionnaires. It is an effective solution to effectively gather opinions and feedback data from respondents.

- **Trello** [98] is a web-based, Kanban-style, list-making program where users can categorize tasks and transparently assign them to group members. It

allows groups to clearly see the status of project tasks at all times and makes collaboration easier.

- **draw.io** [99] is a cross-platform program for drawing graphs. Diagrams, including flowcharts, wireframes, UML diagrams, organizational charts, and network diagrams, can be made using its interface.

- **Microsoft 365** [100] is a line of cloud-based services, collaboration tools, and productivity software. Some of the most relevant tools include Word, a word processing program; Excel, a spreadsheet editor; and PowerPoint, a slideshow presentation software.

3.6.3 File Sharing and Version Control

- **Google Drive** [101] is software a solution for cloud-based storage that lets users save, retrieve, and edit files online in real time. Then, using links or direct invites, several people can share the folders or specific documents. If necessary, access can also be limited to reading, leaving comments, or making suggestions.

- **Github** [102] is a website and cloud-based service making use of the Git tool that assists developers with tracking and controlling code changes, as well as storing and managing various versions of their code. In addition to code version control, it also offers various collaborative productive tools like agile Kanban boards as well as development tools like continuous integration and continuous delivery/deployment support.

- **Unity Cloud** [103] is a collection of cloud-based tools and services that simplify game production and collaboration for teams utilizing the Unity engine. It helps creators create, test, and release their games more quickly by offering cloud storage, version control, asset management, and live services.

3.6.4 Game Development Engines

- **Unity** [104] is a game engine and development platform for creating video games, animations, virtual reality, and augmented reality content. It uses the C# programming language and boasts a vast library of guides and tutorials. It is, for the most part, free to use, unless published games start making more revenue than certain thresholds. It is suitable for 3D as well as 2D game development.

- **Godot** [105] is a free, open-source game engine for making 2D and 3D games and applications. Game makers that use the Godot engine are granted complete ownership of their creations under the permissive MIT license, which has no restrictions or royalties. Although supporting the creation of 3D games, it is recommended to use it mostly for 2D development. It uses its own scripting language called GDScript.

- **Unreal Engine 5** [106] is a game engine that focuses mostly on high-fidelity 3D game development. Numerous well-known games have been made with it, and it may also be used for other media like movies and simulations. Users can use it for free; they only have to pay after the product has earned a particular amount. It uses C++ and is considered the hardest popular game engine to learn because of the complexity of its features.

- **Unreal Engine For Fortnite** [107] is a game engine created from the Unreal Engine developed with the goal of content creation within Fortnite [108]. An in-depth description of this engine can be found in section 5.2.1.1.

3.6.5 Asset Creation

- **Blender** [109] is a completely free 3D modeling program with animation capabilities with a plethora of tools, expandable with user-created plugins. It is used for creating animated films, visual effects, and art, as well as 3D models for video games.

- **Fusion 360** [110] is a CAD software used for 3D modeling, collaboration, simulation, and documentation. It has the ability to control production operations like turning, milling, machining, and additive manufacturing as well as PCB design. Although not usually used in the creation of game assets, because of our previous experiences with it, we consider it a valid and fast option for the effective creation of mechanical assets.

- **Aseprite** [111] is a dedicated 2D pixel animation application that enables the use of layers, drawing tools, and more animation capabilities. It is capable of effectively exporting animation sprite sheets for use in game engine applications.

- **Photoshop** [112] is a program for creating, designing, and altering images. The program offers a wide range of image editing tools for raster and pixel-based graphics that also support vector graphics. It is well-liked among graphic designers because of its wide array of features and tools that facilitate the rapid and effective creation of expert designs.

- **Affinity Designer 2** [113] is primarily vector graphics design software that also supports pixel and texture-based retouching in the same user interface. This program is used by designers, illustrators, game developers, and other professionals to produce digital illustrations, concept art, original graphics, logos, brand designs, and more.

- **Figma** [114] is an online tool for collaborative interface design and 2D application prototyping. It allows numerous members to share and edit its files in real time while storing them online.

- **Microsoft Paint** [115] is a considerably basic graphical program that comes

with all Windows operating system versions. It can be used to quickly illustrate ideas, particularly during meetings.

4

Planning

4.1 Initial Planning

4.1.1 Visual planning tools

In this section, we include visual tools that will help us plan and structure our work over the duration of time we have to complete the master's thesis.

4.1.1.1 Gantt Chart

The Gantt Chart [116] shown in Figure 4.1 describes how we plan to work on the different sections of the thesis over time. Each section takes a certain amount of sprints, and each sprint represents one week.

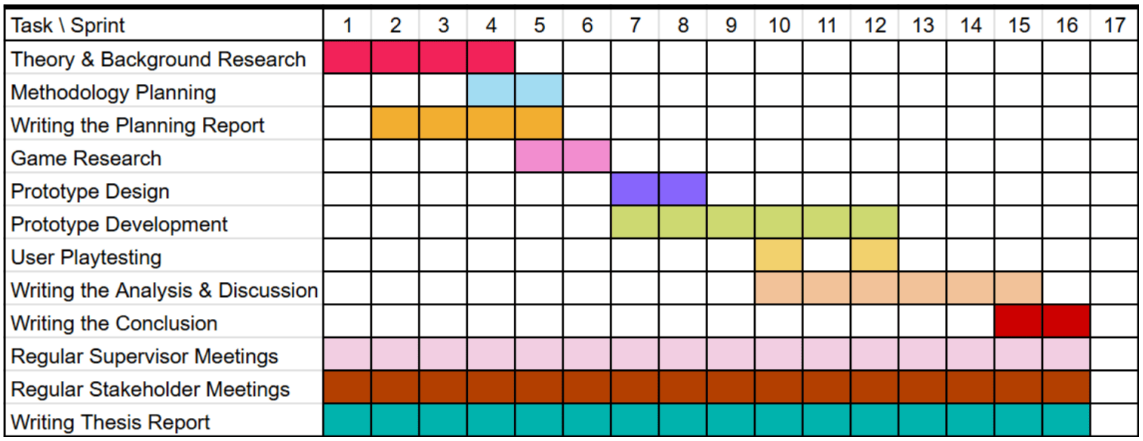

Figure 4.1: Gantt Chart

4.1.1.2 Sprints

Below, in Figure 4.2, we include a table based on the information from the Gantt Chart, with concrete dates for sprints and more detail of the work we will do in each sprint.

Sprint	Date	Detail
1	20/01/2025	Starting the Planning Report
2	27/01/2025	Background
3	03/02/2025	Literature Review
4	10/02/2025	Literature Review \ Methodology
5	17/02/2025	Completing Planning Report \ Start of Game Research
6	24/02/2025	Game Research
7	03/03/2025	Prototype Design \ Start of Prototype Development
8	10/03/2025	Prototype Design \ Prototype Development
9	17/03/2025	Prototype Development
10	24/03/2025	Prototype Development \ First Playtesting Session \ Writing the Analysis
11	31/03/2025	Prototype Development \ Writing the Analysis
12	07/04/2025	End of Prototype Development \ Second Playtesting Session \ Writing the Analysis
13	14/04/2025	Writing the Analysis \ Writing Discussion
14	21/04/2025	Writing Discussion
15	28/04/2025	End of Analysis & Discussion \ Writing the Conclusion
16	05/05/2025	Finalizing the Thesis
17	12/05/2025	Buffer Week \ Improvements

Figure 4.2: Sprint Table

4.1.2 Iterative Writing Approach

We are committed to writing the thesis alongside the research and prototyping that we will do. This will allow us to iterate on the different sections as we integrate different features into our prototype or research into different topics, refining the sections.

The goal is to have continuous development of the thesis paper and so, achieving a naturally polished final paper by the end without having to rewrite a lot of the text in the final weeks.

4.1.3 Adaptability to changes

As mentioned in the Methodology section, we are planning on incorporating Agile into our workflow. This allows us to be able to adapt to change more efficiently, as regular meetings with stakeholders, supervisors and feedback from playtesting will all be reflected and integrated in our paper and prototype.

4.2 Final Planning

The planning system used for the development of the prototype and thesis paper was mostly on par with what was described in the previous section; we used Trello and Discord to distribute tasks; UEFN [107] as our main engine 5.2.1.2; the UEFN built-in version control to share prototype progress; draw.io to create the flowcharts; Microsoft Paint and Photoshop to create design illustrations; and Overleaf to write

the thesis paper. Because we wanted to create a prototype capable of testing all the design concepts we theorized, we ended up taking a bit longer than planned, and so the final schedule for the entire development changed. This final schedule plan can be seen below in Figure 4.3.

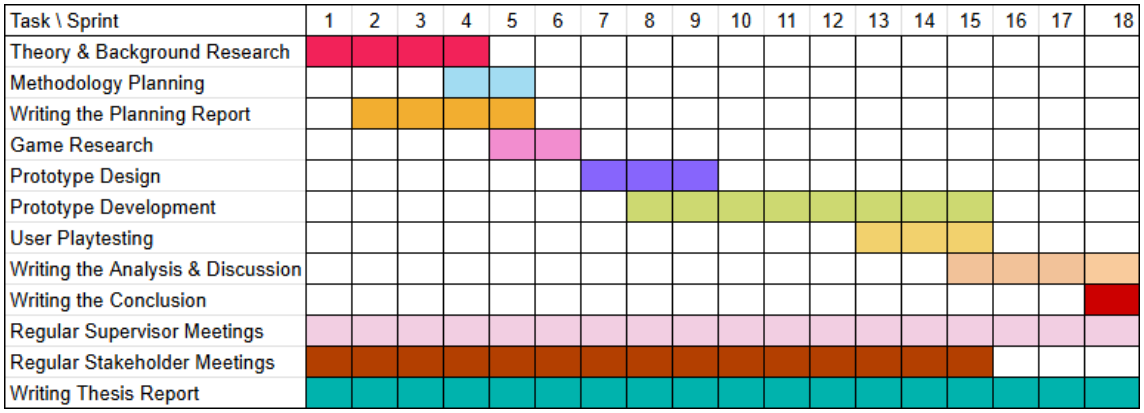

Figure 4.3: Final Gantt Chart

5

Process

5.1 Phase 1: Design

5.1.1 Core Design Decisions

Before designing any concrete systems or mechanics for our prototype, it was crucial to decide on the core identity and genre of the game we were trying to create. This choice would affect players' expectations of the game before they played, the variety of actions they could do while playing, and how well the game could prove the concepts we studied. In order to think of appropriate and effective design decisions for our game concept, we have used ideation methods such as brainstorming and mind mapping, as described in section 3.3.

Based on our design discussions with **FunRock & Prey Studios**, we have defined 4 distinct core design goals that our game concept should try to fulfill to successfully create the desired player experience and behavior. As researched in the **Theory** section of this thesis, these included the game creating engagement through a sense of community, the game requiring deep cooperation between players leading to the creation of role hierarchies, the game being a sandbox giving players the agency to create their own goals, and finally, the game being appealing to the widest demographic of players possible.

The challenge here was to combine these concepts and try to maximize each of them in our prototype's design while also being aware of the time limitations we faced when developing our prototype. Since our prototype had to be massively multiplayer and online to facilitate heavy cooperation among a large number of players, we recognized that delivering a working prototype on time would also pose a technical challenge just in terms of the necessary systems what would support such gameplay, further reducing the game's scope and limiting our ability to implement deep mechanics.

Firstly, in terms of community engagement, it was clear from the beginning that making a prototype that would simulate the feeling of being part of a large community of players and contributing to its success through in-game actions would be virtually impossible. In an ideal scenario for a product-level game that implements the concepts researched in our thesis, pre-existing communities of players, such as followers of

game streamers, would be able to create sessions and play as a single group, utilizing their existing social ties to better organize themselves and compete with other similar communities.

Since we knew that our prototype couldn't possibly create a community around it during the playtesting period, that we could realistically only playtest with groups of a maximum of 10 people at a time, and that we had no access to large pre-existing communities, we knew that this macro player behavior couldn't be researched during this thesis. However, due to these clear limitations, we decided to focus entirely on maximizing cooperation among the players by implementing game mechanics that would require them to communicate and organize themselves as much as possible to enhance their chances of winning the game. By doing so, we hoped to observe a sense of satisfaction in players from contributing to their smaller player groups while knowing that they are more successful when working together, effectively creating small communities in the process.

Secondly, when it comes to player role hierarchies based around cooperation, we believed that this was the concept we could test the most effectively and learn the most from. Instead of being reliant on large player numbers, it is solely dependent on the amount of gameplay options available in the game, how interdependent these different options are, and if parallelizing them makes the overarching goal of the group easier.

Thirdly, the sandbox aspect of the prototype serves as a tool to give players agency over their own actions and also further encourage experimentation and cooperation in the group. Instead of guiding the players linearly through the game with a series of objectives, players are only given one overarching goal that motivates them to progress, and they need to figure out the rest for themselves. In terms of implementing a sandbox in our prototype, it is straightforward since it mostly requires omitting "hand-holding" quality-of-life features in favor of more obtuse game systems that force players to explore and exchange theories and ideas on how to progress.

Lastly, even if it is impossible to make a game for everyone, we wanted to make the game as accessible as possible by not demanding skill and dexterity from its players. Instead, if a player has the desire to be more involved in the game, they should be able to do so by proactively trying to advance the group towards their goal by diving deeply into the mechanics of the game. More casual players can therefore rely on them and be more passive in their trailblazing instead. So in practice, instead of relying on individual gameplay systems that make things challenging for players in terms of skill, the complexity would stem from the interconnectedness of gameplay systems and the social dynamics between players.

Because of all these design considerations, we have decided that the prototype should be a **massively multiplayer cooperative sandbox survival game**, where players need to explore the world, gather materials, and craft items in order to successfully survive. More often than not, games of this genre use a sandbox structure, while the

collective survival aspect pushes players to cooperate organically. Additionally, the multitude of activities, materials, and items needed to progress can motivate players to divide tasks and define roles for themselves depending on the needs of the group. All of these advantages made it the best candidate for a prototype to test concepts we were researching.

5.1.2 Gameplay Loop and Progression

After deciding on the game's concept and core design, we had to define the prototype's core gameplay loop and how players would progress through it. To set things into motion, we needed a thematic setting for the game that would dictate our design decisions going forward.

By studying how other sandbox survival games were designed and also getting inspired by common themes between them, we made the decision to spawn players onto a deserted island with no indication of what to do, only knowing that they need to survive an upcoming catastrophic event that will happen in a set amount of time. We felt that this setting provided the perfect sandbox environment that would allow us to implement a multitude of activities for the players to experience, to give them an organic reason to cooperate while also creating a sense of urgency that pushed them to optimally figure things out together instead of wandering into the world on their own.

Players can gather materials for crafting from various resource nodes or wildlife they encounter while exploring this island. The ability to craft items would allow them to explore further and gather rarer materials, allowing them to craft even higher-quality items, effectively creating a progression loop that organically pushes their technology forward until they advance enough to prevent the catastrophe, ensuring their survival. Once players succeed in preventing the catastrophe, their technology would reset, effectively starting from scratch. Now, a new threat would arise that needs to be taken care of, but this time around, the environment would be permanently changed from the previous extinction event, changing the progression in major ways. For example, if a meteor were to hit the planet, it could completely remove all trees from the island, thereby eliminating wood as a resource. On the other hand, the meteor could be comprised of rare metals, adding new crafting possibilities that didn't exist before.

The key difference in our design from other similar games in the genre is that we don't assign any objectives to our players. Instead, they must independently explore, discover new resources, and develop crafting recipes as a team, without the game providing guidance or assistance. Additionally, the constantly changing nature of the game after every catastrophic event would allow the game to be a continually fresh experience for players in every round, making it a viable candidate for a live service game concept that could foster a community of players around it.

We do this to encourage players to share their discoveries and empower them to take

ownership of their achievements and in-game goals. As with all aspects of the design of our prototype, we want every obstacle that players encounter while playing to push them towards cooperation and an effective division of tasks. In practice, this would mean that when a player finds a new material, they would communicate it to their group and try to find a way to use it. Likewise, if a player finds a new crafting recipe but doesn't know how to get one of its ingredients, they would ask the group if they have seen it and if they could look for it on the island.

As seen in figure 5.1 demonstrating our initial gameplay loop, there are 4 distinct gameplay activity categories that can be specialized in as a player. Each of these offers a breadth of gameplay possibilities to players that specialize in them and also gives them options to pivot within their roles easily depending on the current needs of their team. Together, these roles create an interconnected web of gameplay systems that are dependent on each other to progress. It is important to mention that none of these roles are formally defined in the game and only serve as umbrella terms used by us to divide the different gameplay activities that players can potentially specialize in while playing as a group.

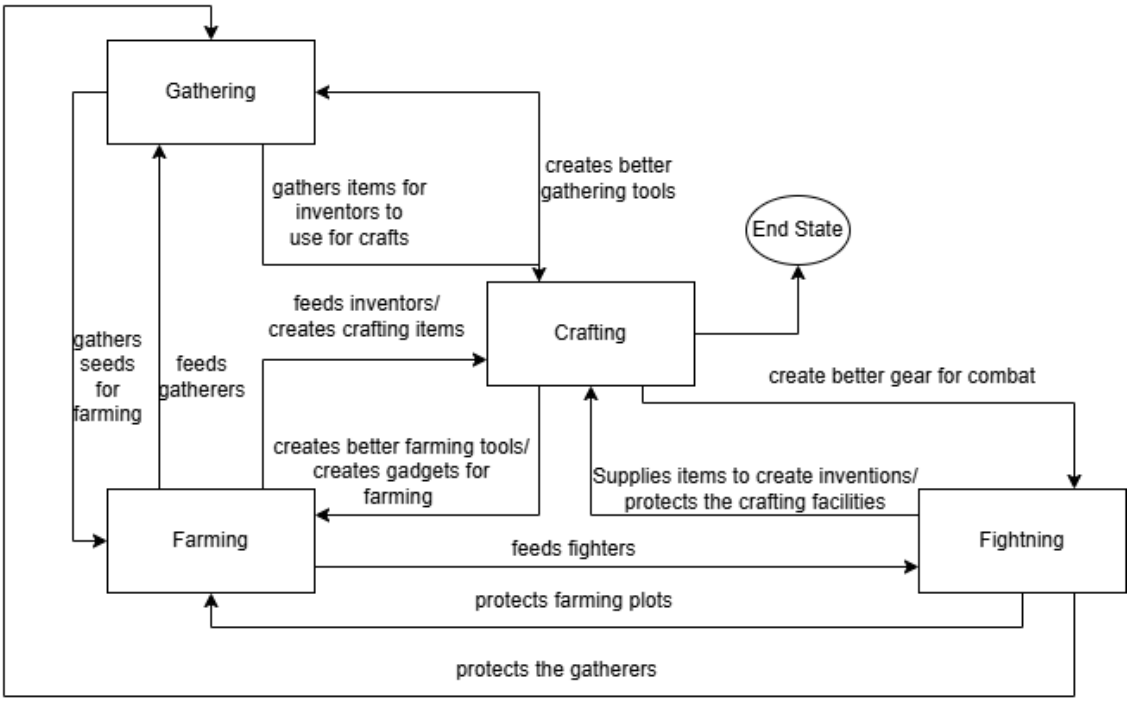

Figure 5.1: Initial Draft of the Gameplay Loop

Firstly, there are gatherers that explore the world and collect resources needed by other players. They either collect already discovered resources by venturing through specific parts of the environment that they know contain those resource nodes or explore the island further with the hopes of finding new materials. They primarily obtain resources from mining nodes in caves and from flora found on the island. They also strive to optimize their farming to gather as many materials as possible in

a single run, while being incentivized to uncover all of the island's secrets during this process. Their role depends on other players, since crafters can provide them with access to more advanced tools to gather and explore, farmers give them the food necessary to survive, and fighters defend them from hazardous wildlife found on the island.

Secondly, players can specialize in fighting, which means their role in the group is to hunt for wildlife and defeat hostile AI-controlled NPCs (non-playable characters) on the island. By hunting wildlife, they can obtain resources not available by any other means, while defeating enemies protects the group from extinction in addition to providing new materials. In an ideal version of the concept, waves of these hostile NPCs would attack the player settlements over the course of the playthrough, giving fighters an even bigger role by making them essential to the active survival of the group during these raids and differentiating them further from gatherers. At all moments of the game's progression, fighters necessitate the help of other roles: crafters give them better weapons used to fight more dangerous foes, and farmers provide them with food and consumables necessary to survive and defend the group.

Thirdly, players can also become farmers who make use of various seeds and other plantable materials found by gatherers to grow crops and supply their group with enough food and consumables to survive. Their purpose is to farm land around the player's base of operations and take care of their crops by watering them and sustaining them with organic materials. By harvesting these crops, farmers supply their team with vital consumables, such as food to alleviate hunger and healing items that enable teammates to explore more dangerous areas of the island safely. Collaboration with other players is crucial, as farmers depend on crafters to provide them with better farming tools, on gatherers to give them seeds they found in the wild, and on fighters for protection against threats to their farmlands.

Lastly, and most importantly, crafters create items using resources gathered by other players. Their role in the group is to advance the team's technology at all times, provide other players with better tools to accomplish their roles more effectively, and build the buildings and fortifications that the group uses as a base of operations. They specialize in creating buildings where they then create various crafting stations that allow them to discover new crafting recipes by experimenting with the resources found by the group. We consider this role to be the most crucial one since all aspects of progression are tied to them; they need other players to give them new resources to craft the tools that those players need to obtain even rarer materials. These newly discovered materials are then later used to craft even more powerful tools, ultimately culminating in them crafting the item needed to finish the game before the timer runs out. Because of this progression loop centered around crafting, we believe that creating items gives a structure to players that they can organize around and gives them objectives that organically and inevitably make them progress to the end state of the game.

It is important to note that all of these different gameplay activities must be self-

balancing. As shown, a group can't be effective if all members do the same things and specialize in the same roles, as every aspect of the game is interdependent and requires collaboration to progress. This concept effectively forces players to diversify their roles based on the ever-progressing needs of their team. To illustrate, if all players were crafters, they would have no resources to craft with. Likewise, all players can't be gatherers, farmers, or hunters, as they wouldn't progress in the game without using the materials they gathered, and they wouldn't be able to explore the island without better tools. This balance makes cooperation and diversification of roles the answer to all obstacles faced by players while playing.

We also believe that this organic rule distribution can efficiently work in small groups while scaling to larger player counts. The more players there are, the bigger the quantities of resources that are needed to advance the group's technology because every member needs access to new tools to stay effective, which creates a demand for more gatherers. The bigger the player settlement is, the more enemies it attracts, creating the need for more fighters. As the number of players increases, the group requires more farmers to ensure their sustenance and well-being. And of course, with an abundance of resources available to the group, a higher number of crafters will be needed to determine how to utilize these resources for further progress.

When it comes to appealing to a wide demographic of players, we want these different options of gameplay to appeal to different types of players, with the hopes that everyone can find some activity they enjoy. It is also important to us to make them not only different thematically but also diversify them in terms of complexity and responsibility in the functioning of the group so that everyone can feel a sense of contribution with varying levels of involvement. To illustrate, we theorize that farming will appeal to more casual players because of its simple, repetitive nature and lower level of complexity. On the other hand, we want to make crafting the "hardcore" part of the game because of its importance in the progression and success of the team. Since crafting dictates the group's objectives during the whole experience, we also believe that the people responsible for crafting will also take up leadership positions in the group and divide tasks among its members to optimally parallelize their tasks to win the game in time, effectively creating the cooperative role hierarchies we are researching.

5.1.3 Map Design

The map design was a crucial next step after the gameplay loop had been theorized. We were tasked with creating a map that not only accommodated all the necessary mechanics of the game but also had a cohesive theme.

We started by researching other games and how they designed terrain and environments in order to provide the best gameplay and exploration possible. Eventually we came across the Island Sanctuary game mode of Final Fantasy 14 [117]. In this contained area of the game, players have access to an island where they can cultivate crops, catch animals, and explore. The reason this stood out to us was due to how

the terrain design was tied to progression: certain portions of the island were only accessible after the player had crafted specific items. These items were linked to the overall progression of the island: to get the ingredients for the craft, the player needed to have a certain level of proficiency in farming and a similar level in the animals they had caught; this meant that every mechanic was tied to the map exploration.

Taking into consideration the principle of the Island Sanctuary design, we started to create drafts of what a potential map could look like. We agreed that having it as an island would work best, as it allowed us to create a self-contained environment that offered an organic invisible wall [118] in the form of a vast ocean. We then started brainstorming potential biomes we could have within the island in order to enhance exploration and break monotony. The biomes we ended up deciding would fit the best together were a forest, a desert, a swamp, and a mountain area. We drew this island on a whiteboard and realized it would also be interesting to have smaller islands alongside the coast that could house mini environments that would further improve the environment.

According to the game loop, we wanted to have a base where players could construct their crafting stations. Initially we had discussed the possibility of players being able to create a crafting station anywhere on the island; however, this would prove to be a challenge as multiple factors would need to be taken into consideration, such as the terrain, potential creatures being around, etc. On top of it, this didn't add anything relevant to our thesis research, and upon giving it a second thought, we realized that having every crafting station in the same place would be better for the research, as it would naturally create a place on the map where crafters needed to be and so a place for everyone to gather, trade resources, and share information.

The first draft of the island included a base in the middle of the map; this served as the starting spawn area and meant that the biomes would be around the base. We discarded the idea early on, however, because we didn't want to overwhelm players on where to go at the beginning. Furthermore, it would've been hard to balance biomes and what resources they would give out if players could just go straight into them from the starting area. Therefore, we decided on having the base at the bottom beach of the island and having the biomes become available as the players progressed north. Below is the draft we created out of this concept.

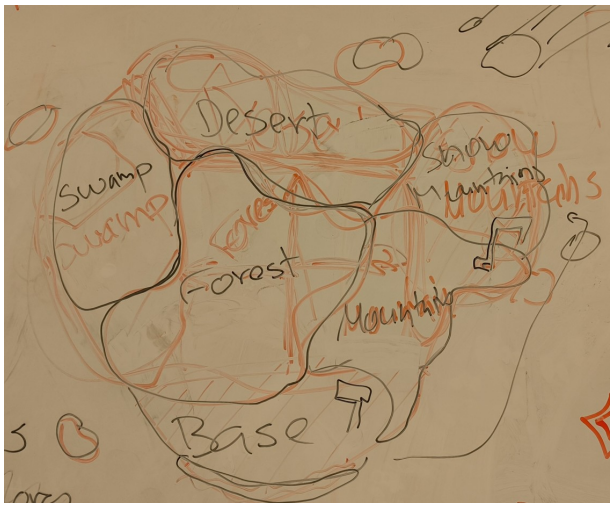

Figure 5.2: Initial Draft of the Island

There are a couple of extra things that should be pointed out from Figure 5.2. Firstly, from the base, the players would have access to two biomes from the start, the forest and the mountain. This was done purposely due to the resource design that we will explain further below. Secondly, there is an extra biome, the snowy mountain, which represents a portion of the mountain that is inaccessible from the start of the game and could only be explored if a specific item is crafted.

Tied to the biomes, there would be thematic creatures and forageable spots, both would give different types of resources to players. The resources were then divided into different categories depending on their source and type. Below, Figure 5.3, is an image of said division.

Ores	Flora	Mob Drops	Craftables	Wildlife	Invaders
Brightcore	Acorn	Animal Bones	Active Powercell	Sky Jelly	Traspasser Defector
Coal	Resin	Bacon	Batteries	Wildwasps	Traspasser Elite
Copper	Blue Mushroom	Eggs	Blast Powder	Spring Chicken	Human Bill
Diamond	Fibrous Herbs	Boar Hair	Butter	Chicken	Big Foot
Malachite	Flower Petals	Cube Monster Parts	Craved Twine	Frog	Creature
Quartz Crystal	Herb	Grub	Char-black Mineral Powder	Boar	
Obsidian	Honey	Milk	Duct Tape	Wolf	
Shadowshard Crystal	Lemon Lime	Raptor Eye	Efficient Mechanical Part	Raptor	
Rainbow Crystal	Pink Mushroom	Roasted Chicken	Fine-grain Mineral Powder	Water Sprite	
Rough Ore	Pumpkin	Shark Tooth	Gold	Air Sprite	
Silver	Red Mushroom	Stink Sac	Mechanical Parts	Earth Sprites	
Spectrolite	Wheat	Wolf Tooth	Oxidized Mineral Power		
Stone	Wood		Peaky Twine		
Sunbeam Crystal	Yellow Mushroom		Planks		
	White Mushroom		Rotating Gizmo		
	Maple Syrup		Rough Mineral Powder		
			Rusty Mechanical Parts		
			Simple Mechanical Parts		
			Simple Mineral Powder		
			Simple Twine		
			Sleek Mechanical Parts		
			Spectral Twine		
			Striny Twine		
			Sturdy Mechanical Parts		
			Sturdy Twine		
			Vindertech Mechanical Parts		

Figure 5.3: Initial Draft of the Resource Categories

There were 6 initial resource categories: the ores were mostly obtained from mining in

the mountain areas; the flora would come from foraging bushes and trees in the forest and swamp areas; the mob drops would come from enemy creatures we would spawn in different portions of the map, such as zombies and brutes; the craftables were the items that could only be obtained through crafting in the base; the wildlife would be resources dropped by different animals around the map, such as boars and wolves; and finally, the invaders would be items only obtained by specific enemies that would periodically spawn around the base and try to invade it. All the categories were used from this point on except the invaders, as we decided that having enemies constantly spawn around the base would hinder progression and would make it too much of an annoyance to always try to protect the base whilst exploring and gathering and fighting enemies in other parts of the island.

Upon having the gameplay loop theorized, an initial draft of the island and the resources and creatures it would house, we decided on advancing to the next phase of development: the prototype.

5.2 Phase 2: Prototyping

5.2.1 UEFN

5.2.1.1 What is UEFN

Unreal Engine for Fortnite, or UEFN [107] for short, is a variation of the Unreal Engine developed by Epic Games [119], specifically to be used for Fortnite [108] or within Fortnite itself.

Fortnite is one of the biggest multiplayer games ever created, both in terms of player base and in terms of content. The game constantly introduces new patches and expansions that introduce or remove mechanics to keep the content always fresh and relevant. For the purpose of expanding the game even further, Epic Games wished to increase the Fortnite ecosystem based on the success Roblox [120] had with their business model.

This model worked around allowing players to create their own games using tools Roblox would provide to them, which they could then publish within the game and earn money based on the number of players playing their game. This system made Roblox extremely popular, as the game had numerous different experiences it could provide from the endless content its users were creating. Fortnite set out to do something similar, and for that purpose UEFN was created.

UEFN takes as its base the Unreal Engine, an established and powerful game engine used by many game studios, and alters it to fit its new purpose better. In order to appeal to a wider demographic and people who aren't familiar with making games, some changes were made to the Unreal Engine in its UEFN form to make it more beginner-friendly; for example, coding was simplified in the shape of a new, easier-to-understand language called Verse.

The key Unreal Engine tools were left in UEFN, but some features were either removed, as they were not needed for the scope of creating a game within Fortnite, or are missing as the development of UEFN is still ongoing. Most importantly, however, are the new additions specific to Fortnite. Due to the engine being built for the game, most of the Fortnite assets are found in UEFN by default. These assets are not only aesthetic but mechanical as well. UEFN has both models, foliage, etc., used in Fortnite, but also the devices that the game features. These devices are the key to developing within the Engine, as they include by default a large variety of features that, when used appropriately, can make an entire game without needing to write a single line of code. These features vary from a character controller to a creature spawner with a multitude of potential creatures with different behaviors to choose from, to terrain generation and editing, and even to mechanics such as teleportation or giving out items to players.

When taking into account the mentioned capabilities of UEFN, it becomes easier to understand why it is such a powerful tool, but perhaps one feature that hasn't been mentioned yet but whose importance to us will become clear in section 5.2.1.2 is the fact that everything made in UEFN is inherently multiplayer and just works in that setting, so there's barely any need to work directly with networking, as that system is already in place.

5.2.1.2 Why UEFN

UEFN, as described in section 5.2.1.1, is a powerful tool to develop games. For the purpose of this research, we decided to choose it for a few reasons that shall be listed here.

Firstly, and perhaps the most important reason, was the fact that UEFN doesn't require networking programming to work online. Everything in the engine is designed to be multiplayer by default, which was a major advantage for us. The prototype we decided to create would involve multiplayer playtests that should be able to host a large number of people. Creating a prototype capable of such a feat in a conventional engine is no simple task. We both have previously worked with networking and so were aware of the necessary time that it could take to get the system to work properly. Furthermore, every new mechanic added would add a new layer of work related to getting said mechanic to work in multiplayer. Upon considering it, we decided that approach was unfeasible; the multiplayer system was not a topic of our research, and it would take away precious time from our time window for prototyping. Faced with time constraints, we agreed that UEFN would allow us to delve deeper into the prototype, as we wouldn't need to worry about the online aspects and so would save time.

Secondly, the more we researched, the more we understood just how helpful UEFN would be for prototyping. As mentioned in section 5.2.1.1, by default, UEFN has access to a variety of devices and built-in mechanics that would allow us to build a prototype quickly. These engine systems have a diversity of customization options, such as being able to tweak the player controller to increase a player's speed or start

with an item or even customize the aim system for any weapon said player holds. Aside from the devices, UEFN also has many Unreal Engine features that would make prototyping faster, such as terrain tools to sculpt and paint a landscape as well as fill it with foliage. What's more, UEFN also had many Fortnite assets, meaning we wouldn't need to look for extra assets and would be able to have aesthetic consistency on the prototype. Finally, on this topic, we discovered that, because the UEFN assets are already part of Fortnite, if we stuck to only using them, the game wouldn't be too big in file size. The reason for this is that UEFN has a way to optimize space for the Fortnite assets, meaning we were capable of creating an environment full of detail without having to worry about going over the limit on file size.

Thirdly, in terms of managing work on the prototype, UEFN has version control built-in. This meant that we wouldn't need to use third-party software like GitHub [102] to push changes in the project to each other. Being built-in also meant that the version control was tailored to work with the engine and its file types. The UEFN version control allowed us to work simultaneously and seamlessly in the same project without having to worry about losing progress or merge conflicts, leading to a smoother development cycle.

Moreover, UEFN had yet another big pro going for it, which is also related to playtesting. Normally for playtesting we are accustomed to creating a build exe file and sharing it with playtesters; this can be cumbersome, however. A large game means a large EXE file, which not only makes it harder to transfer to other people but also reduces the number of potential playtesters, as not everyone has enough free space on their machines for such a file. Furthermore, people tend to be skeptical of such files, and in the case of our project, we were planning on testing it with a group of people that might not be familiar with us; therefore, trusting us to upload an EXE file on their machines and running it would pose a challenge. Luckily, UEFN makes things much simpler in those regards, because games created in it can be directly published to Fortnite. This meant that we were able to publish it in an easier manner, meant that we would not need to share any files as the only requirement was for people to have Fortnite installed, and finally, being a very popular and established game, people trust Fortnite, meaning we wouldn't have to worry about that as well.

Finally, another reason to use UEFN came from our curiosity in wanting to explore the engine and the Unreal capabilities, as well as wanting to learn and become proficient in a new but emerging engine that is regularly growing and getting support and documentation.

5.2.2 Tool Experimentation

Upon reaching the decision to choose UEFN as our engine of choice, we began researching the documentation available and experimenting with different things within the engine. In this section we will highlight some of the experimentation we did in the early prototype phase.

We began by looking into how to create systems that gave players custom resources. If we could achieve this then we would be able to create custom nodes around the world that would give players different types of items. Our research here covered both official documentation and YouTube tutorials.

Initially we wanted to figure out the basics of UEFN, so we created a very simple level where a player would spawn in a custom environment made by us. This environment was made using a UEFN tool called Cube Grid that was perfect for prototyping, as it allowed us to create basic geometry very precisely, meaning we could design and quickly construct a level out of it, as well as discard it and start a new one. This level also contained enemy spawners; these spawners allowed us to choose which Fortnite NPC to instantiate within them as well as other parameters like how many of them would spawn, the frequency of them respawning, their health, their aim, amonst other things. The NPCs themselves also allowed for custom behavior; we could change how aggressive they were against the player, how quickly they could detect and forget about the player, and so forth. The player would then spawn in the map with a weapon and progress through while destroying enemies. The player controller was also modified to fit our needs; for example, when aiming, the player would walk/run slower. Furthermore, we had different cameras set up within the level; these varied from top-down cameras to side-view cameras and even three-quarter-view cameras. The goal was to experiment with these systems and see how much liberty they allowed for creation. Finally, this level also features moving platforms the player has to jump across, respawn points, and an end state. Below is a picture of the level.

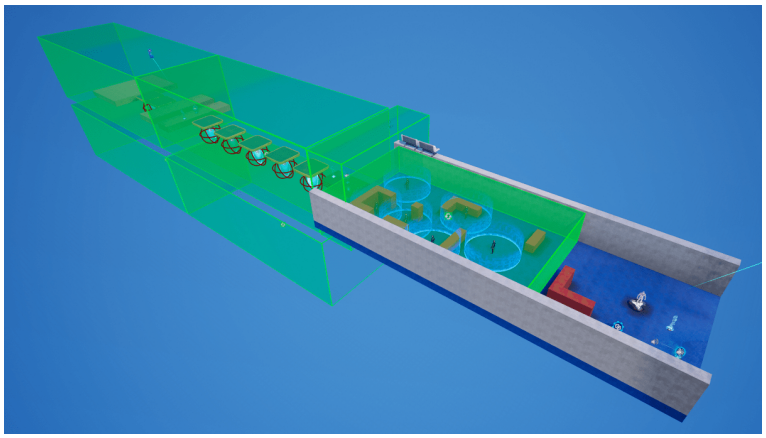

Figure 5.4: Custom level created to experiment UEFN systems

Subsequent to understanding the UEFN fundamentals with the previous level, we began to think about how to create the specific mechanics for our prototype. We started by creating Verse code that would be attached to a Fortnite prop; when this prop would be hit by a specific player, it would increase the count of a resource in their inventory. This system was rudimentary, as it essentially consisted of increasing a value. Attached to this system, however, was a custom UI built fully in Verse as well. This UI would take PNGs that represented the resource and place them next to

a number on the player's screen. This number would then increase depending on the code value for hitting the props. The UI resources were attached to players, meaning that they didn't share resources and couldn't trade them between each other as well. The resources could decrease as well, meaning that we also created a code mechanic for spending the money. Upon reaching a certain threshold, players could purchase a new node to mine for resources; these new nodes could give different resources or could give automatic resources per second without players needing to hit them. When all nodes in the map were bought, the game would finish. This system did what we wanted, but it was too convoluted and limiting. The Verse code wasn't as flexible as we would've liked it to be, and the fact that both resources and nodes were tied to individual players wasn't usable as well, due to the game being co-op in nature; therefore, this concept of doing the systems was discarded for the one we'll talk about next. Below is a picture of the initial resource experimentation level.

Figure 5.5: Resource experimentation level with custom UI

Alongside the experimentations we were conducting in the previous paragraph, we were also researching the built-in Fortnite devices that UEFN had. Three devices that piqued our interest were the item granter, the conditional button, and the skilled interaction device. The conditional button was a device that, when connected to a Fortnite prop using a prop manipulator, allowed us to choose up to three resources as well as specific amounts for each and display them in-game to players. If players had the right resources and amounts in their inventory, the conditional button would turn from red to green and allow players to interact with it. The item granter, as the name suggests, would grant an item to a player based on a condition. Using both of these devices together, we could create a system where the players would need to collect specific resources to interact with the conditional button, and upon succeeding, the item granter would be listening in and would give the players an item of our choosing. This system would be hooked up to a Fortnite prop asset that, when given a prop manipulator, would allow connecting everything to it, functionally creating a prop in the game that served as a buying station that could be easily customizable. To enhance the experience, we could hook up a skilled interaction device to the mix. What this allowed us to do was, upon getting the resources, the

player wouldn't immediately be granted an item but rather would first need to do a mini-game where they needed to succeed to get the item. These mini-games were easily customizable as well; for example, we could create it so that it was a circle where players had to time a rotating dial to stop on a correct zone. The zone system here could also be personalized, as we could give players different things depending on the zone they landed in, meaning it didn't necessarily have to be a success/fail minigame. Finally, to give players custom resources based on nodes, all we needed to do was attach a prop manipulator to a node and specify what items to give players on hit. This system proved to be much simpler and faster to create, as well as allowing for a variety of customization, leading to us deciding on using it for the prototype.

Finally, in regard to engine experimentation, we also took a look at the different island presets UEFN has to offer and the difference between them. Some islands had different sizes, came with caves and tunnels built in, some with different biomes, etc. Ultimately, however, we didn't find the right fit for us, so we decided on creating an island from scratch ourselves to perfectly work around our mechanics and research topics.

5.2.3 Technical Foundations

5.2.3.1 Mechanics and Features

After experimenting with all the UEFN tools available to us, we started to have a concrete idea of the limitations of the engine and therefore how to implement our game concept realistically into a playable prototype capable of testing and proving concepts we were researching. For the successful implementation of our prototype, we needed to find ways to implement the following features:

- Scalable real-time multiplayer for large quantities of concurrent players
- Third-person controller for character movement
- Melee weapons for the gathering of materials
- Ranged weapons with accurate aiming for fighting off enemies and hunting wildlife
- Spawning of AI-controlled non-playable character as wildlife and hostile enemies
- Inventory system for organizing gathered materials
- Resource nodes that give custom resources when hit
- Crafting stations used to create new items
- Buildable structures that serve as a base of operation for players

- Craftable items that can be either used as survival tools or for further crafting
- Explodable obstacles that block exploration until requirements are met
- Buildable traversal gadgets that make further exploration possible
- Custom map allowing communication through pings
- Doomsday clock that causes players to lose after set amount of time

Our informed choice of UEFN as our engine of choice ensured the provision of features such as multiplayer, character movement, weapons, and NPC behavior. As mentioned in previous sections, using Unreal for Fortnite allowed us to concentrate only on creating custom mechanics that were relevant to our research instead of wasting time on foundational back-end features that weren't pertinent to us. However, the inability to easily customize already implemented features presents a drawback. In our prototype, this limitation meant that we could not create custom weapons or tools for players to use, nor could we change the damage and health values of enemies or change the default melee weapon players start with, just to name a few examples. Like all other gameplay mechanics, we needed to adapt our game to this rigidity in customization rather than trying to implement features that conflict with the engine. We felt that this restriction was a worthwhile exchange for hassle-free multiplayer that supports up to 100 players.

Figure 5.6: Wildlife Spawner Device

Figure 5.7: Creature Spawner Device

Figure 5.8: Prop Manipulator Device

Wildlife and creature spawner devices handle the spawning of AI-controlled non-playable characters as wildlife and hostile enemies, respectively. Wildlife spawners (5.6) allow us to spawn different types of wildlife into areas of the map while customizing their parameters. We have the ability to choose the type of animal it spawns (such as boars, wolves, and raptors, for example, each with different behavior towards the player), the spawn rate, and the amount, allowing us to give thematic flavor to each biome and adjust the difficulty of exploring them based on the wildlife hostility present. One unique aspect of wildlife is that they can be made tamable and even ridable if we choose to, effectively making them pseudo vehicles, giving

players more organic mobility options that they can discover on their own. On the other hand, creature spawners (5.7) spawn only aggressive monsters with varying levels of difficulty. As opposed to wildlife spawners, these are visible and destroyable by the players, and we use these to make parts of the map more or less challenging to explore. With the help of the elimination manager device, we can make each of these spawnable NPCs drop different materials, giving players that hunt for resources their purpose.

When it comes to an inventory system, Fortnite already has a very simplistic one that we deemed usable for our purposes, especially considering that making our own UI was out of the question for us simply because of the amount of custom Verse code required to make it work. Using the original Fortnite UI allowed us to use official resource items present in the UEFN libraries since they were compatible by default. These items all have dedicated unique icons and 3D models and are capable of being traded by simply throwing them on the ground through the menu and picking them up, which saved an immense amount of development time. Additionally, these items are also compatible with every device in the engine, allowing us to use as many existing devices instead of coding custom ones for every feature involving items.

For resource nodes, we opted to use prop manipulators that are capable of changing the properties of props that are in contact with them. The prop manipulator device (5.8) can overwrite all default settings associated with props such as mineral veins and trees and allow us to customize what resource they drop when hit by a melee weapon, how much of this material they contain, how long it takes to restock, and also if the prop has health and therefore can be destroyed. Such an approach gave us the freedom to choose thematically appropriate props for all resources in the game and balance the resource economy effectively on a per-prop basis. The disadvantage of this granularity is that if one wants to change the amount of resource given by a node over the course of a game based on achieved milestones, one needs to individually modify every single node on the island at runtime, which is highly inefficient. Additionally, with the inability to give better gathering tools to players over the course of the game, it was challenging to organically make the gathering of resources faster over the course of a playthrough in the prototype.

Figure 5.9: Conditional Button Device

Figure 5.10: Customized Conditional Button

Figure 5.11: Item Granter Device

For the purpose of all crafting mechanics in the game, we found that the conditional button device served our needs perfectly. The dedicated Fortnite resource items work with it perfectly, and as discussed in section 5.2.2, the conditional button device (5.9) can be customized to require up to 3 different items in variable quantities from the player to be activated (5.10), consuming the required items in the process. By connecting the activation signal from this button to various other devices, it can simulate crafting as well as any action that requires the possession of certain resources, such as building structures. If the signal connects to an item granter device (5.11), we can grant specific items to players depending on the recipe shown. This recipe cannot be changed during playtime without complex custom device scripting, making it necessary for every crafting recipe to have their own associated prop with its respective button and granter device. Thankfully, the button can be made invisible, making it easier to create the illusion of using "crafting benches" for specific purposes instead of pressing buttons. If the button device signal is connected to a Skilled Interaction Device first, we can use it to create skillful crafting mini-games to make crafting even more involved.

Figure 5.12: Building Device Combination

Figure 5.13: Explodable Rock Obstacle

Figure 5.14: Ascender Device

We realized pretty early on that players building structures and crafting stations wherever they wanted was impossible with the features and time we had access to. There is no current straightforward functionality in UEFN that would allow us the luxury of implementing such a custom building system, but even if there were, the undertaking of creating such a system would be immense and would also make the balancing of our island environment exponentially harder. We therefore opted to just simulate building by repurposing our crafting system and allow players to build base structures in a predefined static location, enabling us to create environmental progression around it. Instead of a conditional button with resource requirements being connected to an item granter device, it can be connected to a cinematic sequence device and a prop manipulator (5.12). Such an arrangement means that when players activate the button placed on a prop, the cinematic sequence device will play an in-engine animation of a structure rising from the ground being built. The structure was always there, but the animation moves it to the surface from underneath the map. The prop manipulator then hides the associated crafting prop, and the button disables itself, effectively simulating the one-time build of a structure

or crafting station.

Other places we planned on using this flexible combination of devices were to create explodable obstacles that block exploration of caves until players craft a specific item, as well as various buildable traversal machines that make further exploration possible. By linking a conditional button to a prop manipulator associated with a rock obstacle (5.13), we can hide the obstacle once the player crafts certain items, effectively simulating the blowing up of rocks. Similarly, we can reuse the building billboard system we devised to activate various traversal machines in the environment, such as ascender devices (5.14), that allow players to zip-line vertically and access high-up places that weren't accessible otherwise. We can use these environmental obstacle mechanics to lock off certain areas with abundant rarer resources or harder enemies to create a satisfying sense of progression for the players.

Finally, we use a plethora of UI-related devices to implement all aspects of the game that need to be visible in the player's UI. These include a custom map that shows the player's and their teammate's locations using the mini-map device, a countdown timer that tells how much time is left until the group loses using the timer device, and also hiding default Fortnite HUD features that are not relevant to our game using the HUD device. We can also use accolade devices to give achievements to players based on reached milestones, pop-up message devices to deliver messages during gameplay, and end-game devices that cause players to win or lose depending on the end state of the game, showing them the appropriate animation based on the outcome.

5.2.3.2 Environment

Creating the environment was a multi-step process that will be described both in this section and in section 5.2.6. In this one we'll focus on explaining the technical foundations of the environment. As mentioned in 5.2.2, we realized that the default UEFN islands weren't suited for our necessities, and so we needed to create an island ourselves. Fortunately for us, as we talk about in section 5.2.2, UEFN has a tool that can help us with this task, the landscape tool.

The landscape tool is a powerful system that came from Unreal Engine that allows us to create and edit terrain in various ways. To start creating terrain, we first need to decide on some initial parameters for the mesh.

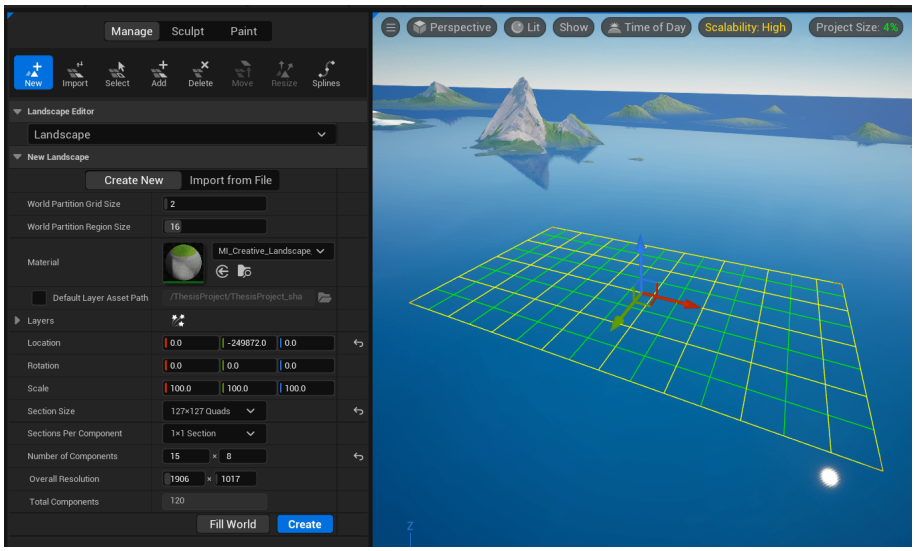

Figure 5.15: Landscape Tool Landscape Manage Menu

In Figure 5.15, the manage menu of the landscape tool can be seen, where different parameters are taken into account to initialize a terrain mesh. Let's briefly talk about the relevant settings and the decisions we made on each one. Firstly, there's a material setting, this material needs to be capable of adapting to terrain variations; otherwise, it will be applied evenly everywhere. The material selected for our project, a UEFN standard landscape material, is capable of painting grass and rock textures seamlessly depending on height difference, meaning that it knows to place rock on mountain sides but place grass on the peaks. An alternative here could've been to create a custom material and paint this ourselves, but the result wouldn't blend as well, would look less natural, and therefore would ruin the immersion of it being a real terrain. Another benefit of utilizing a UEFN default landscape material are the layer materials it comes with. To be able to paint on the terrain, layered materials contained within the original landscape material must be used. UEFN allows for these to be created from scratch, but there are some limitations; for example, in default UEFN landscape materials, the current layered materials can be edited, but it's not possible to add a new one or remove an old one. However, the default layered materials our landscape material brought were already really useful from the get-go; they included a variety of options from rocks, different grass types, and even sand.

Next up, there was the scale of the mesh. This scale is important as it impacts the smoothness of the terrain. If set too high, the quads of the mesh will be bigger, meaning more jagged, less natural-looking terrain. For that reason we decided to leave the scale on the default values but still managed to increase the size of the mesh using the next settings. The section size and section per component settings together determine the size and quantity of each quad in the mesh. By increasing them, we can get a bigger terrain but with an appropriate scale. Furthermore, we can increase or decrease the number of quads, as well as their individual size, to determine how much detail we want in the terrain. More, smaller quads will lead to

higher terrain detail; this, however, also leads to a bigger file size for the mesh, which has limits, and so we decided on values that would give us a decent level of detail without going overboard, as afterwards in development we would add other details such as foliage, which would compensate in detail and enrich the areas. The size of this mesh was determined by comparing it with the biggest default UEFN island, as we determined, from our previous research, that to be the ideal size. Resolution also had a limit, but the default one was enough for the purposes of the terrain, so we left it untouched.

We then created this initial terrain mesh; now we had access to the different options the landscape tool had for editing it in the sculpt menu. In Figure 5.16, we can see these options.

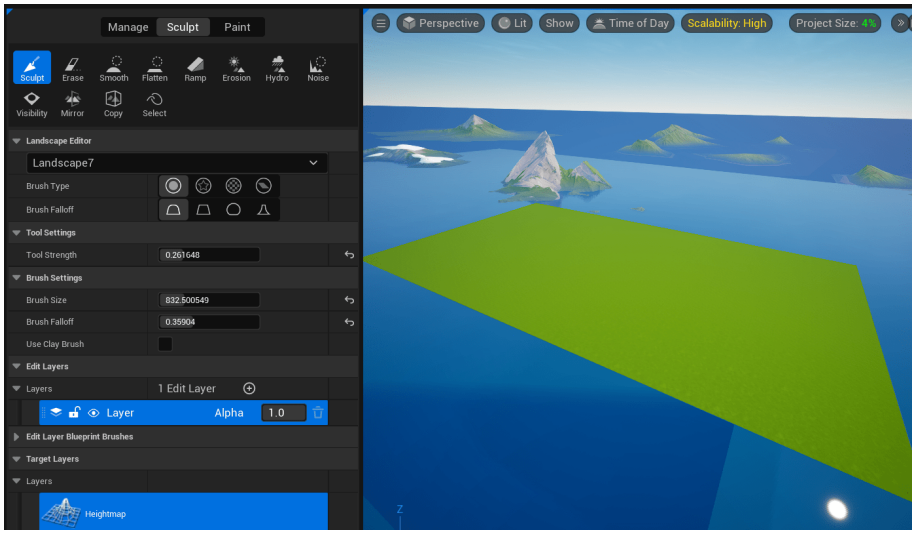

Figure 5.16: Landscape Tool Sculpt Menu

The relevant settings for our terrain seen above were:

- The sculpt tool, which allows us to raise terrain; the erase tool, which erases terrain height data;
- The smooth tool, which smooths terrain and blends layers;
- The erase tool, which erases terrain height data;
- The flatten tool, which levels an area of the terrain;
- The ramp tool, which creates a ramp between two points and then molds terrain to match it;
- The erosion tool, which simulates erosion caused by soil movement;

- The hydro tool, which simulates erosion caused by rain;
- The visibility tool, which cuts holes in the terrain mesh;

Utilizing the visibility tool, we cut portions of the mesh to create something that resembled a natural island shape. After a few tries, we got a good result and started using the sculpt tool to shape the island terrain. As mentioned in 5.1.3, the island was supposed to have multiple biomes. Looking at our initial draft drawing, we were capable of mapping where we wanted each biome to be in this terrain mesh. To help visualize this division, we made use of a third menu in the landscape tool called the paint menu, as seen below.

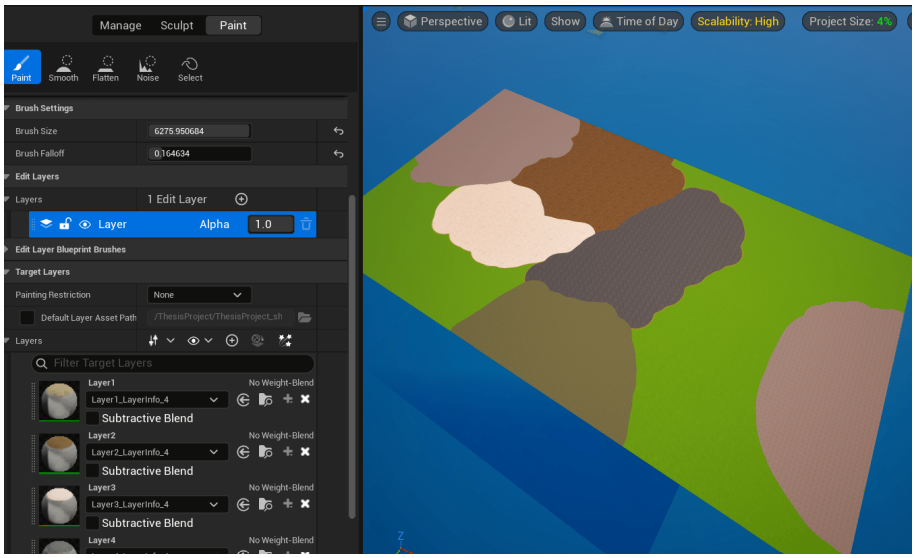

Figure 5.17: Landscape Tool Paint Menu

In this menu, we can find the layered materials we mentioned before. By selecting one of these materials, we can use it to paint the terrain as we wish. We took advantage of this; we painted the terrain areas where the biomes were to be created with appropriate materials, so, for example, where the desert was to be placed, we painted sand; where the mountains were to be created, we painted rock; and where the swamp was to be created, we painted muddy/soaked grass. This was a great visualization helper since it was quick to paint something and erase it. We utilized this to properly design the scale of each biome and place it in the appropriate location. The specific design and process that went into creating each biome will be described from section 5.2.6.6 to section 5.2.6.10.

Finally, water had to be added to the scene. UEFN has four different options available: lake, swimming pool, river, and ocean. All of these need a water volume to be added to the scene in order to work. We opted to use a swimming pool water body. There are a few reasons for this decision. Firstly, this water body didn't affect the terrain; all the other options molded the terrain around them. This was not

ideal for us, as we wanted to first create the island mesh and then add water, not the other way around, and by adding a water body other than the swimming pool after creating the terrain, it would ruin it. Secondly, the wave variations could be customized, meaning we could still achieve an ocean look while using this water body. The wave variations were important, as if we managed to get it just right where it wouldn't create too big of a wave but also would have some wave variation to sell the atmosphere, we could use the same water body as every water source in the game. This meant that, when creating the terrain, we could use it for a river, for puddles, and for the ocean. Lastly, this water body was swimmable, meaning the players in-game would be able to traverse it, allowing us to take it into consideration when designing certain portions of the island.

Upon having the technical foundations for the island terrain set in place, it was time to fully design and create it; this process is explained in section 5.2.6.

5.2.4 Design Updates for the Prototype

During the process of finding ways to implement our game concept inside UEFN, it became clear that we needed to cut down on certain aspects of the initial concept. Because of time constraints and technical limitations of the engine, it was crucial to only concentrate on the most essential gameplay aspects that we knew could be fully implemented in time, while abandoning mechanics that were not strictly required or that were unfeasible to implement with enough polish to be worth our time.

The matchmaking structure of Fortnite lobbies themselves directly constrained the structure of our prototype. Instead of players being able to join a constantly live server that changes over time, the Fortnite lobby system requires the game to adhere to a match structure, where players invite each other to a party and start the game themselves. This means the game must be designed as a single, consistent experience that doesn't change between playthroughs. This is why we chose to omit the live, ever-changing framework discussed in section 5.1.2 in favor of an "escape room" style of implementation. In simple terms, the game is now a sort of complex puzzle that groups are meant to solve together and that is meant to be replayed until the game is won, incentivizing the players to optimize and parallelize tasks so that they get further each playthrough. Once they win the game, they have fully experienced what it has to offer; the only replayable aspect is trying to get faster and more optimized wins.

For the prototype we were implementing, the final game structure and theme were as follows. The players are all part of a crew whose spaceship has crash landed on a deserted island because of technical malfunctions. Unfortunately, they are quickly made aware of the fact that after a specified amount time, a meteor will hit this island, which they can see clearly in the sky, getting closer by the minute. Now they need to work together to find a way to fix their spaceship with materials found on the island to escape in time and survive, with no instructions whatsoever on how to do so.

Figure 5.18: Meteor

Figure 5.19: Island

Figure 5.20: Rocket

In terms of gameplay, we have removed a few options from our initial design. Firstly, we have removed farming because of the amount of time needed to implement it properly and the fact that it wouldn't diversify gameplay much since we decided to make all resources in the game renewable and indestructible anyway. In combination with the fact that we couldn't make a customizable building system (all buildable structures have to be static, as discussed in section 5.2.3), a farming system would also make the player settlement too large and therefore limit other areas. The trade-off just wasn't worth it, and we believe that players who would enjoy farming can discover that same enjoyment in our gathering system, since the resource nodes present in the world renew themselves over time after being harvested, mimicking farming mechanics.

Secondly, we have scrapped the mechanic of waves of enemies periodically attacking the player settlement. The default Fortnite enemy behavior discussed in section 5.2.3 alone isn't practically usable for this application, meaning we would need to make our own AI to control enemies. Even if we developed our own AI, there wouldn't be much reason to do so because the primary purpose of enemy waves in gameplay is to threaten the structures that players have already built, creating a sense of looming danger that progress could be lost at any moment. As we previously discussed, because of technical limitations, all our structures are static, meaning they can only be built a single time and in a single location, effectively making our buildings incompatible with enemies being able to destroy them. In the prototype, players who fight creatures using weapons take on less defensive roles and resemble gatherers, as they hunt wildlife and hostile enemies to collect various resources needed by crafters. Additionally, we believed that the sense of urgency created by the meteor's presence was sufficient to push players toward their goals, not requiring us to add more systems that add more pressure, like losing progress because of enemies.

By scrapping these systems, we have made gathering and crafting the two main pillars on which the game is built, making all other gameplay features adhere to one of these categories. Each of these categories is more fleshed out and varied in terms of gameplay, allowing players to organically specialize into a multitude of roles within them. By doing so, we made the game easier to balance and more realistically implementable in the allocated time we had to create it, while remaining true to the concepts we wanted to research through the prototype.

5.2.5 Crafting System

5.2.5.1 Design

Since the crafting system is the foundational backbone of our gameplay loop and progression, we needed to formally and explicitly define it before starting to implement anything. We needed to have a clear idea of how many crafting materials we wanted to implement, what specific items we needed to give players over the course of their playthrough and therefore how many crafting recipes there should be.

By scouring the UEFN libraries, we found a large amount of existing items that could be used as crafting materials for our system. After knowing the kinds of items we had access to, we separated these items into different categories based on their possible thematic origin, giving us an idea of where to place these items in our world and how players can get access to them. As can be seen in figure 5.21, we have defined the following material categories:

- Craftable Items, only obtainable through the crafting system (blue)
- Minerals, gatherable from mining nodes and caves (yellow)
- Flora Items, gatherable from plants (green)
- Fauna Items, obtainable by hunting wildlife and defeating enemies (red)
- Consumables, items that can be consumed to gain health, shield, etc. (purple)
- Weapons, used for hunting and defeating enemies (orange)
- Environmental Puzzle Items, used to unlock exploration options (pink)

Figure 5.21: Crafting Materials per Tier

Moreover, we have also divided these items into different crafting tiers, which dictate the player's progression through the crafting system. To put it simply, when players arrive on the island, they have direct access to all tier 1 crafting materials and their associated recipes by finding the materials to build the first crafting stations near their crash site. Once they craft the final item in that tier, it will allow them to

build tier 2 crafting stations with it, allowing them to now use materials that are found deeper in the island, further from their base. This same process applies to the transitions from tier 2 to tier 3 and tier 3 to tier 4 crafting stations. In tier 4, they now have the possibility to use all the resources that can be found on the island as well as being able to access all areas of it without restriction. Once they manage to craft the final item in said Tier 4, it can then be used to fix their spaceship to successfully escape the island, effectively solving the puzzle and winning the game. We want this final item to be the culmination of the efforts of every single member of the group, meaning that it should require optimal cooperation from everyone to achieve it, considering all gameplay roles. This means that crafters must have crafted every other recipe to craft this item, and the materials used for it should be the hardest-to-get materials that gatherers can find by exploring the whole island, be it by exploring dangerous ruins or defeating the most challenging boss enemy.

The crafting tiers and their associated recipes have also been divided so that they initially teach the basics organically and then progressively introduce new crafting gimmicks to add complexity and depth over time. Each recipe is technically limited to only support up to 3 ingredient materials at once, which we had to take into account at all times, pushing us to innovate in new and different ways in each tier in the form of new gimmicks. Additionally, since the crafting is done through buttons that only show images of their material requirements, we do not show players what the required materials are called or what item they get once they craft the recipe. At first we wanted to somehow organically show this information, but then we realized we could use this limitation to our advantage. When crafters build a new crafting station, and they have no idea what these materials are, they are forced to communicate within the whole group and cooperate to find them. When gatherers discover a new resource, they have an incentive to inform their group and determine whether the crafters require it yet. On both sides of this equation, the answer is always cooperation, giving a sense of mutual discovery and agency, just like we want it to be. Similarly, having no idea what a crafting station does before using it makes the crafting role more involved and forces crafters to always report their findings to the group.

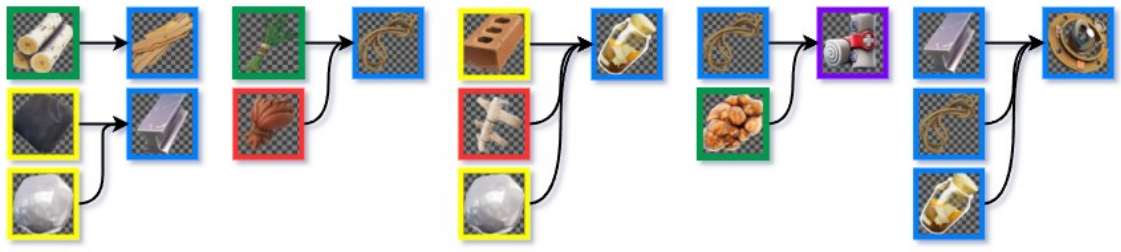

Figure 5.22: Crafting Recipes in Tier 1

In tier 1, our goal was to introduce the concept of crafting to players while not overwhelming them. As can be seen in figure 5.22, this tier is comprised of only a

few simple recipes that create the initial crafting items needed for later tiers. We want these starting recipes to be straightforward to understand and only use easily acquirable resources from the first areas. To illustrate, players can refine wood they gathered into planks and combine herbs and animal hair to create twine. We introduce an important concept here: certain materials can serve multiple purposes through various crafting paths. Here, rough ore can be smelted into metal by combining it with coal, while it can also be ground into rough mineral powder when combined with stone and animal bones using a different crafting station. It was important for us to use resources from every possible category so players are familiar with all the possible sources of materials on the island, be it plants, mineral nodes, or wildlife. Additionally, we introduce the first consumable item at this tier, bandages, which heal the player when used. By introducing this recipe early, we clarify to players that crafting not only produces materials for further crafting but also provides immediately useful tools for exploring the island more effectively. Once they find out what each craftable recipe outputs, they have the possibility to combine all of their newly crafted materials into rusty mechanical parts, which can then be used to unlock tier 2 crafting stations.

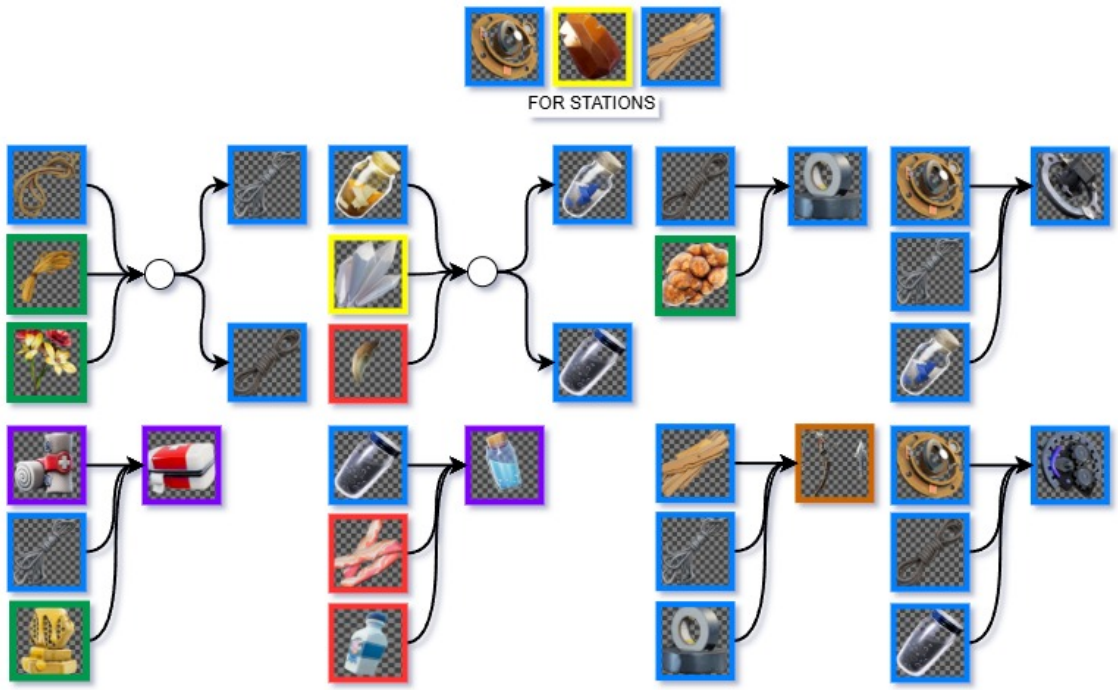

Figure 5.23: Crafting Recipes in Tier 2

In tier 2, demonstrated in figure 5.23, we aimed to elaborate on concepts established in tier 1 while also adding complexity to the system as a whole. In order for crafters to access these new recipes, they need to build crafting stations by using their newly acquired mechanical parts in combination with copper and planks. By using the twine and mineral powder from previous sections in new recipes with additional materials, players can now access their new, upgraded versions. However, a corresponding

crafting mini-game determines the evolution of these materials into two different possible paths. Depending on what players do in this mini-game, they will receive the appropriate material as a result. We believe that this adds more depth and complexity to crafting and gives further incentive to properly communicate when planning out crafting objectives. This tier also adds more types of consumables, like Med-Kits and Shield Potions; moreover, it shows that previously crafted consumables can be used in new crafting recipes, making all resources spent crafting valuable. Tier 2 also allows players to acquire their first ranged weapon, allowing individuals to dedicate themselves fully to hunting wildlife. Additionally, there are now two distinct recipes for creating new mechanical parts, each combining the previous recipe with one of the parallel crafting paths of twine and mineral powder. Crafters must pay attention to which recipe they use, as only one is needed to unlock tier 3 crafting stations, and the other has no apparent use.

Figure 5.24: Crafting Recipes in Tier 3

In tier 3, we aimed to introduce new crafting gimmicks that would challenge the conceptions created in tiers 1 and 2, as demonstrated in figure 5.24. As before, crafters can upgrade twine by combining the two previous versions of it into two new parallel ones. On the other hand, mineral has only one new upgrade path but also introduces a new crafting concept: dismantling. Now, there are crafting stations that require only a single item, which can be dismantled into one of its original components and a brand-new resource. To illustrate, fine-grain mineral powder is crafted by using simple mineral powder with malachite and shark teeth and can then be dismantled back into simple mineral powder, creating spectrolite as a by-product. This creates loops in the crafting progression tree, which theoretically require crafters to revisit earlier stages of progression to advance further. Weapon crafting also receives a new feature in this tier; crafters can create better versions of weapons if they succeed at a skill-intensive mini-game when crafting them, represented with the recursive arrows present in figures 5.24 and 5.25. Even if the crafter fails at this mini-game, the station will still output a default, non-upgraded weapon, not wasting

any resources in the process. This allows us to add some skill to crafting to make it more interesting and fun in terms of gameplay. Lastly, another addition in tier 3 is the ability to craft environmental puzzle items for the first items, allowing players to explore the island deeper by unlocking previously locked areas. To illustrate, crafters can now create blast powder that can be used by gatherers to remove rock obstacles blocking the entrance to mountain caves and tunnels.

Figure 5.25: Crafting Recipes in Tier 4

Tier 4 is the culmination of the crafting system, combining all of the previous materials and gimmicks to provide the greatest challenge that will allow players to win the game once they succeed. The most notable recipe involves crafting the final mechanical part, essential for repairing the spaceship and escaping the island. It requires the active power cell, which is the penultimate crafting material; a cube monster part, which drops from the hardest boss enemy on this island; and finally the rainbow crystal, which represents the hardest exploration challenge in the game. This crystal can be created by fusing the shadowshard and sunbeam crystals together, which can separately be found in different hidden temples on the island. The fusion of these crystals is done by an altar present in the final temple, only accessible by crafting the rotating gizmo, a tier 4 environmental puzzle item that enables the activation of an ascender device in the mountain biome. This altar is the only crafting station that is readily accessible on the island, as opposed to the ones built by players in their base. After the group obtains the final mechanical part, they can use it together with the previously useless mechanical parts available at tiers 2 and 3 to repair their spaceship and escape.

5.2.5.2 Implementation

After having the whole crafting system and progression designed, we needed to discover ways to faithfully implement it inside the game. As discussed in section 5.2.3, our basic technical framework of how to implement crafting stations was to use a combination of conditional button and item granter devices for each recipe.

Figure 5.26: T1 Forge Crafting Station

Figure 5.27: T2 Weapon Crafting Station

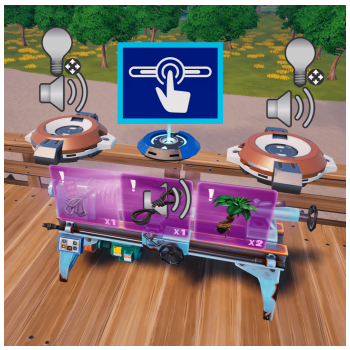

Figure 5.28: T3 Twine Crafting Station

This meant that we had to fuse a thematically appropriate prop model with these two devices to represent each recipe. To reduce the resulting number of different crafting stations on each tier, we sometimes put two of them on the same crafting machine when appropriate. To illustrate, the forge crafting station (5.26) allows players to smelt ore into metal as well as grind it down to mineral powder. On later crafting tiers, we reuse these same physical props for recipes that output the upgraded versions of the same material type so that players familiar with the system can recognize what each new machine might do easily. To help crafters differentiate between the different tiers of the same crafting station type, we associate each tier with a color that represents its rarity. Tier 1 is green for common, tier 2 is blue for rare, tier 3 is purple for epic, and finally, tier 4 is orange for legendary. As demonstrated in figures 5.26, 5.27, and 5.28, the holograms showing the station's crafting recipes are colored appropriately to their tier. Our chosen color scheme follows Fortnite's default color-coded rarity system, which makes it straightforward for players to identify the rarity of their crafted items, such as weapons. For example, a blue weapon icon, like that of the default crossbow, indicates that it was crafted in tier 3. If crafters succeed in crafting the better version of it through the associated mini-game, that crossbow will have an orange icon, instantly showing players that it has more value.

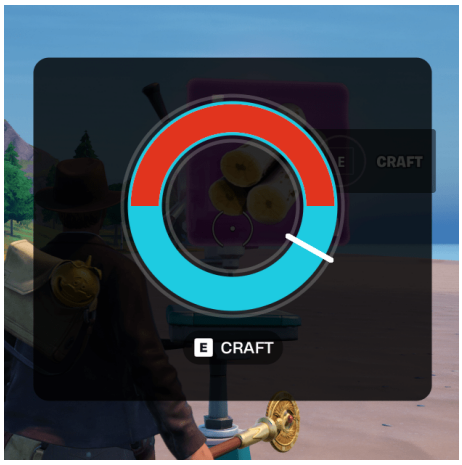

Figure 5.29: Skilled Interaction Parallel Mini-Game

Figure 5.30: Skilled Interaction Weapon Mini-Game

To implement our desired crafting mini-games to certain machines, we use the skilled interaction device, as discussed in section 5.2.3. As demonstrated in figure 5.28, if we link one conditional button to a skilled interaction device, depending on the outcome of the mini-game, we can activate only one of two different item granters, effectively changing the output of the recipe. By customizing the mini-games themselves, we can then implement the different types of mini-games discussed in the previous section. Figure 5.29 shows how parallel crafting paths, like the ones for twine and mineral powder found in tier 2 (5.23), are implemented. There is a cursor rotating around equal zones of two different colors, and depending on when the player presses the craft input, the station will output the appropriate item for the current location of that cursor. Neither of these zones is meant to signify a crafting failure; they show that the item has a main upgrade path and an alternate one, and it's up to them to find out which is which.

The other type of crafting mini-game, shown in figure 5.30, is used for crafting better versions of weapons. It is similar in concept to the previous one, but now, there is an obvious zone on the circle that demonstrates success. Players engage in this mini-game over multiple rounds. Crafters are incentivized to press the input close to the small, brightly colored section of the circle, and if they manage to do it five times in a row, they will be rewarded with a weapon of higher quality. If they fail a single time, they are given the base rarity of the weapon instead, making the mini-game unnecessary and more of a rewarding bonus. This bright section randomly jumps around the circle and grows smaller each round, requiring more skill and precision from players, especially considering that the cursor moves faster each round as well. Additionally, crafters that become skilled at this mini-game are rewarded by skipping a round if they manage to hit the bright-colored zone perfectly, making the process faster.

Figure 5.31: T2 Forge Station

Figure 5.32: T3 Forge Station

The last crafting gimmick we designed, the dismantling of crafted materials, present in figures 5.24 and 5.25, was technically simple to implement. Instead of the conditional button requiring multiple materials to activate, it only needed one in this instance, but now the item granter was giving multiple materials to the crafter as an output instead of a single one. To make this mechanic more thematically intriguing, we hid these recipes inside of machines of previous tiers, forcing players to not only conceptually go back to progress but also physically. To illustrate, when players unlock the tier 2 forge, they will notice that instead of allowing them to smelt ore like before, it only provides them a recipe to grind new mineral powders and that the other recipe present on the machine requires a single fine-grain mineral powder (5.31). This recipe is presented in a purple hologram, as opposed to the other ones found on this tier, which are all blue, and naturally, they have no idea how to obtain this mysterious material. Once they unlock the next crafting tier, where all of the recipe holograms are purple, and craft this specific mineral powder material at the new forge station 5.32, they will realize the old dismantling recipe's purpose.

In this implementation step, it was crucial to identify the right material requirements and quantities for each recipe to make the experience satisfying instead of tedious. While it is impossible to guess these balance values without playtesting, we tried to motivate our decisions for each item recipe in terms of their significance to the progression. For instance, we want weapons to feel like a luxury that not every player can have access to, so players feel special when they become designated hunters of the group, so we intended to make it expensive and therefore time-consuming to craft them. If all group members had easy access to these weapons, it would lessen their importance to players and make it harder to balance the number of enemies on the island. By applying similar reasoning to all the crafting recipes we implemented, we successfully identified logical material quantity requirements for each recipe that we were satisfied with before playtesting the prototype.

When it comes to crafting costs and quantities, we also uncover a new way to show crafters how much they have progressed throughout the playthrough while

implementing our designs. In tier 3 we introduce new recipes for smelting ore to metal and refining wood to planks, which could be previously found on tier 1. By comparing the tier 1 forge (5.26) and the tier 3 forge (5.32) smelting recipes, we can see that this new version requires more individual materials, but in exchange, it rewards players with exponentially more metal, making these recipes strict upgrades. By giving players access to more effective recipes halfway through the game, it allowed us to give crafters a more efficient way of keeping up with plank and metal demand in the later half of the experience without needing them to stand in front of the same station for long periods of time crafting the same thing over and over. We also believe that this addition provides them with a tangible sense of progression, showing them that they are becoming more skilled as crafters over the course of the game, just like when hunters get a new weapon, for example.

We quickly realized that we had a balancing issue on our hands after implementing every single recipe at each station, even with all of our optimization methods to reduce their quantity. Balancing the resource quantities would be nearly impossible if each station had its build costs, due to the sheer number of stations required at each tier. We also found that players would be overwhelmed if they were shown many building signs at the start of the game without knowing what they would get in return. But once they built a station, they would be given a new recipe with its costs, and they would again have no idea what they would be crafting. We simply felt that the feeling of mystery and discovery created by the fact that crafting stations do not show what their recipes create was enough; the crafting system didn't need more layers that would just add frustration and confusion. We realized that this framework was too granular, obtuse, and frankly annoying for players to enjoy but also for us to implement since we would need to create and debug a combination of building devices with an associated cinematic sequence for every single crafting station.

As a solution to this problem, we have decided that players will build every crafting station in a specific tier at once, instead of individually. By doing so, it allows us to only have to balance the resources needed for four different custom-built devices, one for each tier. Now, since players unlock new recipes on a per-tier basis, they immediately know everything they can experiment with at that moment in progression and can effectively delegate tasks based on all visible required resources right away. They can also use their knowledge acquired in previous tiers to try to predict what the newly discovered machines craft based on their visuals and material requirements, adding a sense of mastery and skill expression to the crafting role. Additionally, such an approach allowed us to make building the base synonymous with getting new crafting stations instead of making it two separate building systems.

Figure 5.33: Stations

Figure 5.34: Initial Base

Figure 5.35: Final Base

When players build a new base upgrade, their base physically expands, and the new part contains a new tier of crafting stations to tinker with, as seen in figure 5.33. To ensure that expanding the base is rewarding, we set steep costs for this process, making it the primary goal for players at each tier. Finding a place on the island large enough to support such an expanding base was challenging; we therefore decided to make it a wooden boardwalk that is built over the sea next to the crashed ship instead. By doing so, it allowed us to work on the base without needing to constantly change the landscape around it. Now when players land on the island, they can build their initial base, demonstrated in figure 5.34, by using wood and resin gatherable in the first biome. Once they progress through each tier of crafting, they can use the appropriate mechanical parts from that tier in combination with planks and rare ores to build the next base upgrade. Figure 5.35 shows how the player base looks after all tiers of crafting are unlocked.

5.2.6 Island Exploration

The Island Exploration section will focus on everything that went into creating the environment on top of the technical foundations already established and explained in section 5.2.3. For this purpose we'll divide this section into multiple parts, a design and an implementation part for each biome.

5.2.6.1 Mountain Biome Design

The island now had terrain, and in it there were painted areas that represented where the biomes should be created and their approximate size. The first biome that was designed was the mountains.

The mountains were an interesting area to design; the progression in them was mostly vertical. We wanted to give players the sensation of traversing an actual mountain area, so we knew we would need steep hills, rough edges, and narrow paths. We began by taking a look at how Fortnite was creating their mountains, the reason being that we were using the same landscape material as Fortnite, and so it was a good point of reference on how to create something that looked natural with the given textures. We noticed a trend of big peaks close to each other, traversable by lean, spiral paths that interconnected at certain points. This design concept was insightful to us, as it provided a clear example of how to achieve a natural and

functional terrain layout using the same material setup. We then began to look at the space on our island that we had allocated to the mountains. This space had an initial slope area for players to enter the mountain, then steeper inclines where players would then be led to the heart of the area, but also, at some point, players would need to run into a tall cliff, and on this elevated area we would construct the snowy mountains biome. Apart from what was mentioned, we thought to add caves and perhaps even a tunnel at some point during the players' journey in the mountain; this would not only add to the rocky, mine site atmosphere (as the goal of the mountains was to house the ore resources players would need to mine) but would also allow us to create smaller zones within the mountain with their own design and special resources.

Essentially we wanted to fit a lot of features in a rather small space, meaning that the design would have to be condensed. To achieve this, we started discussing the features in detail, we wrote them down to visualize them, and then started prioritizing them based on how much they contributed to the area, their purpose for game progression, and how aesthetically important they were. This process was of great help and made us understand the area better and what we wanted out of it. Upon having a prioritized list of features, we began mapping them in the island. Figure 5.36 represents that mapping.

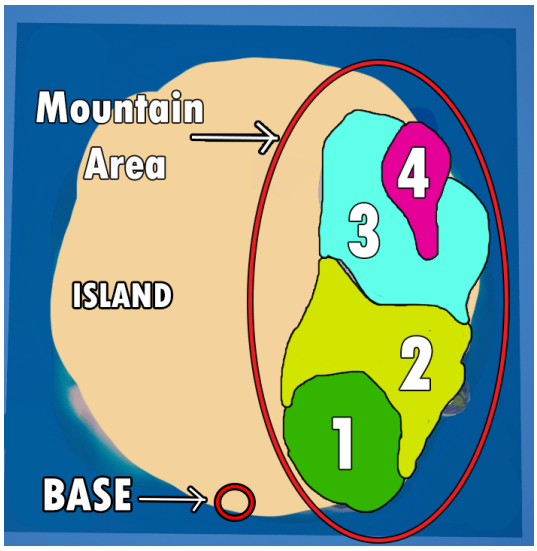

Figure 5.36: Mountain Biome Zones

As explained in section 5.1.3, we decided early on that the base players would use for crafting would be at the south beach of the island. We wanted the base to be near both the forest and the mountain, as both biomes would contain useful resources for the early progression. In Figure 5.36, we divide the mountain into four sections, each with a specific purpose in mind.

The first section, represented by a "1" in Figure 5.36, is an initial slope where players

get introduced into the biome. The slope height hides the paths and geometry of the mountain, but when players reach the top, they get a view of the general landscape of this biome. The goal with this is to intrigue players and incentivize them to explore the area.

Section two, represented by a "2" in Figure 5.36, is where most of the mountain biome exploration will be. This section features multiple mountain peaks that can be reached by following specific coiled paths. These mountain peaks are all relatively close to each other, leading to deeper ravines and giving players a sense of height for these mountains as well as narrow, tighter zones they need to cross before ascending to the peaks. In section two there is also a zone to the right, which is the eastern beach of the island. This zone is not accessible from the start of the game, and we'll talk more about it soon.

The third and fourth sections, represented by "3" and "4" in Figure 5.36, respectively, feature the biome within the mountains, the snowy mountains. This biome can only be reached via an ascender placed at the end of section two; to activate the ascender, players need to craft a specific item at the base, meaning that the snowy mountain biome is not accessible from the start of the game. In fact, it's meant to be the last biome that players can reach. This biome is divided into two sections, as is the normal mountain one, for a couple of reasons. Firstly, we wanted an area in the snowy biome where players would face strong enemies and find rare ores; this is section three. Secondly, we wanted a section on the higher point so it could be seen from anywhere on the island, with a temple; within the temple there would be a mechanic players would need to interact with to obtain an important item to finish the game. We wanted this to be visible to show players that it had high importance, meaning they would feel more compelled to climb to the top, and to add a sense of mystery and wonder into the map; this was section four.

Below there are two pictures, one of the finished geometry (the process of creating it will be explained in section 5.2.6.6) and one with the highlighted mountain paths.

Figure 5.37: Mountain Geometry

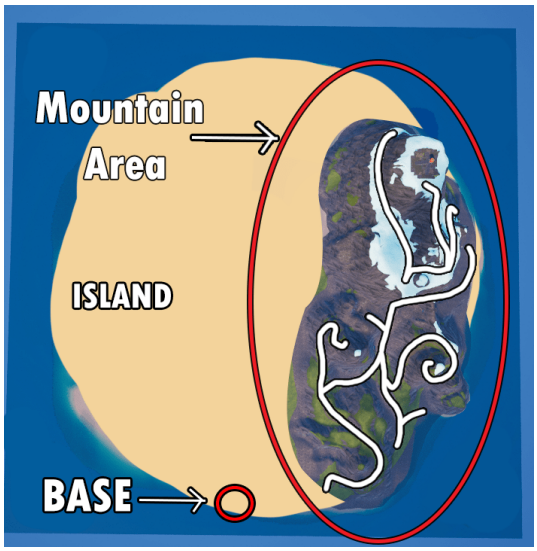

Figure 5.38: Mountain Paths

The paths seen above were designed to cover as much of terrain as possible, leading players from south to north, which was the decided progression flow for the area. The paths also separate into different possible options at certain points; some paths go up, and some continue forward, meaning players have to make decisions on where to go; some paths lead to progression, some to mountain peaks, and others lead to caves. The paths are also twirly and feature many curves as they adapt to the mountain terrain, creating organic-looking paths created by erosion over time.

As mentioned before, we wanted to add caves and a tunnel to the mountain biome. The first task to do here was to scout where to place them. To get a better idea of this, we needed to understand exactly what their purpose was. The caves were to be locked areas, only accessible by crafting a specific item, meaning they would be locked behind progression. They would house a myriad of useful and rare resources contained in a small area, meaning it would be a great place for players to quickly mine a lot of these resources. The tunnel was to partially lock a portion of the mountain, the eastern beach, behind progression, meaning players would also need a crafted item to unlock the tunnel entrance. The eastern beach was to feature rare resources (we will get into the topic of resources later in this section), some enemies, and a tough boss that would act as the guardian of a one-of-a-kind resource players needed to finish the game. Since the boss was so difficult and the resource was only needed late game, we wanted to use the tunnel to express to players that the zone was not needed for early- to mid progression and was only worth exploring later on. Having said that, we partially blocked it, meaning that if the players were ingenious and daring, they could perhaps find another way around the terrain to reach it. The reason for having the possibility of players reaching it early was to add more mystery and flavor to the exploration of the biome.

Now that we had understood the purpose of the caves and tunnels, we had to

find places to put them in the mountain biome. Below, Figure 5.39, is an image pinpointing said places.

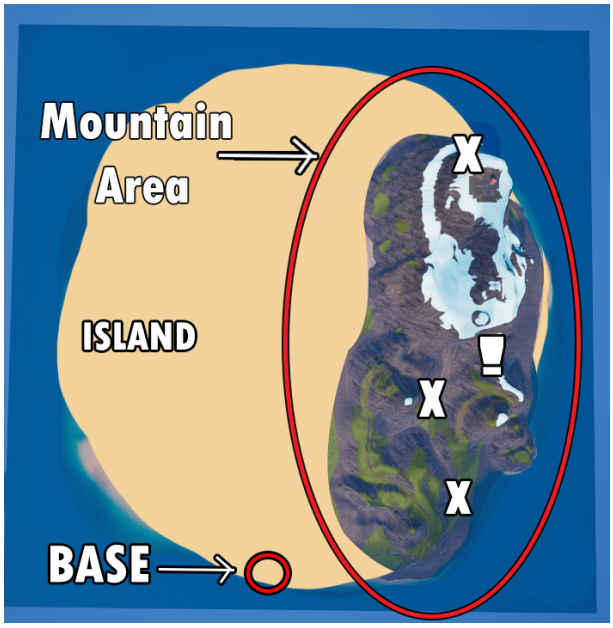

Figure 5.39: Tunnel and Cave Locations

In Figure 5.39, the caves are represented by an "X" and the tunnel by an "!". The tunnel location was relatively simple to figure out; the spot where it is connects directly to the beach, and for players to reach this beach without going through the tunnel, they either have to swim all the way around from the north or south of the island, meaning the beach is secluded enough that the tunnel seems like the only way to reach it. Above the tunnel there's a mountain ridge as well as two big cliffs on each side to prevent players from climbing over the tunnel. We decided on three caves; two would be in the normal mountain biome, and one would be in the snowy mountain. The first cave would be discovered early on, as it is relatively close to the mountain entrance, and taught the player that caves existed but were blocked. The second cave was near the ascension platform, meaning it was at the end of the normal mountain biome. Finally, the third cave would be in the mountain biome but relatively hidden, as players would need to follow a narrow path around the back of the mountain in order to reach it.

The caves each had their own design; the first one featured a small open area with a hole in the middle (represented by cave 1 in Figure 5.40). The second one had tight passageways to lead players to a back area of the game with even rarer resources (represented by cave 2 in Figure 5.40). The third cave was a big open space, filled to the brim with rare ores, representing the final frontier for ore mining and rewarding players for finding it (represented by cave 3 in Figure 5.40).

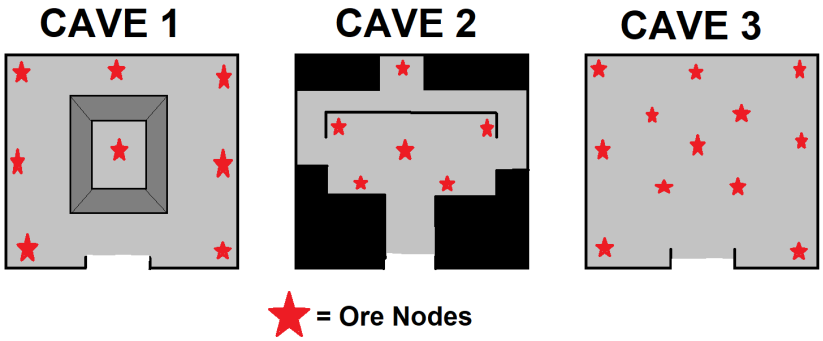

Figure 5.40: Cave Designs

Now that the layout and geometry of the mountain biome had been set in place, it was time to map the resources to each of its sections. The availability of resources is directly tied to game progression; therefore, the same had to be reflected in the mountain. We began by creating a crafting system, explained in section 5.2.5, and from there we knew what resources were needed at each tier of progression.

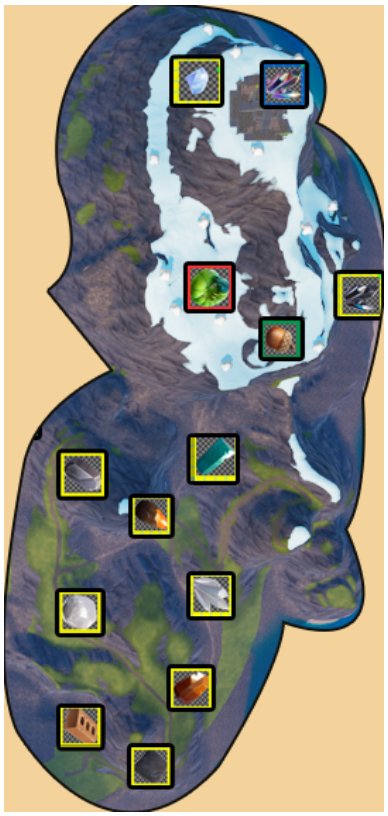

Figure 5.41: Mountain Biome Mapped Resources

As seen in Figure 5.41, the most common and important resources for the initial crafting recipes, such as rock and coal, are available from the start of the mountain

(represented by section 1 in Figure 5.36), and there are plenty of nodes for players to mine them. Rough ore can be found if players progress further down the main path and can still be found in large amounts within this area (represented by section 2 in Figure 5.36). If players go off the main path, they will be able to find a few copper nodes and the first cave. The first cave is filled with copper and brightcore nodes, two relatively rare resources. Still in this section of the mountain, if players go off the path again and explore the mountain peaks, they will be able to find plenty of quartz, some brightcore, and a few silver and malachite nodes. The malachite and silver are especially scarce, as their main node source is found elsewhere. The silver can be found in large amounts inside the second cave, alongside brightcore. The malachite can be found on the eastern beach after unlocking the tunnel entrance. In the eastern beach, players will also find a shadowshard, a one-of-a-kind resource found inside a secret temple embedded in the mountainside and strongly protected by enemies. Finally, if players venture into the snowy mountain biome, they will be able to find diamonds in the third cave as well as the device necessary to fuse the shadowshard and sunbeam in the temple.

To finalize the mountain design, we'll briefly discuss where we placed enemies and wildlife in the biome and their purpose. In the normal mountain biome there are three enemy spawners, one near the copper, one around the middle section, and one near the ascender. All of these serve as guards for specific resources or mechanics; they serve to tell the player that the resources around them are of great importance while also breaking the monotony of mining by introducing combat. In the snowy mountain there are wind sprites up in the temple, that give players a jump boost when held and snow boars, a subspecies of boars that aesthetically fit the biome. These boars drop the same as normal boars but were placed here since boar drops are relevant and needed through the game progression. This snowy section also features strong enemies that protect the diamond cave and the temple.

5.2.6.2 Swamp Biome Design

The goal with the swamp was to create "inwards progression," meaning that that goal would be around the center of the area. In search of references for a swampy environment, we came across the Satori Marsh from the game Xenoblade Chronicles [121]. This area features a muddy, dark marsh with a beautiful twist: the trees are bioluminescent. This feature contrasts really well with the other dark plants and the constant nighttime atmosphere in the marsh. We decided to try and create a similar aesthetic for our swamp.

The swamp, such as the other biomes, already had a pre-established zone in the island that was determined in the technical foundation stage. The zone wasn't all that big, so the swamp would have to be dense, but this was for a few design purposes. Firstly, we wanted the swamp to act as a hidden area within the forest, meaning that it wasn't an area to be explored in the initial stages of the game. Secondly, we wanted to hide the interior of the swamp. The idea here, based on the Xenoblade inspiration, is that we would surround the exterior of the swamp with dark trees with long roots (a section represented by "1" in Figure 5.42), as well as bushes, and the

interiors would be filled with colorful, bright trees to create the fantasy and peculiar atmosphere we were going with (a section represented by "2" in Figure 5.42). By creating it as a dense biome, we could have a natural barrier of trees that hid its mysteries.

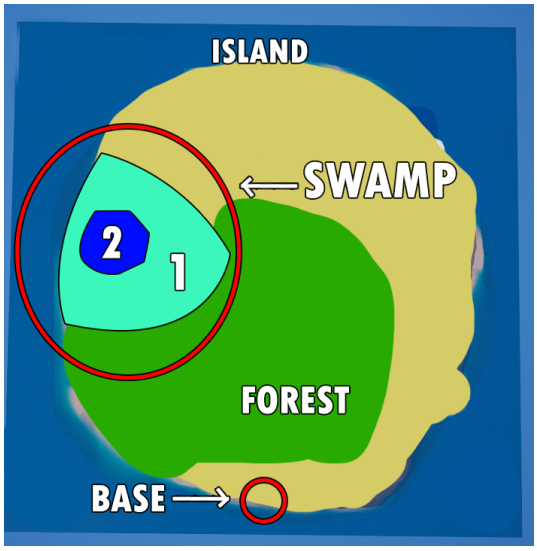

Figure 5.42: Swamp Biome Zones

The swamp now had two main sections set in place, but to help sell the idea of it being a bog, we altered the terrain to create small puddles everywhere in the swamp as seen in Figure 5.43; we also added a small island in the area supposed to be the center, where a temple would be. The swamp terrain with puddles and the final swamp look can be seen in Figure 5.44.

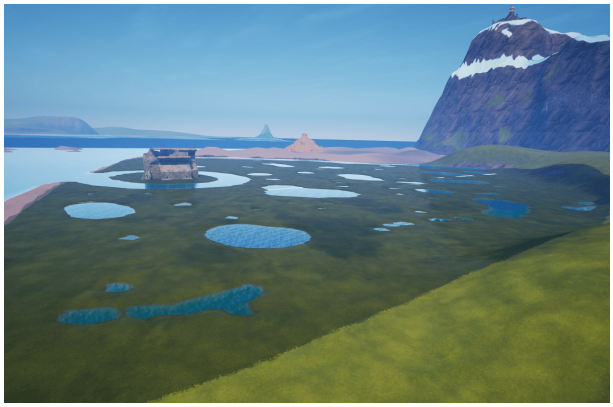

Figure 5.43: Swamp Terrain

Figure 5.44: Swamp Geometry

To further sell the atmosphere, we thought it would be interesting if we added a post-process volume to the swamp. This would mean that, upon entering the swamp, the area would darken, and, if we added a light source to the inner trees, we could achieve our desired aesthetic. On top of this, we also added volumetric fog to finalize the look. Unfortunately, we ultimately decided to remove both the post-processing and the fog for the final version; the reasoning for this will be explained in section 5.2.6.7.

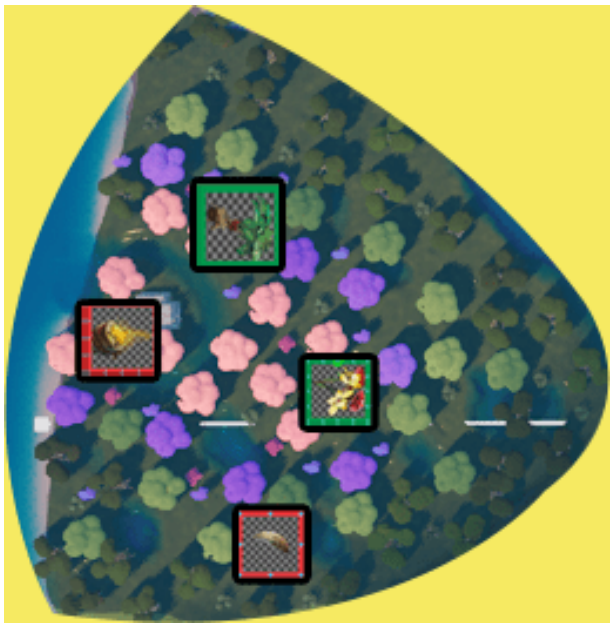

Figure 5.45: Swamp Biome Mapped Resources

Next up was the mapping of resources in the swamp. As seen in Figure 5.45, we decided to have one resource type in the center and the others around it. Firstly, there were the flowers. The flowers were important for mid- to late-game progression. They could be found all over the swamp and even in its outskirts. Secondly, there were fibrous herbs. These were placed mostly in the inner area of the swamp. They were also necessary for mid- to late progression but were of higher rarity, therefore being more scarce. Then there were two resources, wolf tooth and grub, one dropped by wildlife and another by an enemy creature.

The wildlife found within the swamp consisted of two categories: functional and aesthetic. The functional wildlife were the wolves; they served a purpose for progression as they dropped wolf teeth necessary for crafting but also served a purpose as a means of transport, as, if players were stealthy, they could jump on top of a wolf, which would tame it. Upon taming a wolf, players would be able to ride it, effectively increasing their speed; this, however, was not infinite, as the wolves had a stamina bar that had to be recharged when depleted by letting the wolf rest. The aesthetic wildlife didn't have a purpose for game mechanics but was rather there to enhance the environment and sell the atmosphere. These were comprised of frogs that could be hunted by the wolves and magical jellyfish that would float around in the area.

Finally, in the swamp, there was one enemy type. These enemies only spawned within the temple in the inner area of the swamp and would drop grubs (necessary resources for crafting) when killed.

5.2.6.3 Forest Biome Design

The forest biome was designed to be an early game zone that adds direct connections to all the other biomes; therefore, it was placed in the island center. Players start their adventure at the base in the southern beach; the very first biome they see is the forest just north of the beach. The forest progression in the forest goes from south to north. We wanted a somewhat dense forest with an abundance of resources that was also a low-difficulty environment as a means of introducing players to foraging and hunting wildlife. Initially we set up to create a classic green environment but later on divided it into two portions, the normal forest and the maple forest. The goal with the division was to introduce variety to the biome, avoiding the potential aesthetic and mechanical monotony it could have.

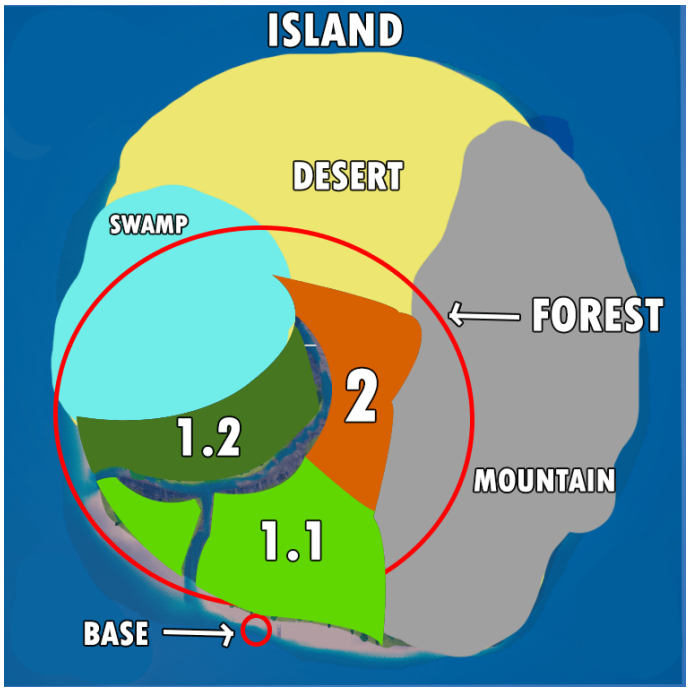

Figure 5.46: Forest Biome Zones

The normal forest is represented by "1.1" and "1.2" in Figure 5.46, and the maple forest by "2." The reason for the normal forest to be separated into two subsections has to do with the terrain design we did in that area. We wanted the swamp and desert biomes to be hidden from players' sight until they were very near them. In order to do this, we first started by just adding a lot of trees in the forest in hopes that they would cloak the other biomes. Unfortunately, the terrain was too flat, and so, even with the trees, players were able to spot the other biomes from afar. To solve this, we made two major changes. The first one was to create a river that separated the forest, where one part of the forest would connect to the desert and the other to the swamp. This separation allowed us to introduce more environmental diversity to the island in the form of a swimmable river but also segment the forest in order to perform the second change. The other major change made consisted of terrain elevations, both near the desert, at the northern point of section "2" in Figure 5.46, and around the swamp, so section "1.2." We elevated the terrain considerably while also adding tall trees. This worked as a natural wall that did a good job of hiding the biomes. We also introduced some minor elevation changes all throughout the forest to have natural-looking terrain.

The maple forest, section "2" in Figure 5.46, contrasted with the green forest by introducing lots of red, orange, and yellow trees. Not only that, but the bushes and resource nodes selected were also of the same aesthetic, and the terrain there was painted for a more brown-looking grass to truly sell the area. Below, the forest geometry can be seen in Figure 5.47.

Figure 5.47: Forest Geometry

The two forest sections were not just differentiated by terrain elevations and their aesthetic looks however, they featured different resources and wildlife.

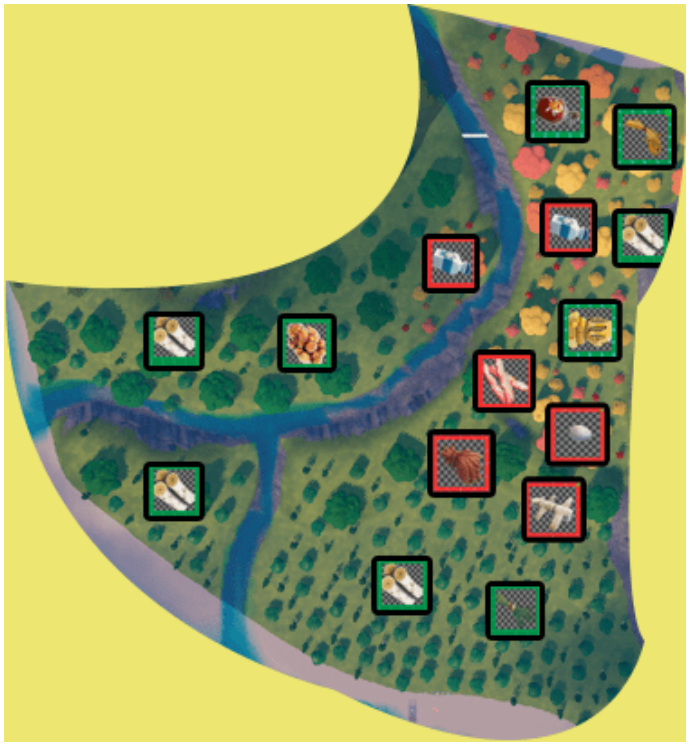

Figure 5.48: Forest Resources

In Figure 5.48, the resource map for the forest can be seen. Being a forest meant that wood could be gathered everywhere from any tree; the abundance of wood was crucial as it was a very sought-after resource for crafting recipes. Resin was also an

early game resource, and so it could be found around section "1.1" of Figure 5.46, but it would be found in large amounts in section "1.2," rewarding players that ventured, crossed the river, and went into the west of the forest. Herb vines were also abundant both in the normal and the maple forest and could be gathered from bushes. The maple forest, however, featured three resources that could be obtained there; they were both required for the mid- to late game and so were chosen to be placed in the maple area, as it was the northern point of the forest, therefore being its final progression zone. These resources were wheat, honey, and maple syrup.

Finally, the forest featured some wildlife, such as chickens that dropped eggs and animal bones when hunted, but most importantly, the boars. The boars, as mentioned previously, were a crucial animal that players had to hunt large quantities of; not only were they tamable, meaning players could ride them (even though they had the smallest stamina and speed of all mounts), but also their drops were needed at every stage of crafting. These drops were boar hair, milk, and animal bones. Boars could be found initially in section "1.1" in Figure 5.46, although in greater quantity on the west part of the section, as well as in section "1.2." Section "2" featured boars with the same loot table, but they were a different kind of boar. They served the same purpose, but to better aesthetically fit the maple forest and to add wildlife variety, they were changed to a subspecies of boars. The maple forest also featured wasps; these animals wouldn't drop loot but rather served as protectors of honey resource nodes. This design choice was to both add combat to gathering, breaking the simplicity of it, and also serve as a point of reference to find honey. If players found wasps, that also meant they had found a honey node.

5.2.6.4 Desert Biome Design

The desert biome was designed to be a mid- to late zone in terms of game progression. We wanted a large desert where players had to traverse north to reach a pyramid temple. The desert is therefore one big section, as seen in Figure 5.46. The dry, desolate climate of the desert would serve as a contrast to the lush forest players had to traverse in order to reach it. The desert featured cacti and dead, dry trees, except for the four large oasis trees surrounding the pyramid. The goal of the pyramid was to be a beacon that told players where to head, to house a one-of-a-kind resource, and to add mystery to the area. The desert geometry featured multiple height bumps that acted as sand dunes, as can be seen in Figure 5.49.

Figure 5.49: Desert Geometry

As for resources, the desert was a great source of obsidian, a mid- to late-game crafting resource. The obsidian nodes could be found anywhere in the biome and were large chunks; the reason for the size was to add another aesthetic element to the desert, breaking the dullness of just having sand and cacti everywhere. Within the pyramid temple, players could find the one-of-a-kind resource, sunbeam, that, when fused with the shadowshard at the snowy mountain temple, would create an important item to finish the game. All of the mentioned resources can be found mapped bellow in Figure 5.50.

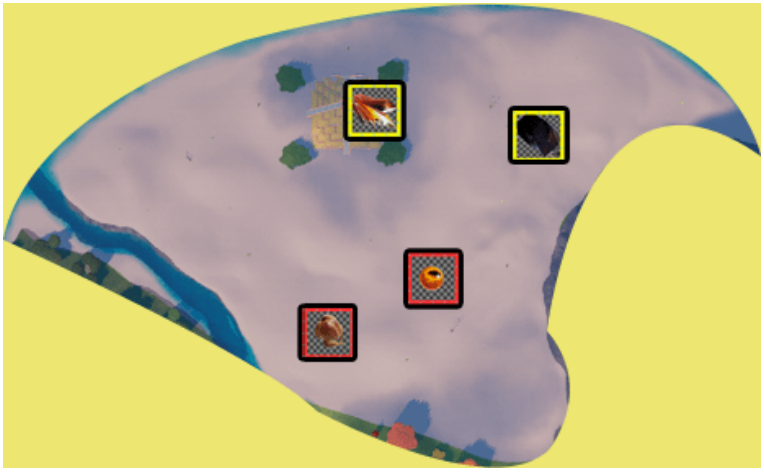

Figure 5.50: Desert Resources

The desert also featured raptors as its wildlife. These creatures were fast, strong, and aggressive towards players. They served as deterrents for curious players who were trying to reach the pyramid before gearing up properly. The raptors could also be tamed if the players were capable of jumping onto them without them noticing, and when tamed, the raptors would prove to be the best mount in the game, with the fastest speed and stamina available. They worked similarly to wolves and boars,

as they had to rest if their stamina ran out.

5.2.6.5 Small Islands Design

The main island features small islands around it that together form the archipelago where the game takes place. We thought of adding them as it would be an interesting way of designing content that didn't take place in the mainland and also would incentivize players to swim into the ocean and explore. The smaller islands are designed to be reached at different levels of player progression.

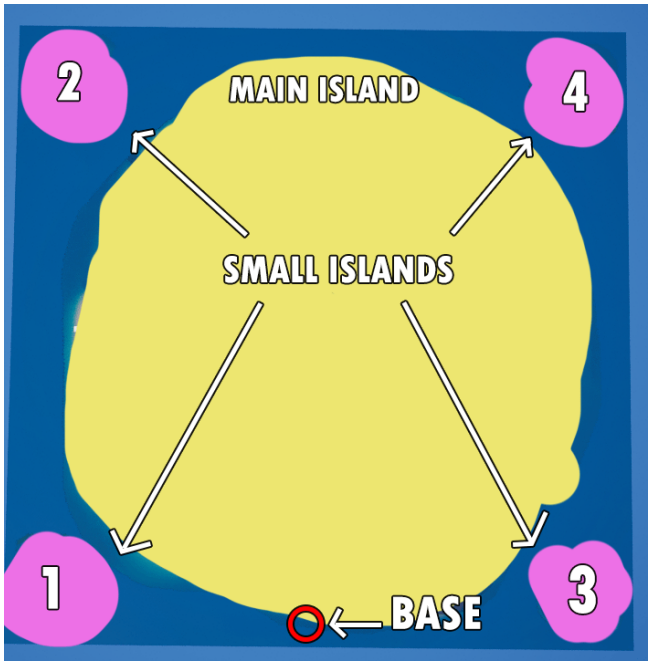

Figure 5.51: Small Islands

There are four small islands (although technically some of these are comprised of multiple tiny islands, but for the purpose of clarity in explaining their design, we'll count them as a whole), each at a corner of the main island. The islands are numbered according to the order in which we designed them to be explored; they become more dangerous and rewarding as the number goes up.

Islands "1" and "3," as shown in Figure 5.51, were the closest to the base but serve different purposes. Island "1" is possible to be seen right from the base, whilst island "3" is somewhat hidden by the mountains. This was a design method we employed to incentivize players to explore island "1" before "3." Island "1" was a simple sand island with palm trees that served to let players know that these existed, but upon arriving to it, players would also discover that they weren't designed to be explored at the start, as they were filled with enemies. This worked as a red herring to lure players and make them waste precious time. The goal was to teach them that not every area should be explored from the start and that they should prioritize crafting

the basics at first before adventuring too far forward. Island "3" was comprised of a donut-shaped sand island with a giant lava pit in the middle.

Islands "2" and "4," as shown in Figure 5.51, were the furthest away from base. Island "2" features a few tiny sand islands with palm trees, while island "4" was the lair of a pirates cove. This cove was hidden not only by the mountains but also by terrain elevation all around the cove. The cove was hidden to add a sense of mystery to the island and a wow factor upon seeing it. Below, in Figure 5.52, the geometry of each of these islands can be seen; the numbers represent which island it is according to Figure 5.51.

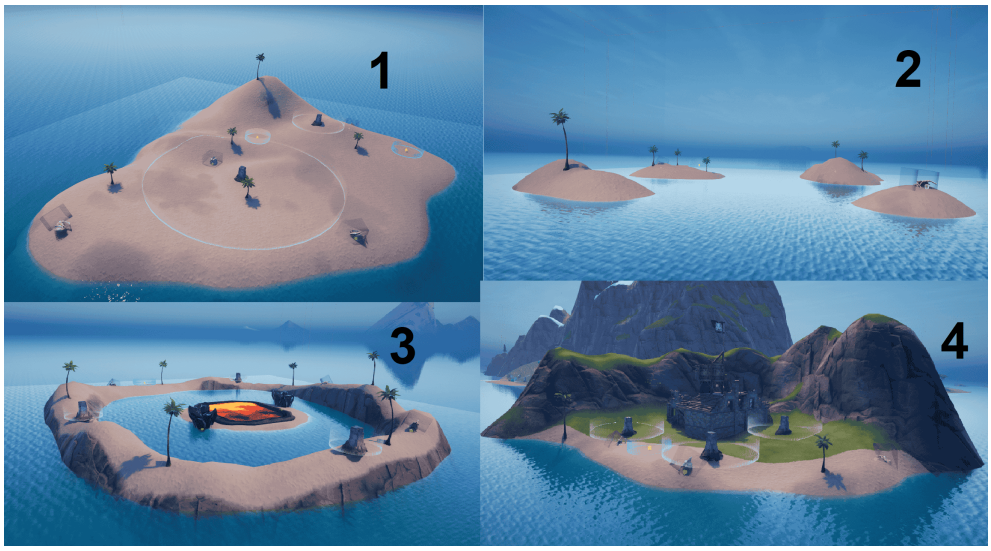

Figure 5.52: Small Islands Geometry

The islands each add their own resources. These resources were relevant mid- to late game for crafting, and their use was mostly for quality-of-life items such as healing and speed potions. As seen below in Figure 5.53, where the numbers represent which island is which according to Figure 5.51, island "1" featured shard teeth and lemons; island "2" had shark teeth, pumpkins, and lemons; island "3" added obsidian and shark teeth; and island "4" added lemons and shark teeth. Originally island "4" was also going to have gold, as it was thematic for the pirate cove, but gold was later dropped as a crafting resource, and therefore it was removed.

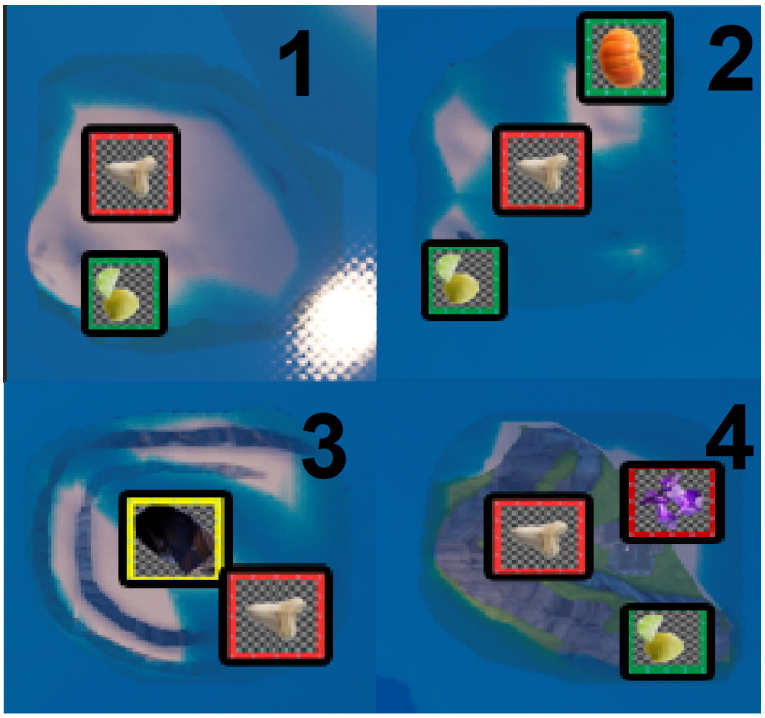

Figure 5.53: Small Islands Resources

Finally, on the islands, there were enemies and one type of wildlife. Each island featured specific strong enemies only found there that would drop monster parts if hunted. The pirate cove had a stronger boss enemy that not only guarded the resources but also a special wildlife type, the water sprite. The water sprite was an interactable wildlife creature that players could hold and carry with them. If players wished, they could use the water sprite to create a zone that gave shields to everyone in it; this could be done up to three times before the sprite disappeared.

5.2.6.6 Mountain Biome Implementation

The implementation of the mountains started by sculpting the biome itself. As described in section 5.2.6.1, we wanted to have steep hills, rough edges, narrow coily paths, and an elevated snowy mountain biome all in this area of the island. By using the mapped configuration seen in Figure 5.36, we were able to determine the sizes for each part and what to sculpt in them. Utilizing the sculpt tool, we raised the terrain incrementally according to the sections. In section 3 of Figure 5.36, we raised the terrain considerably to create the elevated biome. The steep hills were a combination of a small sculpt brush with high intensity to get those natural-looking peaks and tools such as erosion and hydro to give them those realistic-looking edges and sides. Below the elevation for the snowy mountain biome, the steep hills can be seen.

Figure 5.54: Steep Hills and Peaks on the Mountain Biome

For the paths, we used the flatten tool on the mountainsides. This tool would try to flatten a vertical surface, and by doing so, it would carve a horizontal path in the mountainside. By carefully doing this all around the side whilst going up every time, we managed to create a spiraling upwards path on each hill. These paths from the flatten tool were rough-looking; however, lots of unnaturally sharp vertices would pop off the ground as well as other types of weird geometry. To fix this, we used the smooth tool to eliminate sharp vertices; however, this would give the mountain a smooth-looking geometry, which also wasn't very natural-looking. Therefore, after smoothing, we would apply the erosion and hydro tools on the geometry to give it a more edgy, rocky look. Below, Figure 5.55, is an example of these paths.

Figure 5.55: Mountain Biome Path Geometry

Upon having a satisfying result with the normal mountain, we started working on the snowy one. The first thing was to create a platform for the ascender to be placed. This was a bit tricky due to how the ascender device works in UEFN. The ascender will drop a rope directly down when it gets placed anywhere in the geometry; however, if there are any obstacles in the way of the rope, the rope won't go down properly. This meant that we had to erase and erode a portion of the cliff to accommodate it and to make sure the rope reached section 2 from section 3. Thereafter we decided to perform another terrain raise in section 4 of Figure 5.36, as this was supposed to be the highest point on the island. We applied a similar combo of smoothing, erosion, and hydro to get this terrain to work. To connect sections 3 and 4, we made use of the ramp tool. We chose a point in section 4 and one in 3, and the tool created a ramp between them. We then applied some erosion to it, and the result was a crossable rock ridge between the sections, as seen bellow in Figure 5.56.

Figure 5.56: Snowy Mountain Biome Ridge

To finalize the geometry of this area, we customized one of the layered materials from the landscape material to create a snow material that we used to pain the terrain in this region. We also introduced some terrain bumps using the sculpt and erosion tool as well as making a path going around the back of the snowy mountain. This path was made like the previous ones and served as a way for players to reach the cave located in this biome.

For the construction of the caves, we used UEFN props that worked as building blocks for the cave structure. The blocks already had colliders and fit well together, so they were perfect for this purpose. Bellow, Figure 5.57, is an example of one of these caves.

Figure 5.57: Cave Geometry

The tunnel in section 2 was done similarly to the caves. Having the three caves and tunnel created the challenge of how to place them in the mountain's geometry. To achieve this, we made use of the visibility tool to cut holes in the terrain geometry. First we would place a cave in the location we wanted it to be (according to Figure 5.39), with the cave entrance sticking out from the geometry. We would then carve a hole in the terrain to match the size of the cave entrance. However, this tool is not very precise, and the geometry was somewhat stretched from all the sculpting and eroding. This meant that the holes would sometimes be bigger than expected or have strange shapes that made it hard to hide them. These holes obviously had to be fully hidden, as we didn't want any players falling off the island into the void. The solution was to cut holes that would cut a bit of extra geometry on top of the cave entrance; this was much more manageable as we could use a rock prop to close the hole without it looking totally out of place. The tunnel placement used exactly the same method. Below, Figure 5.58, illustrates a cave entrance and the fix.

Figure 5.58: Cave Entrance

Next up, we had to place the two temples in the mountains biome. The first one was to be embedded on the mountainside located on the eastern beach, after crossing the tunnel. To place it, we used the same method of placing caves and tunnels where we cut a hole in the geometry to open the entrance to the temple and then used rocks to hide potential holes. The second temple was placed in section 4 (Figure 5.36) and required some flattening, smoothing, and eroding of the terrain to get it to fit nicely.

Afterwards we painted some foliage in the biomes using the foliage tool, a few trees in the normal mountains, and snow-covered trees in the snowy mountains, as well as some pebbles on the ground. We then scaled and placed all the resource nodes where they needed to be according to the resource mapping in Figure 5.41. Finally, we placed the wildlife and enemy spawner in the place discussed in section 5.2.6.1. The spawners also had to be tweaked to accommodate for the space the geometry allowed; this meant changing the spawning range but also the spawning amount so as not to overcrowd the region.

5.2.6.7 Swamp Biome Implementation

The swamp biome implementation started by creating puddles in the terrain. To achieve this, we used a combination of a low-intensity erase tool with the smoothing tool to avoid any weird vertices or geometry resulting from erasing portions of the terrain. We also applied the hydro tool in certain portions of the terrain, as the swamp was a very humid, wet biome, and so we wanted to simulate rain and water erosion. These puddles can be seen in Figure 5.43. Next up we used the same combination of tools to create a donut-shaped river with a small island in the center, as described in section 5.2.6.2.

We then started by placing trees and bushes; these had to be placed manually, as the foliage tool doesn't allow non-static props to be painted. We used non-static props, as each prop had a mechanic attached to it in order to drop resources when hit. Placing them manually also allowed us to carefully design where things should be, something also discussed in section 5.2.6.2. The foliage tool was used, however, to paint grass, pebbles around the biome, and lots of flowers in the inner section of the biome, represented by 2 in Figure 5.42.

A temple was then placed in the small island surrounded by the donut-shaped river. This temple houses the enemy spawner for the swamp biome. The spawner range and spawn quantity were adjusted to fit the temple. Wolf spawns were also placed all around the biome except for the temple section.

Finally, the post-processing of this area was added by utilizing a volume box that would trigger a post-processing effect for the player that walked in. Not only this, but the volume box would also trigger volumetric fog inside of it. This box encompassed the entire biome and was created to enhance its atmosphere. Sadly, it was later removed from the game, the reason being that we didn't have the necessary time to create an interesting post-process effect, and so, when activated in the game, it would confuse players as they would think their camera was having some sort of

issue instead of understanding it as an environmental effect.

5.2.6.8 Forest Biome Implementation

The first step in creating the forest biome was manually placing trees. We couldn't make use of the foliage tool as these trees were non-static and interactable. Initially we did a completely random spread of trees in hopes of creating a realistic-looking environment, but the method of placing one of each type we had available always in the same order led to patterns that looked weird in-game. We started looking at how other games place trees in their environments and realized it was fine to have multiple of the same type near each other as long as we made some small changes, such as tilting the tree a bit or rotating it. Another thing we realized is that the forest should be denser; we were lacking in trees, and so we did just that. We also added some trees to some specific areas of each section. So using Figure 5.46 as a reference, section 1.2 and the border between 1.1 and section 2 had taller trees, in part to hide the other biomes. Both the maple forest and the normal forest followed this strategy to place trees, bushes, and tree stumps.

Upon having the trees placed, we started painting foliage such as pebbles and grass. For the grass, we wanted it to match the type of forest it was in, so the maple forest would have yellow grass and the normal one green grass. The standard UEFN grass didn't allow for this type of customization and would change color based on settings we couldn't touch. Therefore, we decided to create our own grass. We created some grass blades and made a custom material for them. The result was sufficient, and we managed to have grass of all colors, meaning we could even add white grass to the snowy mountains or purple grass to the swamp. However, there was a major problem, as we explained before: when using Fortnite assets, the engine has a built-in way of optimizing their size and performance; with custom imported meshes, this was a different story, though. We had thousands of grass blades painted around the island; this was significantly impacting the game performance and was even making the UEFN editor lag. Therefore, we made the decision to remove it and use the UEFN standard grass. It wasn't ideal, but for the purpose of this research, it was more than enough.

Trees, bushes, and other details such as grass and pebbles were now in the normal and maple forest; however, they were still missing something, and that was terrain changes. We realized that the original terrain was too plain, and so players could see the entire forest and other biomes right from the starting area. To solve this, we used the sculpt and smooth tool to add small hills and bumps in the forest, enhancing its terrain and giving it a more organic look. This was still not fully hiding the other biomes, however, so as mentioned in section 5.2.6.3, we decided to use the sculpt tool to raise the terrain in the borders between biomes to fully hide them. For a similar purpose, a river was also created using the erase and hydro tools. We also customized one of the default layered materials in the landscape material to obtain a more brown-looking terrain, perfect for the maple forest look we were going for.

Finally, after we made sure that every tree, bush, and tree stump was dropping

the correct resource and amount, we started placing wildlife. The normal forest featured boar and chicken spawners, both adjusted to fit where they were placed. The maple forest also had boar spawners and wasp ones as well. The wasp spawners were smaller, as they were only to be around the tree stumps that dropped honey, and so we also had to properly adjust the spawn amount so as not to overwhelm the players with wasps.

5.2.6.9 Desert Biome Implementation

The implementation of the desert biome began by altering the terrain. Multiple small slopes were created and smoothed with the smooth tool to create realistic-looking sand dunes (as seen in Figure 5.49). A pyramid was then placed at the northern point of the biome, and for this, the terrain had to be flattened and smoothed to accommodate the pyramid's geometry. After placing the pyramid, the terrain around it was slightly raised using the sculpt tool to create the sensation of the pyramid slowly being buried by the sand. The same was done inside the ground floor of the pyramid. By raising the terrain inside, we created an initial area of the temple overrun by sand blown in by the wind. Bellow, Figure in 5.59, the pyramid interior can be seen.

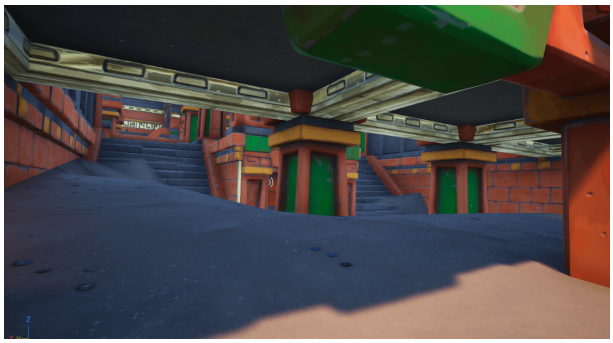

Figure 5.59: Pyramid Interior

We then began painting foliage. The foliage here was non-interactive, meaning we could've used the foliage tool; however, all the desert props we had were non-static, meaning we had to place them by hand. Different types of cacti were placed in the desert as well as some dead trees and logs to really sell the arid environment. Around the pyramid were placed four tall oasis trees that acted as beacons for the player and organically enhanced the pyramid's importance in the zone.

Thereafter we placed the resource nodes for the zone, the obsidian. The obsidian nodes were scaled up to add another aesthetic layer to the biome as described in section 5.2.6.4. Finally, raptor spawners were placed all around the desert; these were altered to have proper range and spawn count relative to their positions.

5.2.6.10 Small Islands and Beaches Implementation

In order to create the islands, a new landscape had to be created for each one. The original landscape mesh used for the main island had been cut to create a natural-looking terrain layout, and so we couldn't make use of it for the small islands. Each small island group, these groups can be seen in Figure 5.52, therefore had a small landscape mesh created for it.

We placed these landscape meshes below the surface of the water and used the sculpt tool to raise portions of the mesh above the surface, creating the small island terrains. Each terrain had bumps in it that were made by using a mix of the sculpt, smooth, and hydro tools to give it a natural look that was meant to represent the terrain changing over time due to wind and waves. Island 3 in Figure 5.52 had a hole in its center conceived by erasing that portion with a large brush at medium intensity. It also had a lava pool in its interior. This pool was created by using different UEFN lava chunks and arranging them so it would create the desired shape, as can be seen below in Figure 5.60.

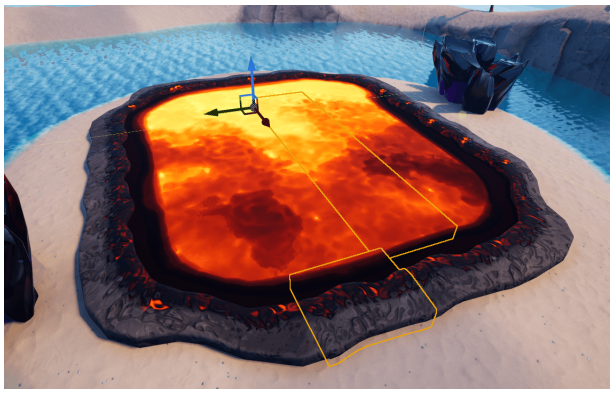

Figure 5.60: Lava Pool

Island 4, as described in section 5.2.6.5, had a hill around the back side to hide the pirate cove from players at first. This was achieved by raising the terrain with the sculpt tool and then eroding it. To place the pirate cove on this island, a few terrain alterations, such as flattening and smoothing, were also necessary.

With the small island's geometry ready, we started placing the resource nodes. These nodes consisted of obsidian chunks, animal skulls for shark teeth, and bushes for lemons and pumpkins. Thereafter, enemy spawners were placed in their correct positions on all islands. For these spawners, we choose a type of enemy that fits the pirate aesthetic. Island 4 also had a boss, which was a different, stronger enemy type. Finally, we placed some water sprite spawners in islands 3 and 4 to reward players brave enough to explore and clear them.

In this section we also wanted to include a brief mention of the creation of beaches on the main island. This was done by using the erase and smooth tool to lower the

terrain until it was just barely under the water. We also added some bumps with the sculpt tool to simulate sand dunes.

We talked about, in section 5.2.3.2, how we didn't use ocean water but instead the swimming pool water body in the game due to it ruining the island mesh. Even though this happened, we made an effort to try to fix it and use the ocean water instead. Essentially, when adding the ocean water, the whole terrain would be engulfed in water, and raising the mesh entirely wouldn't make a difference, as the water had to be tied to it. What we started to do was use the spline tool in the ocean water body to "cut" holes in the ocean for the island mesh, and then we would use the sculpt tool to try to raise the mesh above the water. This, however, didn't really work and would create a weird issue where the mesh and water surface touched (as seen below in Figure 5.61), and so for that reason and the other reason we explained before, we went with the swimming pool water body instead.

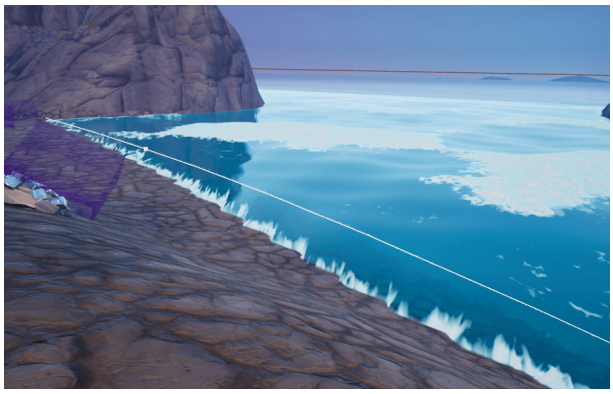

Figure 5.61: Beach Mesh Issue

5.2.6.11 Island Geometry Over Time

In this section we want to showcase the overall island transformation from the point where the technical foundation had been set in place to its final look. Below we show the three main stages of this evolution.

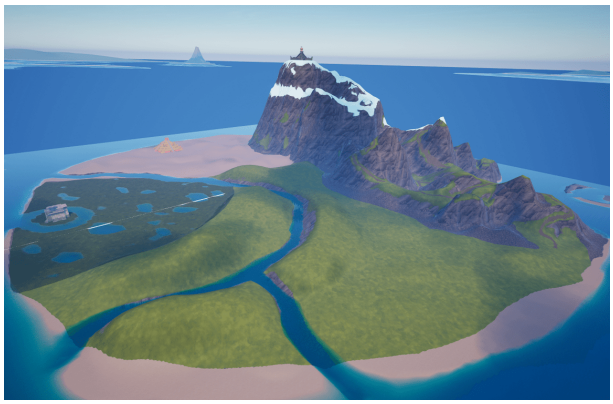

Figure 5.62: Initial Stage of the Island After the Technical Foundations

Figure 5.63: Second Stage of the Island after Modifications

Figure 5.64: Final Stage of the Island

5.3 Phase 3: Playtesting

5.3.1 Survey Conception

The prototype was now ready to be playtested, and so we had to create a structure to effectively obtain data from playtesters. As mentioned in section 3.5.4, we wanted to create surveys to complement the information we would gather by observing the testers with concrete data.

We initially created one survey with all the main questions we needed data on, but upon review, we realized it would be better to separate it into two, where each survey served a specific purpose. The objectives and questions on each survey are explained in the following sections.

5.3.1.1 Pre-Session Survey

The first survey playtesters had to fill out was the pre-session survey (section **??**). The goal with this survey was to gauge the type of audience that would test the prototype. For the purpose of this research, as mentioned in section 3.5.2, we wanted to have a wide demographic of people interact with the game, from gamers to those who usually don't tend to play many games, and so, to understand if the testers were within our expectations, we used the pre-session survey. This survey was short, and all the questions were multiple choice, as we didn't want people to spend too much time on it.

The first question asked the tester to rate themselves as a gamer, ranging from casual to hardcore. The goal here was related with section 2.3; we wanted different types of players to experience our prototype, as it was designed to appeal to both casual and hardcore players.

The second question asked the tester if they tended to position themselves as leaders in a group setting; it was a range from "Never take leadership" to "Always take leadership" This question was related to section 2.4, as one of the key insights we wanted to obtain from the playtest was how players hierarchically organized themselves, and so, having one or more people who tended to be leaders, or perhaps a whole group composed of people that never took on leadership roles, would yield different data results, all valuable for this research.

The third question asked the tester how much experience they had with cooperative games, where they could choose from "Very little" to "A lot" This question was also related to section 2.4, as this was going to impact how they organized themselves in-game.

The fourth and final question on the pre-session survey asked the tester to rate how familiar they were with survival games, from "Never Played" to "Very Familiar" Our prototype used the survival aspect to promote and try to invoke all the behaviors we were researching, and therefore we wanted to know how knowledgeable players were

of this genre.

5.3.1.2 Post-Session Survey

The post-session survey (sections A.1 and A.2), as the name implies, was intended to be filled out by players after they playtested the game. This survey was longer and was divided into three main sections, each with specific goals.

The first section was comprised of questions related to the tasks players performed in-game, as well as balancing questions. The goal with this first section was for us to get feedback on the prototype's playability and be capable of changing it between playtesting sessions based on the given suggestions. The questions included here touched on the following topics:

- What tasks they mainly performed in the game (crafting, gathering, hunting, exploring or leading);
- How they contributed to the group and if they felt a sense of accomplishment from the contributions they made to to group;
- How much they felt they contributed to the overall game progression;
- If they thought it was possible to win the game within the given time;
- If they thought the game would become easier after multiple playthroughs;
- How complex they found the crafting system to be and what their thought about its costs;
- How rewarding they found the map exploration to be and what they thought of the island design;
- How interesting they found gathering to be and what they thought about the amount resources given by nodes;
- How enjoyable they found hunting to be and if they thought they had enough access to weapons to hunt effectively;
- If they thought they had enough quality-of-life items available;

The second section of the survey focused on aspects directly related to our research. The questions included here touch on the following topics:

- How organized they thought the group was during the playtest session and if they thought they would be more organized if there was someone taking a leadership role;

- How much they thought a leader could actually impact the group performance;
- If they thought the game was capable of appealing to both casual and hardcore players;
- If the lack of in-game explanations promoted group work and communication and in what ways could the game promote more group work and communication;
- If the in-game achievements gave them a feel of accomplishment and progression;

The final section was composed of an open-ended question where people could write in-depth feedback or other thoughts they had about the prototype.

5.3.1.3 Changes Made In-Between Sessions

The post-session survey helped us gather data in the first and second playtest sessions. After the second one, we had a meeting with **FunRock** to discuss the findings and explain how the playtesting sessions went up to that point. During this meeting, we realized that there were a few questions that we could add to the form, not only to give us more data but also to help **FunRock** in their research. **FunRock** also suggested having a third playtest session with employees from their company. This meant that we could rework the post-session survey and use it in the company playtest.

The first change we made was to the structure of the survey. We categorized the three different sections mentioned in section 5.3.1.2, and properly divided those questions into their separate survey categories. With improved structure in place, we looked at the questions again and noticed it lacked consistency; for example, on the thesis-related questions, some of the questions had follow-ups depending on the testers' answers, while some didn't. However, having follow-up questions for every question in this category was beneficial to us, as it provided valuable data. Therefore, we started analyzing the survey categories and began designing them according to our goals.

The method we used to design the game-related questions category was as follows: we would start with a topic, for example, crafting. To reach this topic, the tester would need to choose "crafting" as one of the activities they did in-game in a previous question. Then, we would start by asking how complex they found the crafting system to be, followed by a question about the crafting costs and finally one asking the tester if they thought that their job as a crafter would've been facilitated had there been more specialized in-game tools to support it. This final question came as a result of the **FunRock** meeting, and if testers would answer "yes," it would lead them to a follow-up question asking them what types of tools they would like to see to support them in their crafting tasks. All the tasks in this category used this format; this includes crafting, gathering, exploring, hunting, and leading.

The thesis-related questions category was changed to have a follow-up question to

every main question; these follow-ups were moved to the open-ended questions as we wanted testers to be able to write down their thoughts on the topic. For example, if testers answered "yes" to the question "Do you think that the game is capable of appealing to both hardcore and casual gamers?", they would get this subsequent question: "In what ways do you think the game could appeal more to both casual and hardcore players?" This gave us more insights into the testers' opinions of the prototype.

In the end, after all the mentioned changes had been done, we had a final version of the survey that we believed was capable of giving us concrete data and valuable information.

5.3.2 First Playtesting Session

5.3.2.1 Parameters

We held our first playtest purely online through voice chat, with six players participating. Some of these participants were friends, but most met for the first time. They all play games, but they have different preferences for what games they like and how casual or hardcore they are. We were satisfied with this initial playtest group because it represented a wide variety of player demographics and also allowed us to test how our game mechanics incentivize players to cooperate, even without pre-existing social ties and structures. Additionally, to be able to observe these participants in action, we joined their groups as players. To remain neutral and avoid influencing the players' decisions or providing hints, we played only as passive observers, refraining from helping with discovery or exploration and fulfilling tasks only when given orders. After one 30-minute playthrough of the prototype, all players were interested in trying the game one more time, giving us valuable insight by observing how they adapted their strategy the second time around.

5.3.2.2 Feedback and Implemented Changes

During and after the first playtesting session, players expressed the following feedback:

- Players repeatedly expressed their want for a **common storage solution in the base**. However, as discussed in the previous section, we believed that this emergent behavior could guide players toward optimal organic cooperation without their awareness. It was also impossible to implement such a feature inside of UEFN in the time frame we had.

- Players clearly expressed their desire for **better movement options**. Players were running at all times to travel to places faster, which caused their stamina to be constantly depleted, making them considerably slower. Players suggested that a car would solve the issue.

- Players communicated they would appreciate **access to weapons** to be able to defend themselves better when exploring. Since weapons are an existing

feature of the game, and the group did not progress far enough to unlock them, we didn't implement any changes based on this feedback.

- Similarly, players stated that they would value the inclusion of **better healing items**. While the bandages in tier 1 are not very effective at healing, tier 2 already offers the med kit that solves this issue. Just like with weapons, we believed we would address this issue only after players achieved that point in progression.

- Some players expressed their concern that the **amount of resources available** on the island is too low, especially given the quantity of wildlife being spawned there. We felt that we needed to playtest more to find out how to correctly balance the game's values, especially since players didn't get that far into the game during this session.

- Similarly, players thought that we should **increase the time limit**. Although we agreed that 30 minutes is insufficient to complete the game, we believed that requiring participants to attend an hour-long playtest would discourage potential playtesters, so we decided to maintain the current playtest duration.

- Some players were annoyed that they **constantly needed to ask other players for information and help**. Since this was the primary goal of our design, we were pleased that our design decisions and mechanics created this sense of need among the players.

- Players wanted to **know what crafting stations make** after they had used them once. We thought that this fact made crafting more cooperative and caused crafters to rely on each other more, so we left it as is.

- A player suggested that it would be beneficial if the **map was annotated with helpful information after being explored**. While we agree, we strongly believe that the existing ping system can substitute such a feature while also supporting cooperative communication.

- Players also reported a multitude of **minor bugs** they encountered while playing. Some places on the map are difficult to enter or exit, and the base, crafting stations, and temples drop wood and metal when hit. Additionally, when the game ended, the game showed them the win screen instead of the loss one.

- Finally, we were glad to hear players say **the game is fun and engaging**, and they want to play more to solve the prototype's puzzle.

After reviewing all feedback, we made the following changes between the first and second playtests:

- We **added an introduction message** that is shown when players spawn into the game. This work has been done to give an immediate sense of urgency to players and explain the fundamental goal of the game to prevent the aimless wandering we observed at the start of the first session.

- We made it so players now have **infinite stamina**. This tweak was our solution to resolve the issues players had with mobility and getting around the map. It was the easiest adjustment we could realistically implement between the first and second playtests.

- We **fixed most of the minor bugs** players mentioned, such as structures and crafting stations dropping resources when hit. We also noticed that some props still supported the critical melee hit system, which is present by default in base Fortnite but was not used in our prototype, so we fixed those props as well.

5.3.3 Second Playtesting Session

5.3.3.1 Parameters

Unlike the first playtest, we held the second session in person with a group of seven people, just a few days after the first one. This time, all participants were in a single room playing together, allowing them to communicate freely without needing to speak over each other in voice chat, making communication easier and more organic. Since this session was held at the university, we invited people we knew from our master's program, so they were all familiar with each other and games as a whole. We thought that this layer of social ties and gaming experience realistically simulated a friend group trying out a new cooperative game together, increasing their chances of cooperation and giving us a more accurate representation of the behavior that we could expect from players playing an actual game implementing concepts we researched. Moreover, some players who were present in the first session were also participating in this playtest. We believed that these participants would introduce intriguing dynamics to the group by simulating experienced players in real scenarios, which we hoped would lead to the organic emergence of a leader, enabling us to study the resulting role hierarchies formed by the division of tasks among players. Since this session was held in person, we could just observe the players as they were playing instead of participating in the game, which minimised the risk of us having influence over the players' behavior during the game and during their task division procedures. Additionally, during this session, we tested the game simultaneously on different devices, with some players using PCs and others using Nintendo Switches. Because of time constraints, we could only organize a single playthrough of the prototype.

5.3.3.2 Feedback and Implemented Changes

During and after the second playtesting session, players expressed the following feedback:

- Even after the stamina changes we implemented, players still unanimously expressed their desire for **better movement options**. This meant that we needed to find a way to implement a diegetic vehicle feature that could increase the player's movement instead of just changing the default values of the player controller.

- Some players still had **issues with the map's terrain** at certain spots. For example, in some spots in the river that flows through several regions, the terrain was steep enough that players couldn't get out of the water.

- Just like in the first playtest, players believed that the **time limit was too short**, which made it impossible for them to successfully finish the game. After seeing players interacting with tier 2 crafting during this session, we realized that it is crucial to adjust all these values.

- After seeing what tier 2 crafting has to offer, players made it clear that it would be beneficial to **add weapons and useful healing items earlier**. During the first playtest, players were unaware of the existence of these items; however, after experiencing their role in the progression, they strongly felt that receiving them earlier would make the experience better.

- Players expressed unanimously that **having a designated leader made the game easier** by making them cooperate more effectively. This confirmed our observations from their gameplay, clearly demonstrating the importance of establishing optimized cooperative role hierarchies in the game's design.

After reviewing all feedback, we made the following changes between the second and third playtests:

- We added the possibility to **craft weapons in tier 1**. The bow weapon that was craftable in tier 2 is now available in tier 1 with an adjusted recipe that is achievable earlier in the game, while the tier 2 weapon station crafts a new bow that is more powerful than the previous one. Now, new players know that weapons are available early in the game, instantly rewarding them for their investment into the crafting system.

- Similarly, we **revamped the healing items in tiers 1 and 2**. Since bandages were next to useless, we removed them from the game and just made med kits craftable in tier 1 instead. We added the med-mist item as a replacement output for the tier 2 med kit recipe, which is also a tangible upgrade over it that increases the player's quality of life significantly.

- To solve the mobility needs of players, we **made some wildlife on the island tamable**. Players can now tame boars in the forest by jumping on them instead of just hunting them. If they succeed, they can keep them as pets and mount them whenever they need to, making their movement speed considerably

faster. Instead of spending time adding a vehicle crafting system to the game and revamping progression around it, we have opted to use existing Fortnite features that do not interfere with our current crafting structure. Now, this new mobility option rewards players for their experimentation and curiosity, giving them useful knowledge they can share with the team when they discover it.

- We found that players were more confused in tier 2 crafting than we anticipated, so we **removed the alternate cog recipe** and made it a parallel crafting path with the original one, which made it more in line with other recipes on the tier.

- We **adjusted all crafting values** in the game to make it more fair and achievable to win the game.

- We **increased the timer to 60 minutes** to be more in line with the new crafting values and our new game balance philosophy.

- We **increased the player limit to 100 players** from 16 in order for the prototype to be ready to be officially published inside of Fortnite.

- To track the behavior and progression of players playing our game through Fortnite, we **added analytics devices** that are able to be triggered by any in-game event and display that information to us in our creator portal, giving us valuable data in the future.

- We **modified the island's terrain** to address some unintended traversal challenges.

5.3.4 Third Playtesting Session

5.3.4.1 Parameters

The third playtest session was held online similarly to the first one and had ten participants. The participants were comprised of the two of us and **FunRock** employees, two of them being the people that have been following and supporting the prototype development since the beginning, and the others, people that had never heard about the prototype up until that point. All of the **FunRock** employees knew each other well, meaning we could have the atmosphere of having a group of friends play the prototype and try to figure it out together. Furthermore, since two of the employees knew about the prototype, they could act as experienced players and guide the others throughout the session. The two of us, much like how it was in the first playtest session, were mostly there as passive observers, not giving any hints and only doing what tasks were assigned to us by others. Moreover, the **FunRock** employees were all game developers; this gave us an interesting insight that no other group could. How would game designers, programmers, and so forth react to our prototype and its mechanics? How would experienced developers tackle the

challenges we had set in place? The final prototype had a playtime of one hour, but the first playthrough with the group ended around the forty-minute mark, as they realized they wouldn't be able to finish on time and wanted to give it another go with their newfound knowledge. These two playthroughs and the player behaviors we observed would prove to be very valuable data, as we will explain later.

5.3.4.2 Feedback and Implemented Changes

During and after the third playtest session, players expressed the following feedback:

- Players expressed their **want of specialized tools** to help them with the different tasks in the game, so for example, a quest board the leader can create and place down, where the resources needed to be gathered can be found, facilitating information sharing in the team;

- Players also expressed that **it is unclear when resource nodes have restocked**, meaning they would have to hit the same node at different time intervals to figure out it the restocking cooldown had ended;

- Players once again expressed their desire to see **different types of storage** being implemented;

- As mentioned previously, the **lack of boars was a big issue**, therefore a common feedback we got was to increase the boar spawn amount and the amount of resources each boar drops;

- Players also realized that the **crafting recipes and tier upgrades requires a lot of wood planks**, but the only way to craft these was by a tedious process of crafting small amounts each time, leading to a lot of time spent just clicking the crafting button continuously to get planks and so, they would like to get access to a better way to craft this item;

- The **mounts were an interesting concept that people liked**, however the fact that they had limited stamina and would despawn after a few uses was not well received as players would have liked to constantly used them without having to worry about stamina, as they themselves had infinite stamina as well;

- The swamp biome also got feedback, as players described it as having **way too many enemies and too few wolves**, meaning the risk was high but the reward was very low;

- The post processing in the swamp also visually confused players who thought it was a visual bug;

- Players also explained that **crafting costs after tier 2 were way too steep** and unachievable in the time window the game allowed;

After we reviewed the feedback we got, we made the following changes to the prototype:

- We **removed the post processing in the swamp**. Sadly as described in section 5.2.6.7, we simply didn't have the time to create the desired effect we wanted and so opted to discard it;
- We **removed most of the enemies in the swamp**, leaving only a spawner in the temple, which is surrounded by a donut-shaped rived, meaning the enemies are self-contained there;
- We **increased the amount of wolves** in the swamp;
- We **fixed the boar spawns**, increased their spawn amount and the amount of resources they dropped;
- We **tweaked the restocking cooldown for resource nodes**, decreasing it where we saw fit;
- We **upgraded the plank and metal refining**, to fix the tedious process of crafting these;
- We **balanced the crafting costs overall**, reducing them considerably and making them feasible and achievable;

6

Results

6.1 Player Behavior Analysis

6.1.1 First Playtest Session

As discussed previously, this playtest session was divided into two 30-minute playthroughs. At the start of the first playthrough, players were chaotic in their behavior and didn't seem preoccupied with agreeing on group goals; instead, they mostly ran in random directions exploring, going on their own individual adventures, only occasionally reporting on their findings to the group. At this point in development, the prototype had no introduction message explaining the group's goal: to escape the island. After observing this player behavior, it was immediately clear to us that players need to have some form of introduction to the game's concept to prevent them from being aimless at the start of the game.

Nevertheless, once the meteor approached the island closely enough to create a real sense of urgency among players, it motivated them to gather resources and determine their next steps. They realized that the ship needed to be fixed because of the crafting recipe visible when close to it and also noticed the billboard saying "BUILD BASE" right next to it. After seeing the resource costs, all players shared what they found in the wild and where. After realizing how to gather the appropriate resources to craft the first base upgrade, namely large quantities of wood and resin, most of the players gathered in front of the building billboard to observe what it would do. Once the boardwalk had been built along with its associated tier 1 crafting stations, the players present started to inspect the recipes present on the new crafting machines and try to figure out what the material icons corresponded to and if they had encountered them before.

At this point in the playthrough, many players were still exploring alone and not participating in group activities. After deciphering a few of the necessary materials, they managed to figure out where to obtain some of these resources, and the players present took it upon themselves to obtain them. After acquiring the resources, players attempted to craft some of the recipes for which they met the requirements. Unfortunately, due to poor communication, each player crafted items independently, which left them confused about what the machines were producing, despite having

used them multiple times. During the final minutes of the playthrough, they succeeded in understanding the functions of each tier 1 machine and successfully crafted the tier 2 base extension before the meteor struck the island.

After the session had ended, the whole group was unanimously vocal about the fact they wanted to try the prototype again with the hopes of getting further in the progression. This time, when the second playthrough started, everyone immediately went to gather wood and resin as a team to build the first crafting tier as soon as possible. After building their base, the players searched for the appropriate materials to achieve tier 2 machines as quickly as possible. However, we still observed several issues with the group's efficiency. The players dropped the resources they gathered on the platform for someone else to pick up and craft, as they had no dedicated crafters or leader. On multiple occasions, a player assumed the role of crafter and used it to help advance the group to the next tier, but soon after, they gave up this responsibility.

This caused the team to become confused at multiple points in the playthrough; individual players did not know what needed to be done to progress further since no one was in charge of keeping track of the team's current and future tasks. Although the group was working as a unit this time around, players had the tendency to try to do everything at once but on an individual level. They all had the instinct to gather and explore, sometimes in small groups, but they didn't seem interested in organizing and using the materials they had collected. Even though they had achieved tier 2 considerably faster than in their first try, they only crafted a few new recipes before the game ended. Tier 2 of crafting introduces several conceptual curveballs for crafters to handle, which caused chaos in the group since no one was dedicated enough to crafting to properly understand the nuances of the previous tier and therefore deduce what the new machines did.

One intriguing behavior we observed in the players during both playthroughs was that every time players who had gathered something came back to base, they simply dropped their materials on the ground and left to acquire additional ones. They repeatedly expressed their desire for a shared storage solution within the base, where they could transparently deposit their gathered materials. The absence of this feature necessitated that one team member take on the role of a "human chest," meaning they were always stationed at the base to collect materials from others and communicate to the rest of the players how many resources they had and what additional amounts were needed. During this first playtest, one of our team members took on this responsibility so that the other players would not have to remain in the base and could explore more of the island. After the session, we realized that assigning this role was a significant mistake because we believed it had important implications for organizing the group as a whole and fostering organic leadership positions within it.

6.1.2 Second Playtest Session

This second playtest session was characterized by a few behavior factors that greatly influenced the group's cooperation. As we had anticipated, the people who had previously participated in the first session were immediately useful to the team and were able to guide those without previous experience in the right direction. With their help, players were able to divide tasks efficiently between themselves right away and gathered all of the necessary materials to build their first base upgrade in record time. Additionally, since the experienced players knew what materials were needed for the most important crafts in tier 1, such as ore and stone, they had already instructed some players to venture into the mountain region of the map to gather them in advance. Now, all group members were always contributing to the team's goals and were working as an efficient unit with parallelized tasks.

These experienced players had a profound positive impact on the optimal functioning of the group, and the other team members seemed eager to learn from them throughout the course of the playthrough. This organically put them in positions of leadership without them realizing it, which was made even clearer once the first crafting tier was unlocked and the "human chest" phenomenon, discussed in the first playtesting section, became apparent. Since all gatherers were dropping off their resources in the base, one specific experienced player started picking them up because he knew exactly how to use them to progress. Such behavior made him become the de facto master crafter of the group, always knowing which resources the group had and which were needed at all times and constantly trying to push the group forward through the use of crafting.

Naturally, this player organically then became the indisputable leader of the group, since they were always aware of what needed to be done to progress and were therefore able to effectively divide tasks among other players. This ensured that no player was confused about their next steps, as they could always ask the leader for guidance. All of the players then could specialize in their roles, such as gathering ore, hunting boars, and finding resources that were needed but hadn't been discovered on the island yet. These changes created a fluid and efficient role hierarchy system with a definitive leader predicated on knowledge, experience, and investment, just through the mechanics of the game alone, without in-game instructions or outside intervention.

We believe that this efficient, organized cooperation was also facilitated by the ease of communication enabled by the fact that this playtest was held physically instead of online. It was simply easier for players to communicate with the person they needed to at any moment without needing to speak over each other all at once in a common voice chat. The experience showed us that if this concept were to be made into an actual product with online players, it would benefit greatly from additional in-game communication features that would make playing with larger player counts smoother and more efficient.

In this 30-minute session, the group got far into tier 2 crafting, but unfortunately,

because of steep crafting cost increases on new machines, they didn't manage to unlock tier 3 before the meteor struck the island. This experience definitively proved to us that all resource values in the game needed to be drastically rebalanced in order for the game to be winnable, including increasing the time limit. We severely underestimated the fact that requiring previously crafted items for new crafting recipes exponentially increased the time needed to unlock the next tiers of crafting progression, which meant that players simply didn't have the opportunity to properly experiment with all the new crafting stations and learn their newly introduced gimmicks and what new tools they could create with them.

Overall, we were more than pleased by this playtest. Players worked as one cohesive unit thanks to some members organically taking on leadership positions and were visibly more optimized in their in-game actions as well as their communication. This dramatically increased the rate at which they progressed and how far they got into solving the game's puzzle, which proved the concepts we have put into the design of our prototype. Additionally, the "human chest" phenomenon, which organically emerged from players interacting with the game's various systems, proved to be an invaluable tool that can be used to push players to take on crafting while incentivizing them to also take on leadership roles in the process. Every time a player encountered an obstacle in the game, the answer was always cooperation, which is precisely what we wanted to observe.

6.1.3 Third Playtest Session

The first playthrough conducted in the third session lasted around forty minutes, as mentioned previously. The group started off much like other testers had started in the past, by each doing their thing, not being too worried about the timer or making progress. They soon felt the need to progress the game, however, as they encountered the plaque telling them to create a platform, and so they started exploring and looking for the right resources. The people from **FunRock** with previous knowledge of the prototype also started steering the group in the right direction and making them understand the sense of urgency.

The group started getting more organized and understanding what they had to do; however, they were still lacking much information, such as where to gather materials and what the crafting stations would give them. Therefore, the next portion of the playthrough consisted of an experimentation phase, where people would explore the map, gather different kinds of resources, and try to craft what they were able, while keeping tabs on what each station created. It then came to a point where the group was focused and had the information they needed to get through the early progression and part of the mid progression. Unfortunately for the group, this realization came rather late, as the timer was more than halfway done. Fortunately for us, though, we saw the group express interest in playing a second time right after, with their newly found knowledge. This was perfect, as this was the largest playtest group we had test our prototype, and by the end of the first playthrough, they were also becoming the most organized one as well. The decision was then made to finish the

first playthrough early, as there was no hope of clearing it, and start off the second one right away.

The group was ready to jump back into the prototype, but then we saw an interesting behavior emerge for the first time: they decided to take a little bit of time off to discuss their findings from the first playthrough and plan their strategy for the second time around. During this planning meeting, they discussed what to prioritize at the start of the game, from resources to crafts. They also decided to structure themselves hierarchically; a leader was chosen, one of the two people that had previous knowledge from the game and so had more experience and insight on what to do. The rest of the group divided themselves into multiple groups of two or three people. Each group had a specific goal in mind; some were to hunt boars in the forest, some were to go to the mountains and mine ores, and others were to gather other key resources. With the plan set and a motivated team, the second playthrough began.

The second playthrough start was a complete contrast to the first one; the group was focused, everyone immediately went to their designated locations, and they started working. The leader kept asking the different groups for progress and the amount of resources gathered. When it was enough to craft the necessary amount of items, the leader would call the groups to the base to get the resources. This process continued for a while, and the team managed to clear tier 1 of crafting in record speed. Upon reaching tier 2, they realized that the constant back and forth from the gathering locations to the base was also detrimental to progress, as precious time was being lost in the constant journeys. Therefore the group adapted; instead of everyone going to base to drop their resources, they took advantage of the fact that resources don't despawn when dropped on the ground to establish a transport system. It worked as follows: the resources gathering group would go to the edge of their biome closest to base and drop the their resources, meaning they never had to leave their zones; then someone would come by, pick up their resources and the ones dropped by others, and deliver them to base. This method was refined a few times to make it more optimized, and by the end it translated into increased efficiency that led the group to tier 3 of crafting.

Upon reaching tier 3, the group faced a massive progression wall. The problem here is that no other playtesting group had reached this point, and so, from tier 2, we were balancing the game based on our intuition. Unfortunately, the costs of crafting became exponentially higher, to a degree that wasn't achievable in the time frame the group had. In addition, something was wrong with the boar spawners; the boars weren't spawning frequently, and boar hair, the main resource they dropped, was crucial to progressing the game. Therefore, after much valiant effort by the group until the last minute, the playthrough ended still in tier 3.

Regardless of the outcome, this final playthrough proved invaluable data to us, both for the thesis research topic and also to further balance the game, and so we found that the third playtesting session was extremely worthwhile.

6.2 Survey Analysis

6.2.1 Pre-Session Survey

For the analysis of our survey responses, we have decided to divide the playtest data we gathered into two categories: university playtests and the **FunRock** playtest. We use the term "university playtests" to refer to the combined data from the first and second playtest sessions as a single category. We have combined the data gathered from these two sessions because the playtests were held only four days apart, meaning that the prototype didn't change drastically between them. Additionally, a considerable number of players who participated in the first playtest have also joined the second one, meaning that they answered the pre-session survey only once. The participants in these two playtests were mostly our university classmates, hence the name. On the other hand, the "FunRock playtest" data designates responses gathered from the third playtest, where the participants were solely employees from **FunRock & Prey Studios**. The changes made to the prototype and the post-session survey between the second and third playtests were so transformative that we needed to create a dedicated category for them.

As discussed in section 5.3.1.1, the pre-session survey is comprised of four distinct questions that provide us information on the player demographic of our participants. It tells us their gaming experience, familiarity with games similar to our prototype, and behavior tendencies in cooperative groups. We can use this information by comparing these results to the answers we see in the post-session survey and seeing if players adhere to their predicted behavior. Now we'll go over each question and analyze the responses we gathered from both categories. In total we have 19 responses for the pre-session survey, 11 from university participants and 8 from **FunRock** ones. The appendix displays all of these answers.

In the first question (6.1), "Where do you put yourself, as a gamer, in this spectrum?" participants answered in a range from 1 to 5, representing casual to hardcore. Here, we can see a clear division between university and **FunRock** participants. We can observe that university participants are spread out, with values ranging from 2 to 5, with responses creating a normal distribution around 3.25, which tells us that this demographic of players is average in their casualness, realistically representing the general distribution of players we could expect to play our game. In contrast, **FunRock** participants tend to be above average and are more skewed towards the hardcore side, exhibiting a narrower normal distribution centered around 4, with no responses below 3. This means that in the third playtest, players were generally more hardcore, meaning they tend to get more invested in their games and are more demanding when it comes to mechanical depth in order to test their skills, as discussed in 2.3, which means we can expect them to do better in the prototype while also getting more critical feedback from them.

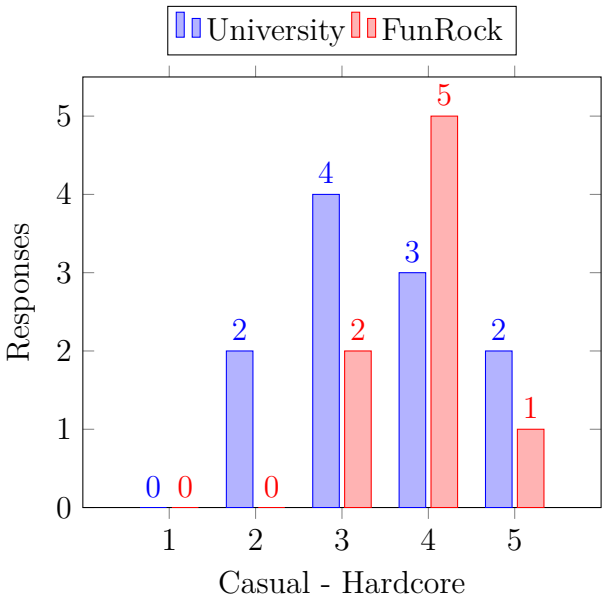

Figure 6.1: Did you feel a sense of accomplishment from the contributions you made to the group?

When it comes to question 2 (6.2), "In a group scenario, do you tend to position yourself as the leader?", we see that university players are more shy than their **FunRock** counterparts in terms of taking leadership roles when playing cooperative games. On a scale from 1 to 5, with 1 meaning they never take leadership, most university answers are in a normal distribution around 2, with only a couple of answers above 3. This data shows that once a leader organically coalesces in this group, even though not many will willingly take on that mantle, 81.8% of them will be satisfied being managed and getting tasks, which is a behavior we observed in the second playtest (6.1.2). Since we designed our prototype in a way that having a leader is essential for the optimal functioning of the group (2.4), we are glad to observe that even if the group's individuals are generally reluctant to become leaders, our game mechanics did organically create one in the second playtesting session (6.1.2). In contrast, more than half of **FunRock** players responded with a 4, meaning that nudging somebody in this group to be a leader with mechanics is substantively easier and they will also be satisfied being in that position, which we clearly saw in the role hierarchy created during the third playtest (6.1.3).

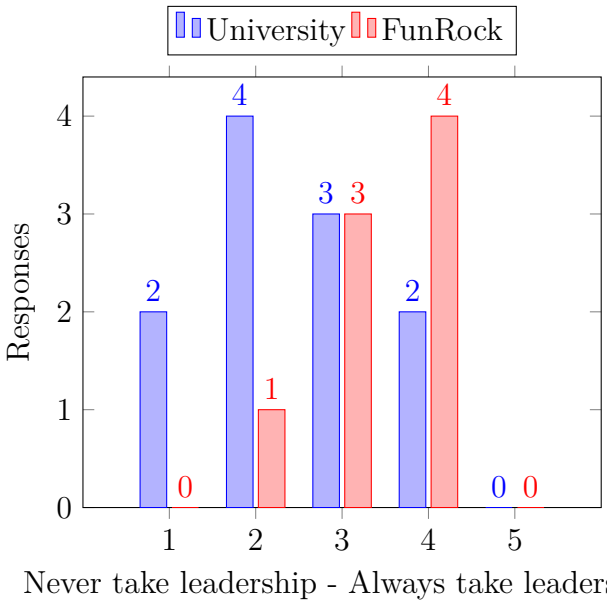

Figure 6.2: In a group scenario, do you tend to position yourself as the leader?

In the third question (6.3), asking players about the experience they have with cooperative games on a scale from 1 to 5, we can see that responses in both categories are spread across the whole spectrum. A couple of participants in the university group had very little experience with cooperative games, answering 1, which might be correlated to the fact that in the first playtest (6.1.1), a similar number of players were mostly adventuring on their own for the majority of the playthrough and didn't communicate much with the group. Since the game becomes much easier once players start cooperating, we saw these specific players become more communicative and cooperative over the course of multiple playthroughs, allowing the team to progress even further, which is precisely the emergent behavior we want to see (2.4). Apart from this, it's evident that most players in both groups are accustomed to collaborating during games. Similar behavior was evident when both groups functioned as a cohesive unit; there were no instances of frustration between players, no disputes requiring resolution, no doubts about leadership, and players were content with completing their assigned tasks and communicating accordingly.

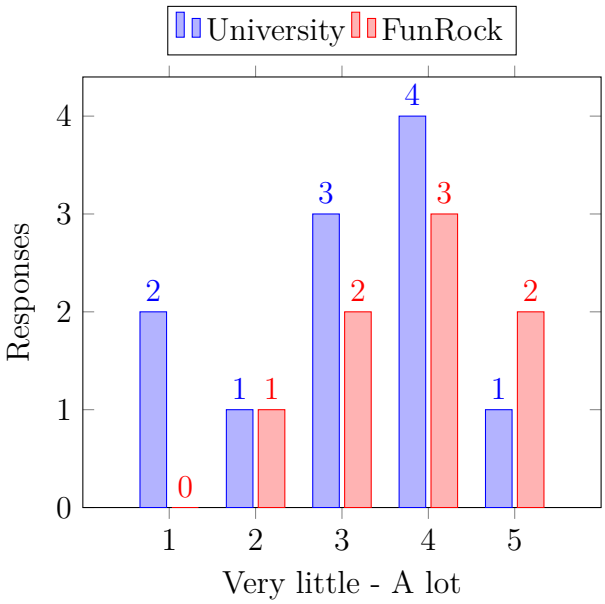

Figure 6.3: How much experience do you have with cooperative games?

The fourth question (6.4) asks players how familiar they are with survival games on a scale from 1 to 5, ranging from never playing to being very familiar. This question allows us to see how experienced our playtesters are with mechanics similar to the ones in our sandbox prototype 2.5, allowing them to potentially figure things out faster and be able to rely on intuition. The university participant data shows us that most participants barely play survival games, which might explain the initial chaotic behavior in the first playtest (6.1.1), where players were not grasping the crafting concepts quickly and were reluctant to interact with them, mostly opting to run around aimlessly. On the other hand, **FunRock** playtesters have visibly more experience with survival games, which might have been a contributing factor to how far they got in the game's progression.

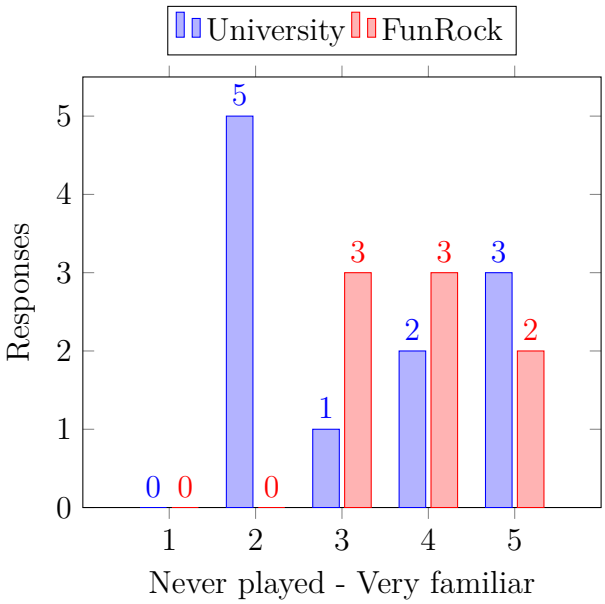

Figure 6.4: How familiar are you with survival games?

6.2.2 Post-Session Survey

6.2.2.1 University

In this section we'll go over the post-session survey results for the university playtest session, as defined in the previous section, and analyze them question by question. We collected 12 responses to this survey, 5 following the first playtest and 7 following the second. Players who have participated in both playtests were asked to fill out the form twice since their experience could have differed between the two sessions.

The first question (6.5) asked players to select tasks they had performed during their playthrough. A key aspect of this question's data is that participants could select multiple options simultaneously, as they likely changed roles during the session or held multiple roles within the group. By analyzing the gathered data, we can see that in both playtests, most players became dedicated gatherers, while smaller subsets of those players also considered themselves explorers or hunters, sometimes even both. In other words, no player only considered themselves a hunter or an explorer, since the game required them to always contribute to the group's progress by gathering. The only players who did not gather were the players who specialized in crafting. As we said in sections 5.1.1 and 5.1.2, we wanted crafting and gathering to be the two main gameplay pillars, and this data shows we made them so complex and interdependent that players can't do both at once. Although this question suggests to participants that there are five distinct activities in the game, we actually designed it so that players fall into these two main categories: gatherers, who also explore and hunt (the majority of the group, 100% in the first playtest and 71.4% in the second), and crafters, who lead by designating tasks based on their knowledge of progression (just a few individuals).

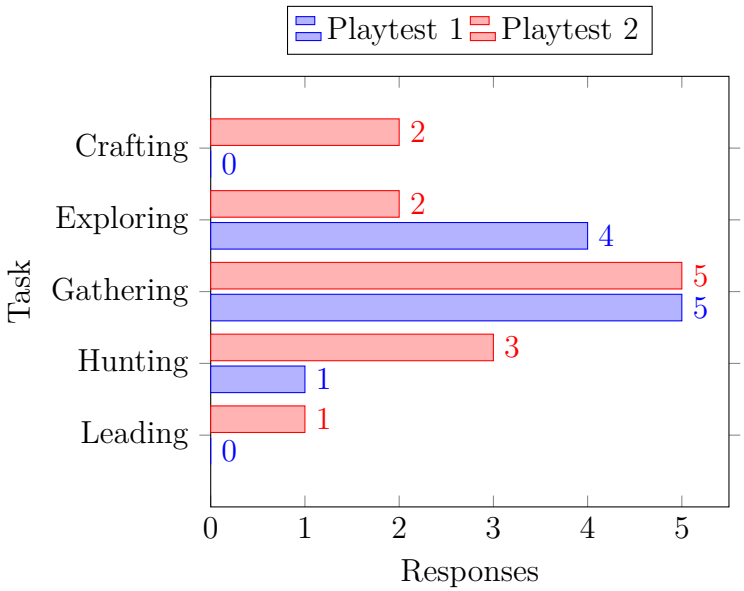

Figure 6.5: What tasks did you mainly perform in the game?

In this question's answers, we can see that in the first playtest, no player considered themselves a crafter, which explains the lack of progress we saw in that specific playtest session. In this first session, we also saw that most gatherers identified as explorers, which explains their individualistic behavior and lack of concern for what they were gathering or how they could use it. On the other hand, we can see that someone took up the dedicated mantle of leader in the second playtest, which is precisely what we noticed when observing the group's dynamic. This singular leader also felt responsible for crafting, which is precisely how we wanted the position of crafter to function: by being so integral to the progression that it inadvertently puts players who specialize in it into positions of leadership, creating role hierarchies in the group 2.4. The second question (A.1.1) provides us additional written open responses about the contribution each player made to the group. These manifest the observations we made while watching these two playtests, but most importantly, they prove even further the conclusions we drew from the analysis of the first question.

Question three asks players if they feel a sense of accomplishment from the contributions they made to the group 6.8. According to the data we gathered from both playtests, figures 6.6 and 6.7, respectively, we can clearly see that the player sentiment is overwhelmingly positive; 100% of answers were "Yes" in the first playtest and 85.7% in the second when it comes to getting satisfaction from contributing to the group in our prototype in both sessions. Since creating satisfaction from being part of a community (2.2) was the main goal of creating such a demanding, hyper-cooperative experience, we are glad to see these results.

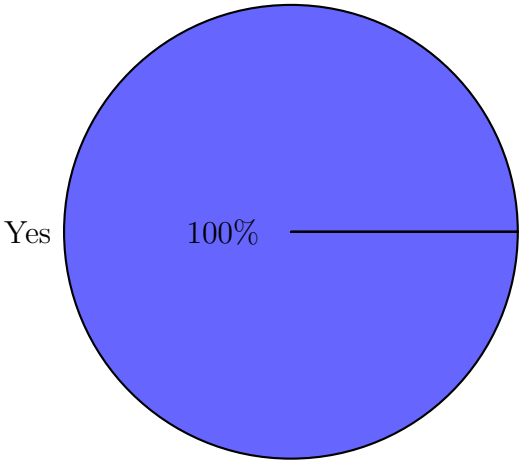

Figure 6.6: Playtest 1

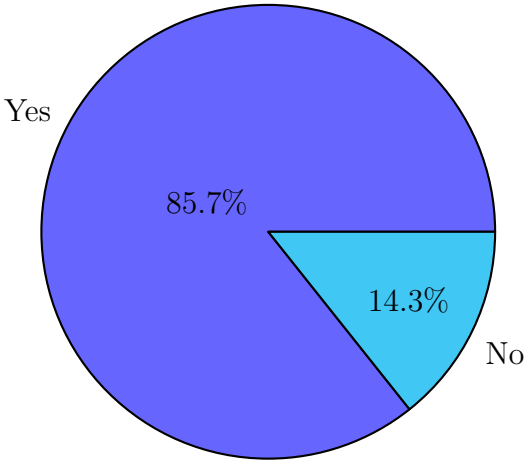

Figure 6.7: Playtest 2

Figure 6.8: Did you feel a sense of accomplishment from the contributions you made to the group?

In the fourth question, "On a scale of 1 to 5, how much do you feel like you contributed to the progression of the game?" (6.9), the two groups show quite different results. In the first playtest, 80% of players answered "3," which makes it clear that they mostly feel that they contributed an average amount to the group's progression. This is most likely due to the fact that there was not much of a group to contribute to in this playtest, since they had no leader, were individually adventuring, and had no effective semblance of a plan. When it comes to the second playtest, we can see an even spread of answers divided into two distributions, centered around 1.5 and 4.5, respectively, skipping over the neutral answer of 3. This tells us that in this session, where we could actually observe some group hierarchy dynamic 2.4 with distinct allocation of tasks organized by a leading figure, players either felt that they contributed a lot or not much. Thankfully, such an outcome doesn't mean that these players were unhappy with the amount they were contributing, since according to responses to the third question, nearly all players were satisfied with their contribution to the team, which is precisely how we wanted to make players feel, according to our research (2.2).

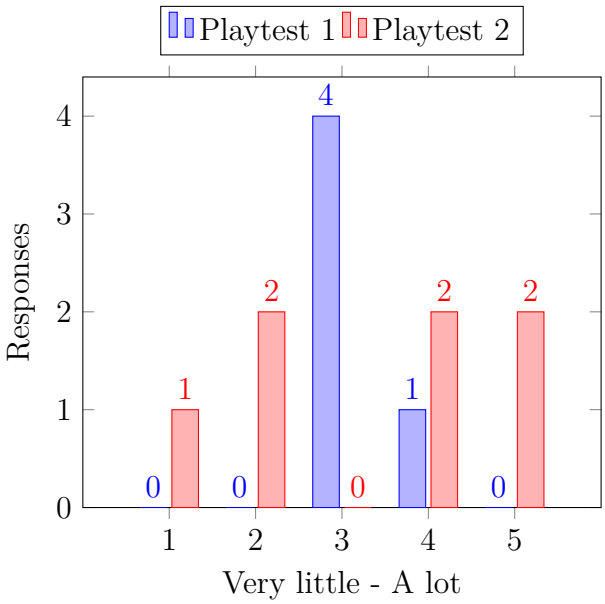

Figure 6.9: From 1 to 5, how much do you feel like you contributed to the progression of the game?

The fifth question, "Do you think that it is possible to win the game within the given time?" (6.12), is part of a series of questions that we used to gather formal feedback on the progression-related values in our prototype. We used this data to implement balancing changes to make our prototype a better game with the right amount of challenge. Other questions in this category include question eight, "What do you think about the crafting costs?" (6.15) and question twelve, "What do you think about the amount of resources that resource nodes give you?" (6.18). When comparing the responses we received from the first and second playtests, we can deduce that the further in the progression the group advances, the more issues they start seeing with the balance of the game's costs and end timer. This test proved to us that the early game's balance is adequate, but the game's resource requirements start to become exponentially more demanding in later stages of the game, making the game impossible to win in the time allocated. After seeing these issues, we have tried to balance the game as best as we could before the third playtest, as previously discussed in section 5.3.3.

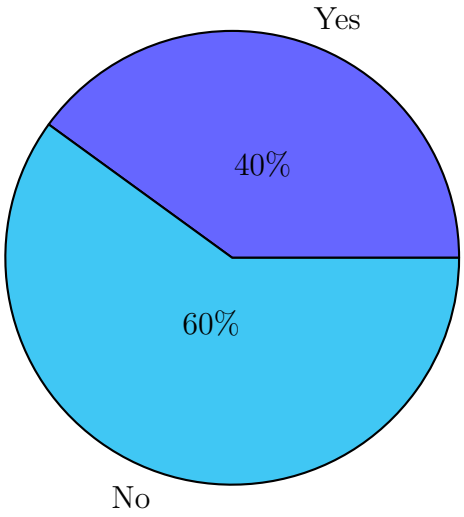

Figure 6.10: Playtest 1

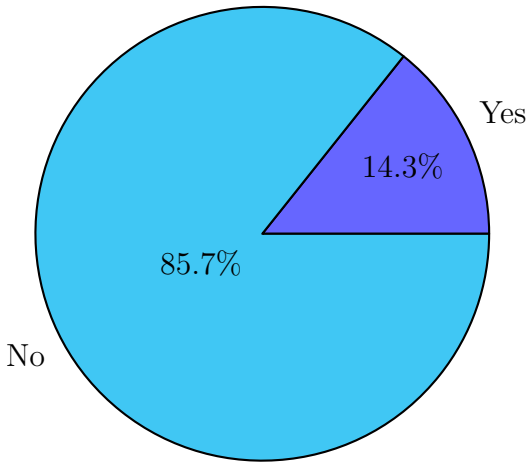

Figure 6.11: Playtest 2

Figure 6.12: Do you think that it is possible to win the game within the given time?

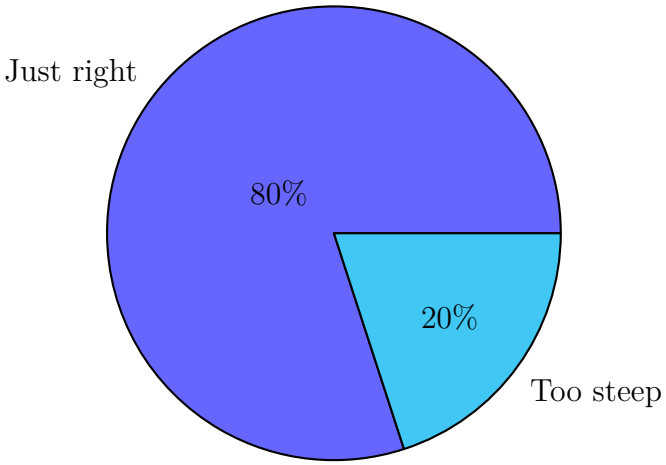

Figure 6.13: Playtest 1

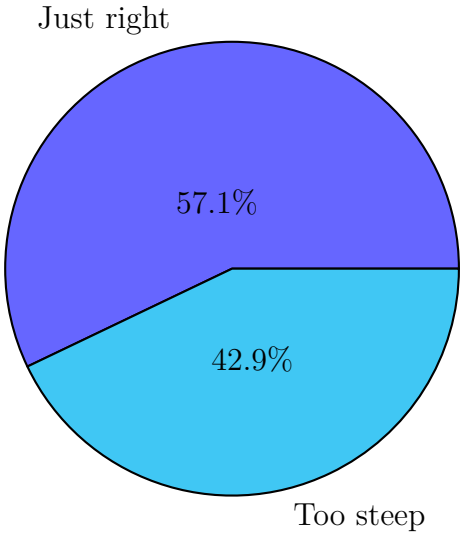

Figure 6.14: Playtest 2

Figure 6.15: What do you think about the crafting costs?

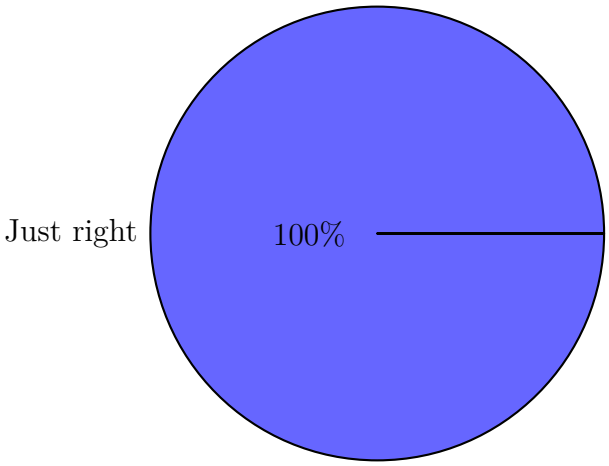

Figure 6.16: Playtest 1

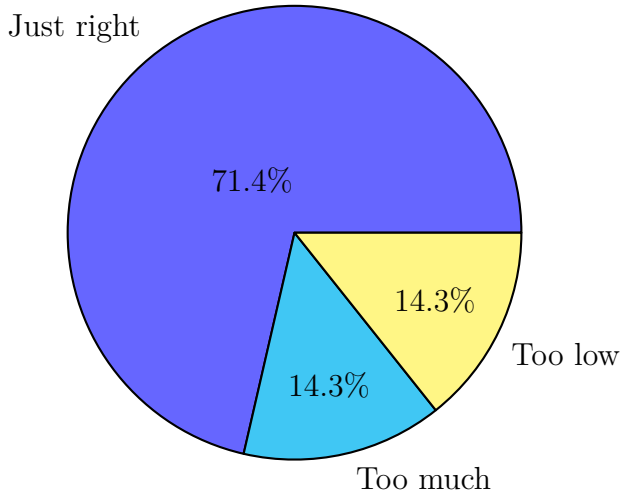

Figure 6.17: Playtest 2

Figure 6.18: What do you think about the amount of resources that resource nodes give you?

Question six asks the participants if they think the game becomes easier after multiple playthroughs. We are delighted to see that all participants in both playtests unanimously believe that the game becomes easier with each subsequent playthrough (6.21), since it was one of the priorities when designing the mechanics for our prototype, as discussed in section 5.2.4. Because we designed the prototype to be an "escape room"-like" puzzle experience, it is crucial that players do not feel discouraged and helpless every time they start a new playthrough; on the contrary, they should feel that through better cooperation, they will advance further as a team. The answers we received for this question effectively prove that our playtesters have this sentiment.

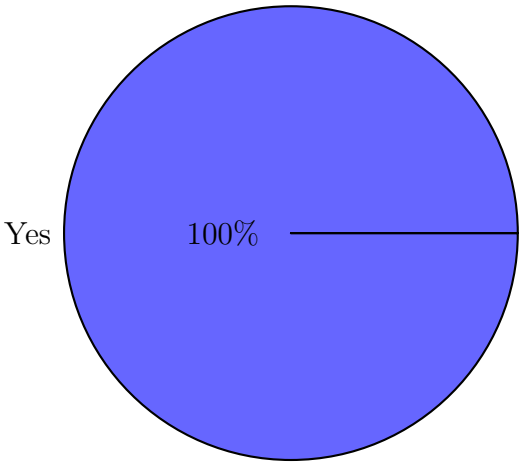

Figure 6.19: Playtest 1

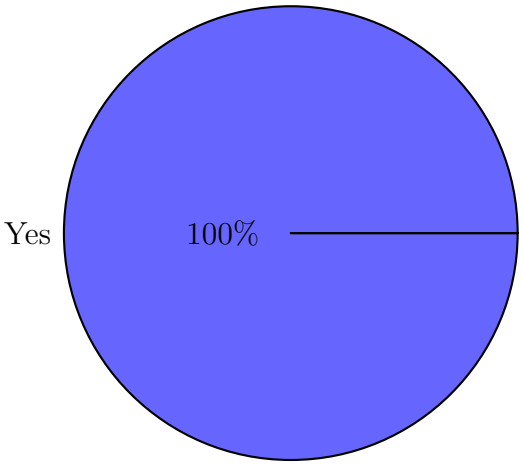

Figure 6.20: Playtest 2

Figure 6.21: Do you think the game becomes easier after multiple playthroughs?

Question seven, "How complex did you consider the crafting system to be?" (6.22) is part of a large category of questions that allow us to diagnose the quality of all components of our game's design and see how close they are to fulfilling our vision for them, with the hope of gathering enough data to be able to pinpoint aspects that need improvement in our prototype. The other questions in this series are question nine, "How rewarding did you find the map exploration to be?" (6.23), question ten, "What is your opinion on the map's design?" (A.1.2), question eleven, "How interesting did you consider the resource gathering to be?" (6.24), and finally question thirteen, "How enjoyable did you find hunting to be?" (6.25). Thankfully, there was no specific aspect of the game that visibly failed, but there are some important takeaways that we should consider in some of the answers we gathered. Firstly, in question seven, since most players didn't interact with crafting, their opinion of the system's complexity is not valuable as a metric of success. However, the players who actually specialized in it believed it to be very complex, which is exactly what we wanted to see. Secondly, the open answers to question ten about the opinions of participants on the map's design serve us as a valuable basis for ideas on how we could improve the map in the future, but it also diagnoses an issue with the game's mobility and traversal options, which we ended up addressing by implementing updates after the second playtest (5.3.3). Lastly, players primarily experienced issues with hunting, as indicated in question thirteen. This can be attributed to their belief that weapons were not craftable for most of their playthroughs (6.1.1 6.1.2), a point that will become proven in the next questions we will discuss.

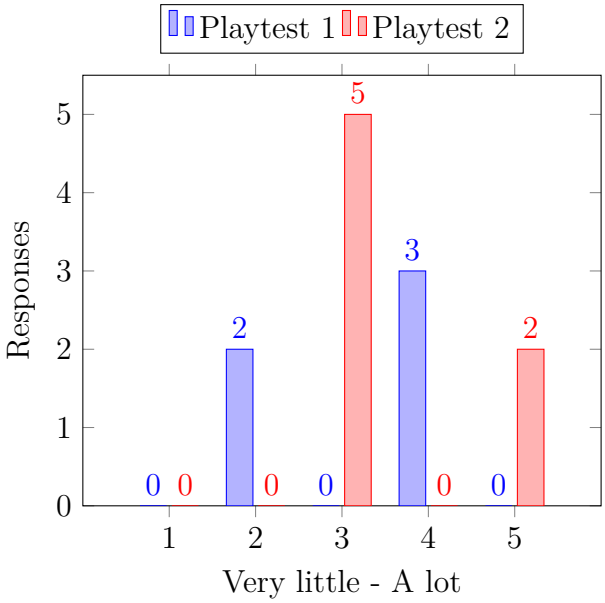

Figure 6.22: How complex did you find the crafting system to be?

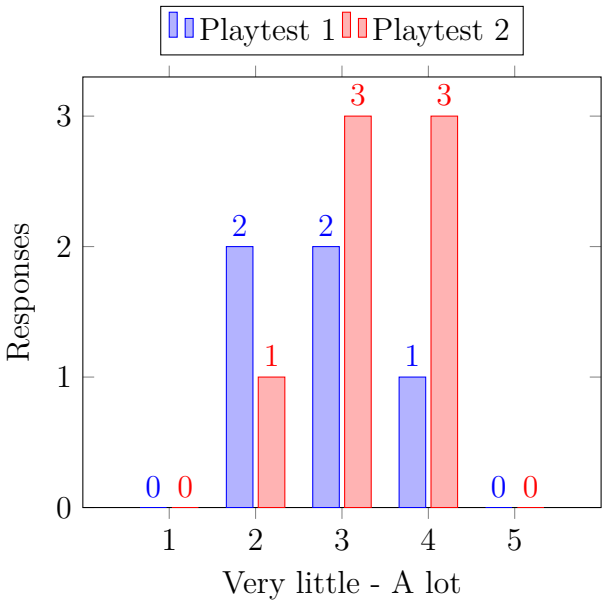

Figure 6.23: How rewarding did you find the map exploration to be?

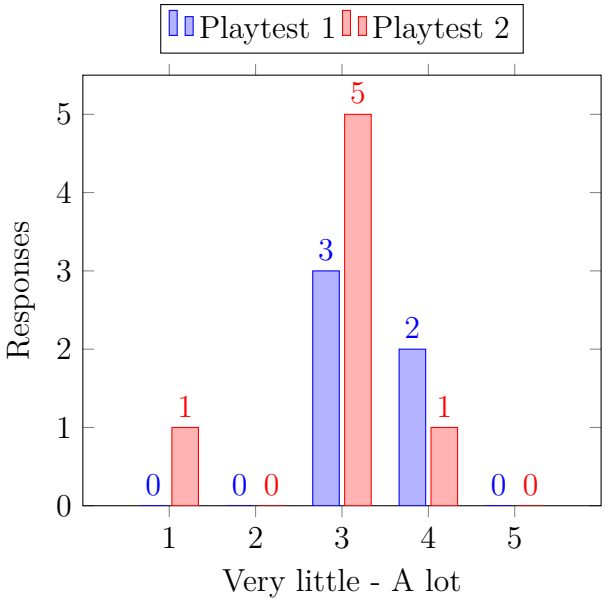

Figure 6.24: How interesting did you find the resource gathering to be?

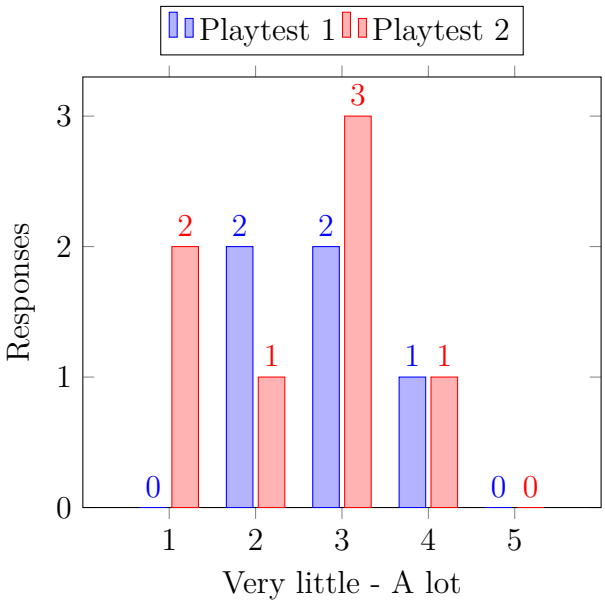

Figure 6.25: How enjoyable did you find hunting to be?

Question fourteen, "Do you think there is enough access to quality-of-life consumables to succeed in the game? (healing, shield potions, etc.)" (6.28) and question fiftenn, "Do you think there is enough access to weapons to hunt effectively in the game?" (6.31) both provide us insight into the playtester's opinion of the reward structure of our prototype's crafting progression. To satisfy our players at all stages of the game, we need the crafting system to provide them with progressively more efficient tools that serve as rewards for their investment into the different systems of the game (5.1.1). According to the results of these two questions, we have failed in this mission in the early stages of the game, since players believe there are not enough weapons or quality-of-consumables to feel properly rewarded at that point in the progression. Additionally, we have seen in their playtest behavior that, because of this lack of rewards in Tier 1 crafting, players do not actually believe they will ever get rewarded with such tools. 6.1.1 6.1.2. Because of this, we have revamped the crafting recipes in earlier tiers and added new rewards to compensate 5.3.3.

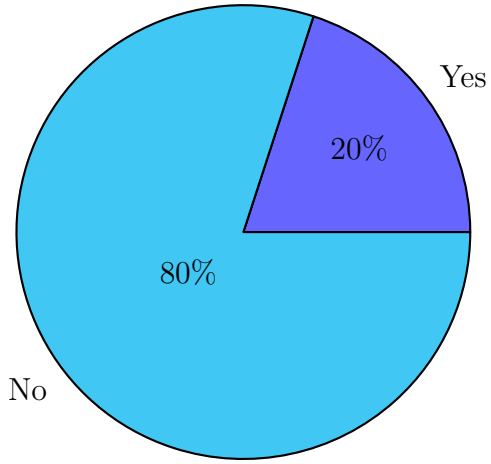

Figure 6.26: Playtest 1

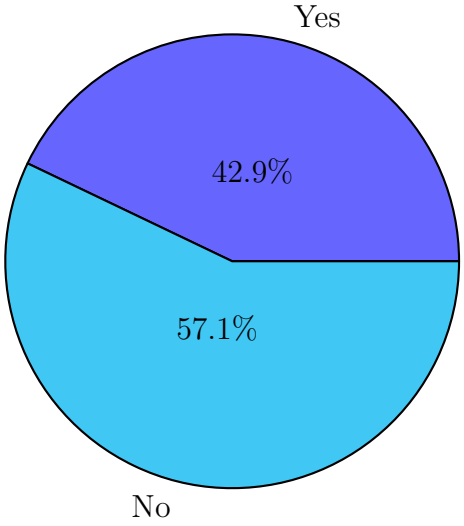

Figure 6.27: Playtest 2

Figure 6.28: Do you think there is enough access to quality-of-life consumables to succeed in the game? (healing, shield potions, etc.)

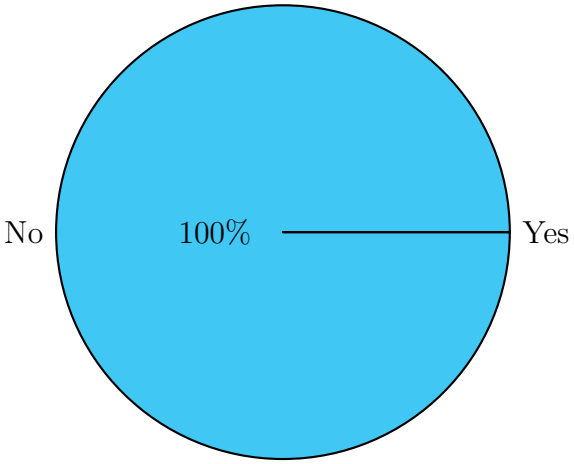

Figure 6.29: Playtest 1

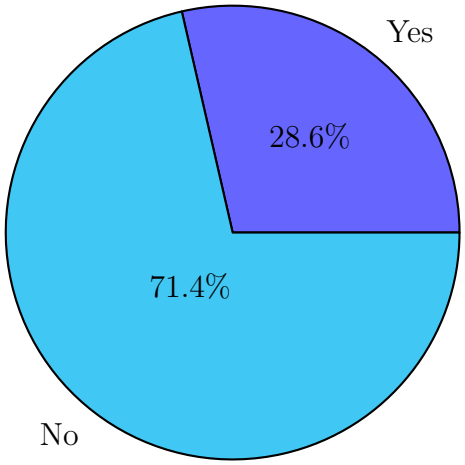

Figure 6.30: Playtest 2

Figure 6.31: Do you think there is enough access to weapons to hunt effectively in the game?

The sixteenth question asks players how organized they thought their group was while playtesting (6.32). Here, we can clearly see a difference between the centers of the two distributions created by the data gathered from their respective playtests. On one hand, the normal distribution representing the first playtest is centered around 3, showing that participants generally had a neutral opinion towards the cooperation of their group, which could be seen in their lacking cooperation while playing, caused by the lack of a leader 6.1.1. On the other hand, the normal distribution of the second

playtest is evenly centered around 4, with some answers even being 5, meaning that the group in this playtest was much more unanimously confident in their cooperation and believed themselves to be more productive as a unit. They very clearly displayed this behavior when observed by them, which was undoubtedly correlated with the fact that they had a dedicated leader who organized everyone's tasks (6.1.2).

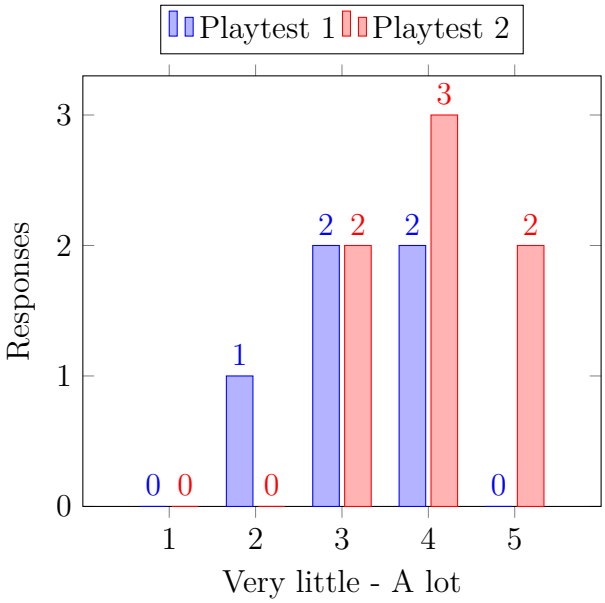

Figure 6.32: How organized do you think the group was during the playtest session?

This observation is proved once again by responses gathered by question seventeen (6.35), "Do you think the group would've been more optimized if there was someone taking a leadership role?" In the first playtest (6.33), even when they didn't have a leader up until this point, all participants unanimously agreed that their team would be more efficient if someone took on a leadership position within their group. Conversely, 71.4% of players in the second playtest said that they had a dedicated leader during this session (6.34), and they all agreed that the positive impact this leader had on their effective cooperation was monumental. This particular data is demonstrated in question eighteen, "How much do you think the group leader impacted the group performance?" (6.36). The combination of these two questions allows us to prove that our game concept undoubtedly requires the creation of a cooperative role hierarchy to succeed 2.4.

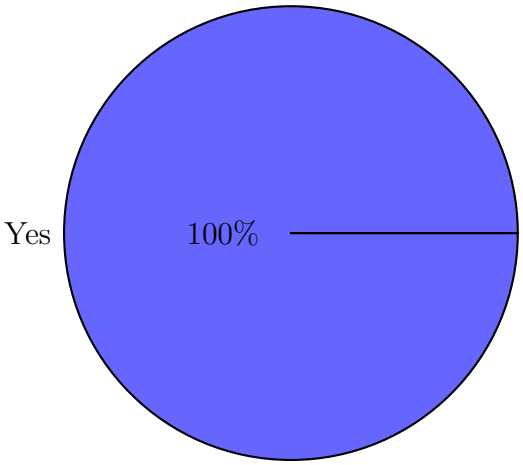

Figure 6.33: Playtest 1

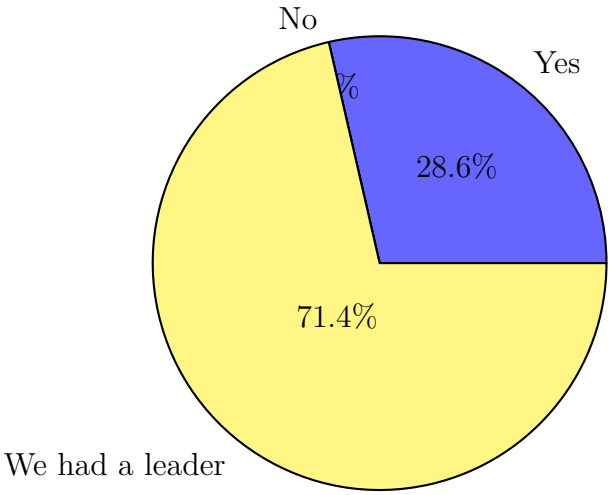

Figure 6.34: Playtest 2

Figure 6.35: Do you think the group would've been more optimized if there was someone taking a leadership role?

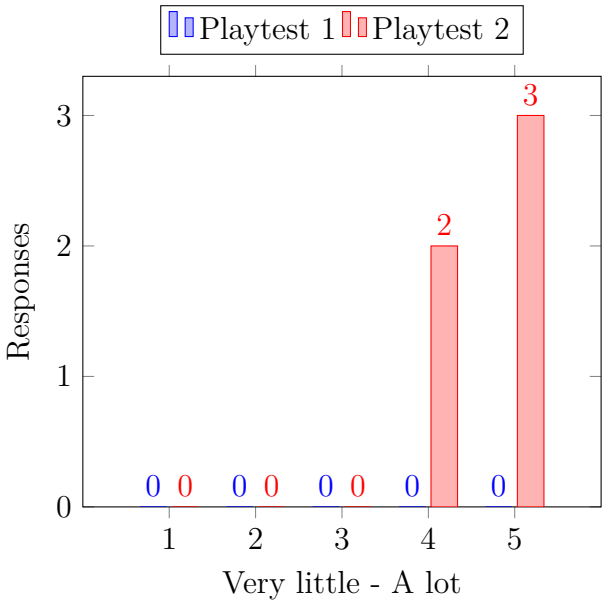

Figure 6.36: How much do you think the group leader impacted the group performance?

In question nineteen, "Do you think that the game is capable of appealing to both hardcore and casual gamers?" (6.39), the vast majority of players, 100% in the first playtest and 85.7% in the second, answered "Yes," which shows us that, for the most part, we achieved our goal to create a cooperative experience that is capable of appealing to players of all skill levels (2.3). There was one participant who didn't agree with this in the second playthrough, however, and in question twenty, "In

what ways do you think the game could appeal more to both casual and hardcore players?" (A.1.3), they responded that they think adding more late-game content and progressively increasing the player's statistics, such as movement speed, by progressing through the game would make the game more appealing to hardcore players. We agree that giving players tangible gameplay upgrades by unlocking new crafting tiers is something the game needs to reward players even more for their efforts. However, we believe that the game offers sufficient late-game content. The problem lies in the fact that players have barely explored the mid-game progression due to the way the prototype was balanced in this version.

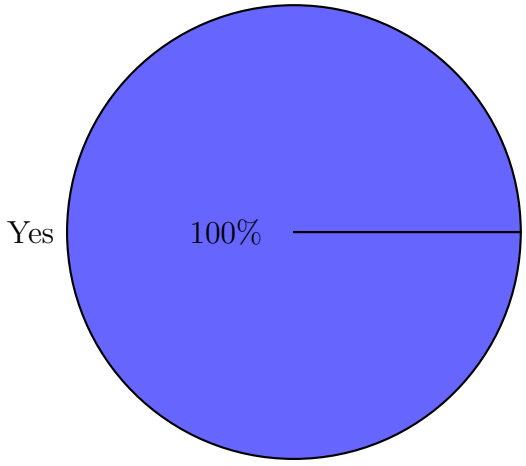

Figure 6.37: Playtest 1

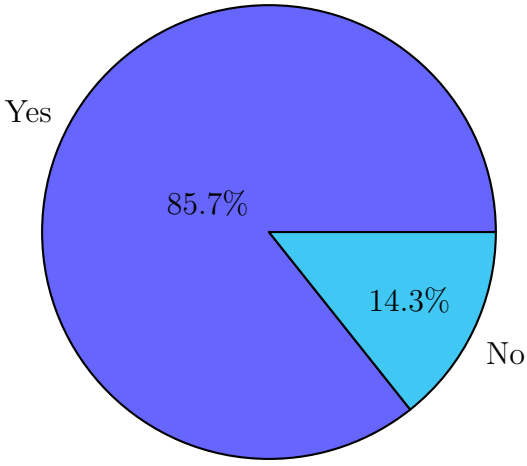

Figure 6.38: Playtest 2

Figure 6.39: Do you think that the game is capable of appealing to both hardcore and casual gamers?

In the twenty-first question, "Do you think the lack of explanations in the game promoted group work and communication?" (6.42), 80% of players agreed with the statement in the first playtest, while 100% of players unanimously answered "Yes" after the second playtest. These answers are tightly related to question twenty-two, where we ask players about their thoughts regarding this lack of explanation and guidance (A.1.4). Here, 83.3% of players manifested this point even further, talking about the fact that this sense of collective discovery without guidance added to the cooperative experience and made them communicate more and that having things explained to them would hinder the social aspect of the game. This data proves our theory from section 5.1.1, where the lack of explanations and guidance typical in sandbox games (2.5) brings players together to create efficient cooperative groups in order to trailblaze progression collectively. However, many players noted that not knowing what items the stations craft after use does not contribute positively to the game and is generally frustrating. After seeing many people interact with this system, we agree with this sentiment and would like to update it in the future.

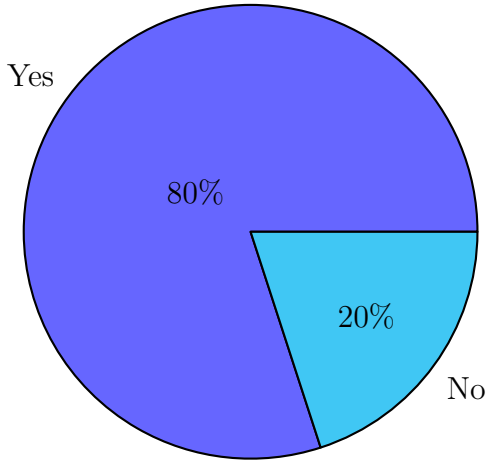

Figure 6.40: Playtest 1

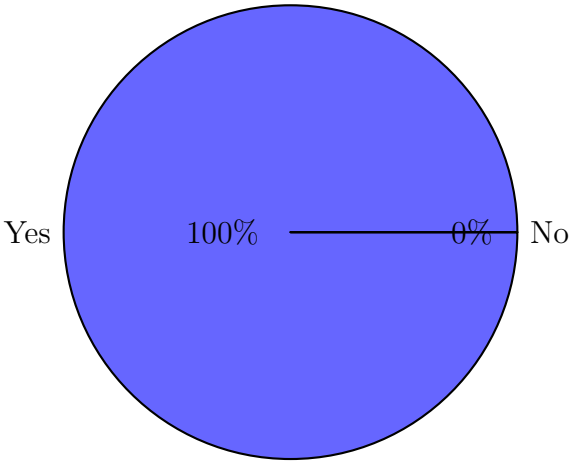

Figure 6.41: Playtest 2

Figure 6.42: Do you think the lack of explanations in the game promoted group work and communication?

The second-to-last question of the survey, question twenty-three, "In what ways do you think the game could promote further group cooperation and communication?" (A.1.5), gave us a variety of responses. Some noteworthy suggestions were to add more social-oriented tools that would allow players to communicate effectively, such as a more customizable map ping system with proper coordinate information capable of marking resource locations, being able to draw and write information on the map for every team member to see, a journal that marks previously discovered landmarks on the map, and even having a quest board-style system where players can write down what resources are needed or what tasks need to be done and players can assign themselves to them. The common theme of these features is that players need ways to effectively communicate information in-game without needing to explicitly ask individuals for knowledge every time when playing in large groups. This is already a concept we saw as necessary when observing the second playtest (6.1.2), and all of these mentioned features would work as functioning solutions to this communication issue.

The final question of the survey, question twenty-four, "Do you have any other thoughts/feedback?" (A.1.6) was also an optional, open-ended question where playtesters could express additional feedback they had on their mind. We used most of this feedback to implement changes between the second and third playtest (5.3.3). Unfortunately, while most of these suggestions were implemented, some of them were simply out of the scope of our possibilities, such as giving gatherers more efficient tools, like we discussed in section 5.2.3.

6.2.2.2 FunRock

In this section we'll go over the post-session survey results for the **FunRock** playtest session and analyze them question by question. In total, we got 6 people to answer

this survey.

In the first question, "Did you feel a sense of accomplishment from the contributions you made to the group?" (Figure 6.43), five people answered "yes" and one person answered "no". Here we were hoping to see players feel a sense of accomplishment regarding their work for the group, as we talk about in section 5.1.1. These results show us that this was the popular sentiment between players and that, regardless of the tasks people were doing, they felt like a core part of the group dynamic. In this particular case, we talked with the person who answered "no" and they explained to us that they felt this lack of sense of accomplishment because their task in the game was to hunt boars, and as we described in section 5.3.4, boars weren't acting as intended during the playthroughs.

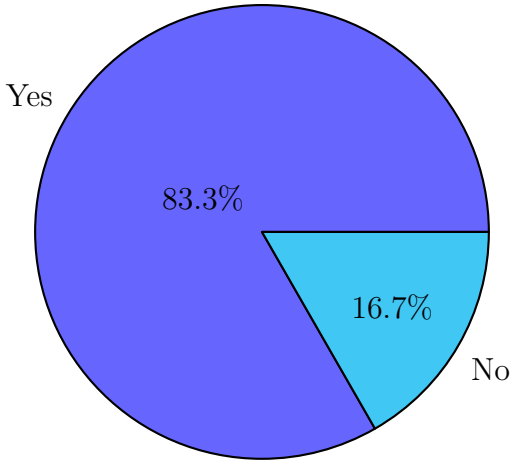

Figure 6.43: Did you feel a sense of accomplishment from the contributions you made to the group?

On the second question, "On a scale of 1 to 5, how much do you feel like you contributed to the progression of the game?" (Figure 6.44), two people answered "3", three people answered "4" and one person answered "5". This distribution leans towards people feeling a good sense of contribution to the overall game progression. Regardless of their in-game tasks, no one answered below "3", meaning that at the very least they felt a moderate sense of contribution, while around 83% of players felt that they contributed a good amount. This is what we wanted to achieve, as discussed in section 1.3. These results, together with the ones from the previous question, show us that we managed to create a cooperative experience that gave players a sense of accomplishment regardless of their in-game roles.

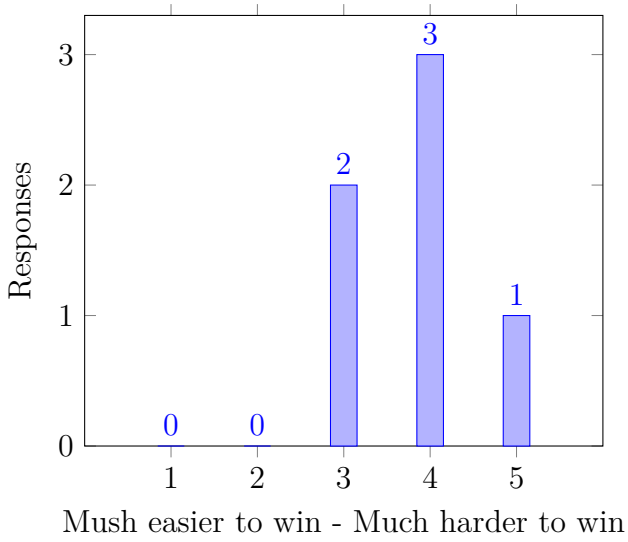

Figure 6.44: On a scale of 1 to 5, how much do you feel like you contributed to the progression of the game?

The third question, "Do you think that it is possible to win the game within the given time?" (Figure 6.45), saw only "no" as answers. As we discussed in section 5.3.4, the prototype version used for the session wasn't properly balanced towards the end game progression, making it impossible to clear, and therefore it makes sense to get these results.

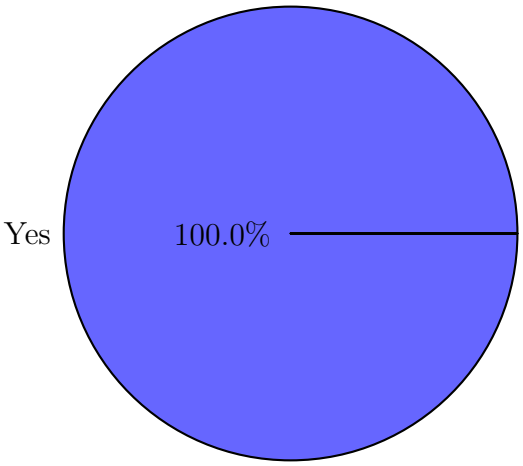

Figure 6.45: Do you think that it is possible to win the game within the given time?

Question four, "After multiple playthroughs, I would expect the game to become" (Figure 6.46), had the same results as question two, so two people answered "3", three answered "4 " and one answered "5", "5" in this question meaning that players thought the game would become significantly easier after multiple playthroughs. This question is directly tied to the sandbox element of the game, discussed in section 5.1.1; the lack of explanations incentivizes players to experiment, leading them to

accumulate knowledge in-between playthroughs. This theory can be observed in the question four results, as 100% of players expected their progression to be, at least, somewhat faster and the game easier as they replayed and understood the mechanics and environment better.

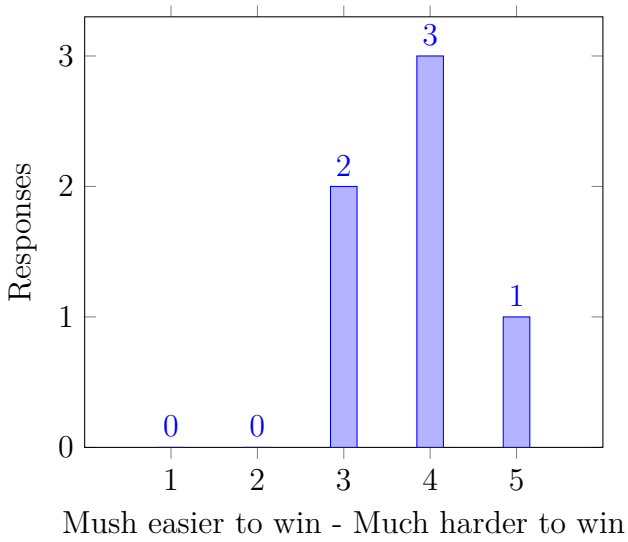

Figure 6.46: After multiple playthroughs, I would expect the game to become

Question five, "The amount of player access to quality-of-life consumables (healing, shield potions, etc.) is" (Figure 6.47), had one result in "2", two in "3" and three in "4". A high number in this question meant that people thought the in-game quality-of-life consumables were sufficient. We can observe that, although around 80% of players thought it was sufficient, not everyone agreed. The reason for the lower score is due to how quality-of-life items are locked behind later progression. There are some items of this category players can craft relatively early; however, their use is close to none as they don't provide meaningful support. The ones that provide significant support are obtained way later in the game, and due to the later game not being properly balanced, most players never got to see them.

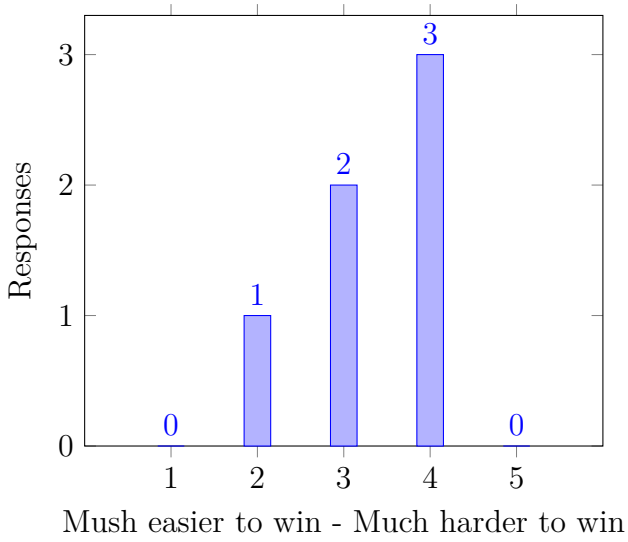

Figure 6.47: The amount of player access to quality-of-life consumables (healing, shield potions, etc.) is

The next set of questions was related to crafting. The first one of the set, question six, "Did you use the crafting system in the game?" (Figure 6.48) got three "no" answers and three "yes". This is likely due to the fact that, as talked about in section 5.3.4, in the first playthrough the group was a bit more disorganized, and therefore more people interacted with the crafting, whereas in the second playthrough only one person was in charge of crafting. The second question of the set, question seven, "How complex did you find the crafting system to be?" (Figure 6.49), had all the answers in "4", meaning most people found it to be challenging. This is yet another intended behavior that was expected to be observed, as we discuss in section 5.1.2 and is also observable in section 5.2.5, crafting was meant to be the most challenging system in the game and also the one designed to appeal to hardcore players. Therefore, seeing the 100% players agree that it was complex meant that mechanically it worked as planned. The third question of the set, question eight, "In your opinion, are the crafting costs" (Figure 6.50), everyone agreed that crafting costs were too steep. As mentioned already multiple times, the prototype was not balanced properly on the later stages of progression, and so this data helped us understand that so we could improve it. The fourth question of the set, question nine, "Do you think your job as a crafter would be facilitated if you had access to different tools to support you? (ex.: a chest system)" (Figure 6.51), got two "yes" and one "no". The objective of this question was to understand the importance of custom tools and also to branch into a follow-up question if players had answered "yes". The follow-up question was, "What types of tools would you like to see to help you facilitate the crafting duties?" (section A.2.1), the responses to this question were varied as it was open-ended, but the general sentiment was that the game would benefit from chests and trackers for items such as quest boards.

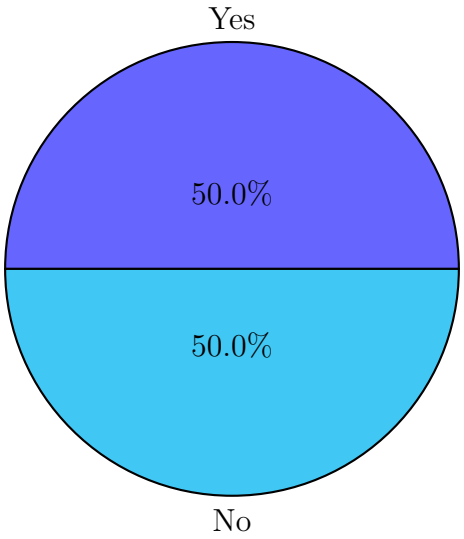

Figure 6.48: Did you use the crafting system in the game?

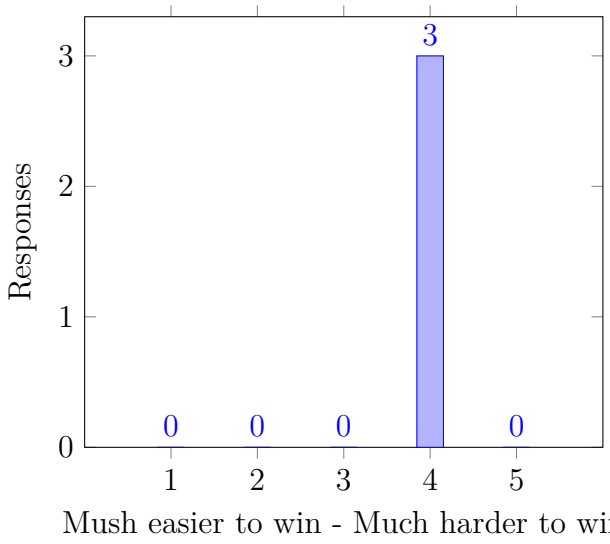

Figure 6.49: How complex did you find the crafting system to be?

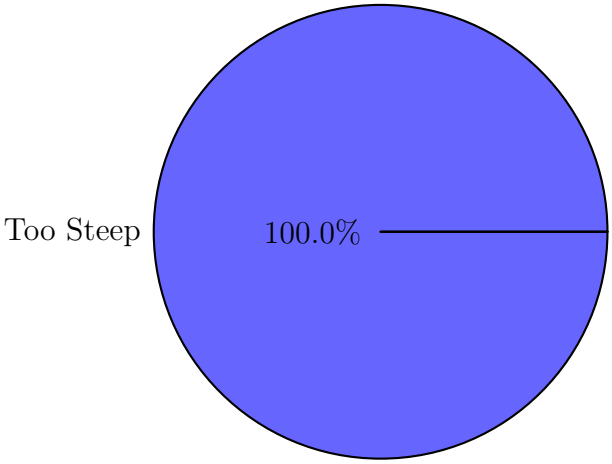

Figure 6.50: In your opinion, are the crafting costs

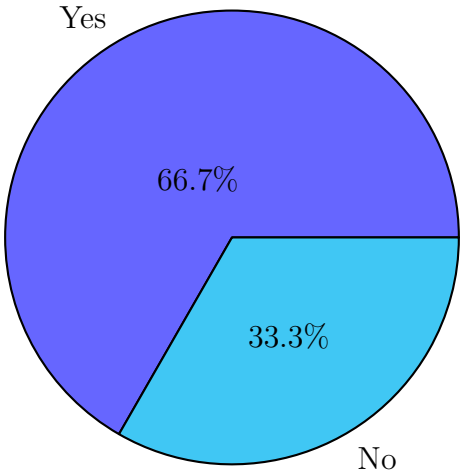

Figure 6.51: Do you think your job as a crafter would be facilitated if you had access to different tools support you? (ex.: a chest system)

The second set of questions related to in-game tasks was about exploring. The first question of the set, question ten, was "Did you explore the map in the game?" (Figure 6.52), and everyone replied "yes" to it. This question might seem a bit obvious, but we wanted to filter out anyone that potentially hadn't explored, such as the dedicated crafter, except this time around, everyone did. The second question of the set, question eleven, was "How rewarding did you find the map exploration to be?" (Figure 6.53), and we got five answers in "3" and one in "4". This question was related to sections 5.1.3 and 5.2.6, as we wanted to understand if our island design translated into players feeling rewarded. The answers were mostly in the middle; the cause of this, which we understood from talking with players and cross-referencing it with the data, was the fact that a lot of the interesting parts of the map were locked behind progression, and to get to that point, players had to reach the later tiers of crafting, which, as discussed previously, wasn't possible in this prototype

version. The third question of the set, question twelve, was "What is your opinion of the map's design?" (section A.2.2), this question was optional and open-ended, so the questions were varied, but the general idea we got from them was that players enjoyed the different biomes, but some areas didn't feel as rewarding as others due to either a lack of resources or being locked behind progression. The fourth question of the set, question thirteen, was "In your opinion, would your job as an explorer be facilitated if you had access to different tools to support you? (ex.: vehicles to traverse the map faster)" (Figure 6.54), to this question we got three "no" and three "yes". This question served the same purpose as the one in the crafting section and, likewise, had a follow-up for those who answered "yes". The follow-up question was, "What types of tools would you like to see to help you in exploration?" (section A.2.3), like before this question was open-ended, but the general consensus was that people would like to have tools to mark specific spots in the map and tag them with a name so others could see what the mark was about.

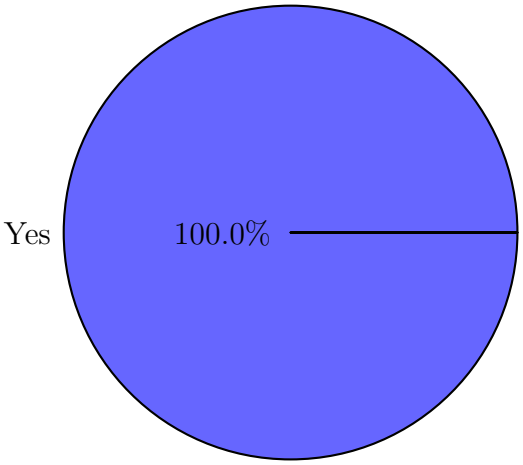

Figure 6.52: Did you explore the map in the game?

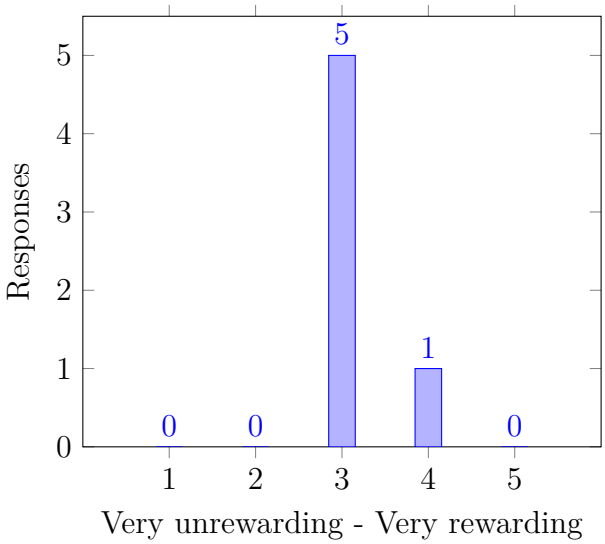

Figure 6.53: How rewarding did you find the map exploration to be?

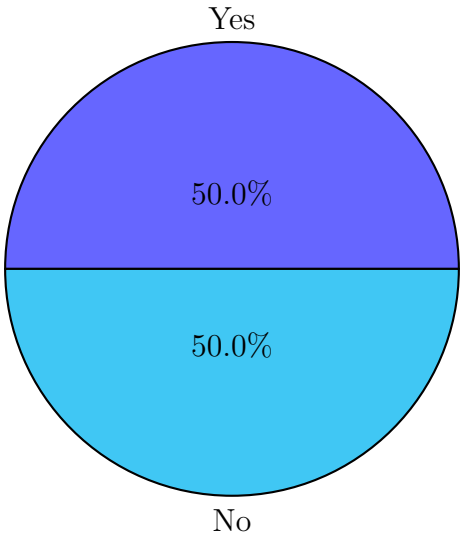

Figure 6.54: In your opinion, would your job as an explorer would be facilitated if you had access to different tools to support you? (ex.: vehicles to traverse the map faster)

The third set of questions was about gathering. The first question of the set, question fourteen, was "Did you gather items in the game?" (Figure 6.55), and everyone answered "yes" to it. This question was to filter only those who gathered, which, in this case, was everyone. The second question of the set, question fifteen, was "How interesting did you find the resource gathering to be?" (Figure 6.56), to this question we got two answers in "2", two in "3", one in "4" and one in "5". The results are quite dispersed, and we theorize it has to do with the zone people were gathering in as well as the resources they were gathering. Different zones offered different gathering experiences, as we describe in section 5.2.6. As mentioned in section 5.3.4, on the second playthrough, the group divided themselves into smaller groups with different resource goals in mind, and so, we find the spread of answers in this question to be related to that. The next question of the set, question sixteen, was "The amount of resources that resource nodes give you are" (Figure 6.57). To this question, we got three people who thought the amount was just right and three people who thought it was too low. This can also be connected to the resource groups we mentioned; not all resources were properly balanced at this stage, so for some, the amount they were collecting was enough for the crafting recipes, while for others it was lacking. The final question of the set, question seventeen, was "In your opinion, would your job as a gatherer be facilitated if you had access to different tools to support you? (ex.: different icons you can place on the minimap that represent resources)" (Figure 6.58), this question got four "yes" and two "no" and it served the same objective as the other similar questions from the previous sets. The follow-up to it was, "What types of tools would you like to see to help you in gathering?" (section A.2.4), and the responses here were similar to the ones in the exploration part, where people wanted better markers to pinpoint resource nodes.

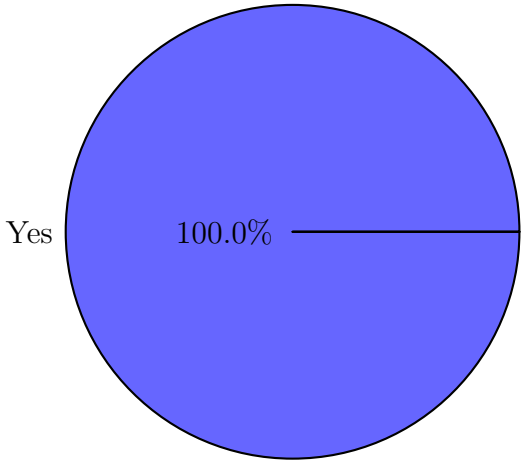

Figure 6.55: Did you gather items in the game?

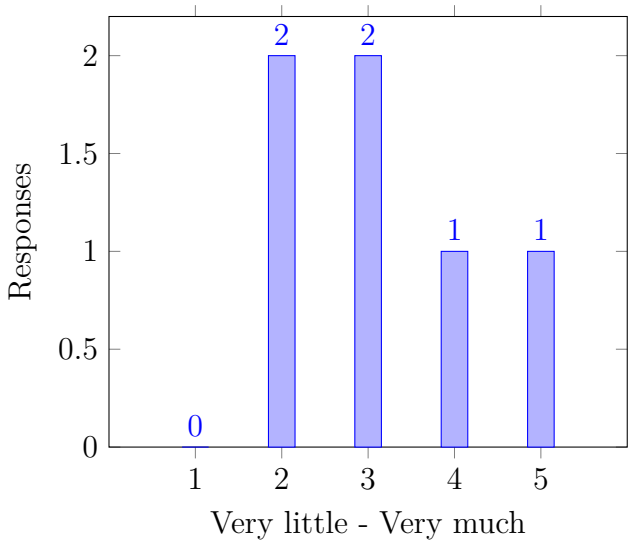

Figure 6.56: How interesting did you find the resource gathering to be?

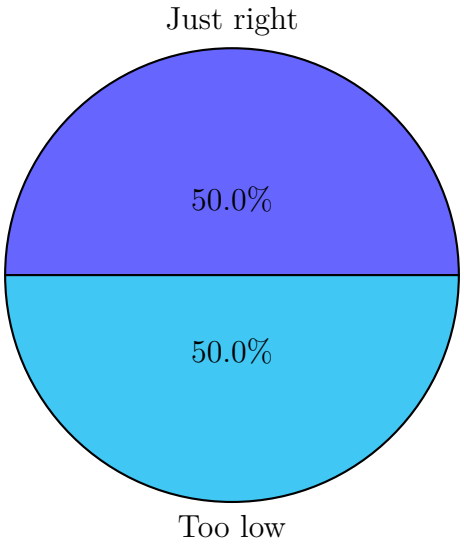

Figure 6.57: The amount of resources that resource nodes give you are

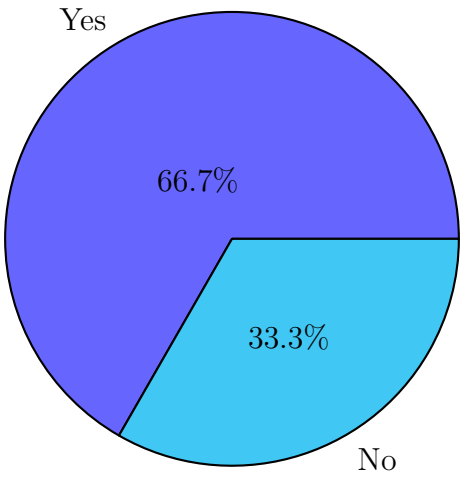

Figure 6.58: In your opinion, would your job as a gatherer would be facilitated if you had access to different tools to support you? (ex.: different icons you can place on the minimap that represent resources)

The fourth set of questions was about hunting. The first question of the set, question eighteen, was "Did you hunt wildlife or monsters in the game?" (Figure 6.59), everyone replied "yes" to this question. The goal was the same as the similar questions in the previous sets, which is to filter only those who partook in hunting. The next two questions of the set are closely related. Questions nineteen and twenty were, respectively, "How enjoyable did you find hunting to be?" (Figure 6.60), and "Do you think there is enough access to weapons to hunt effectively in the game?" (Figure 6.61). If we analyze the results, we see that, in question nineteen, four people found hunting to be enjoyable (three answered "3" and one answered "5"), and four people also said there were enough weapons available for hunting in question twenty.

According to what we observed during the session, we conclude that the people that got access to weapons were the ones who found hunting enjoyable, while the other two, stuck with only a pickaxe, didn't enjoy hunting as much. This data is also related to the balancing we had in the prototype, because the crafting costs were so steep, people couldn't craft as many weapons. What is important to understand here, however, is that this was intended by us; in the previous session we talked about balancing issues towards the end of the game. That part was something that we needed to balance properly, as it fully prevents players from finishing the game or accessing other areas. This is a different matter, we purposely made the weapons hard to make to express to players that not everyone should be hunting; the weapons should be scarce to incentivize a few people to become dedicated hunters as others perform other tasks. This is part of the parallelization design strategy we talk about in section 5.1.1. The final question of the set, question twenty-one, was "Do you think there is enough access to weapons to hunt effectively in the game?" (Figure 6.62), and again, was made for the same reason as the similar ones in the previous sets, and we got four responses as "no" and two as "yes". The follow-up was, "What types of tools would you like to see to help you in hunting?" (section A.2.5), and in here we got suggestions for more weapons or to make weapons more easily available; however, that is not our goal with this mechanic, and so, although more weapon variety would be interesting, this specific data wasn't of much value to us.

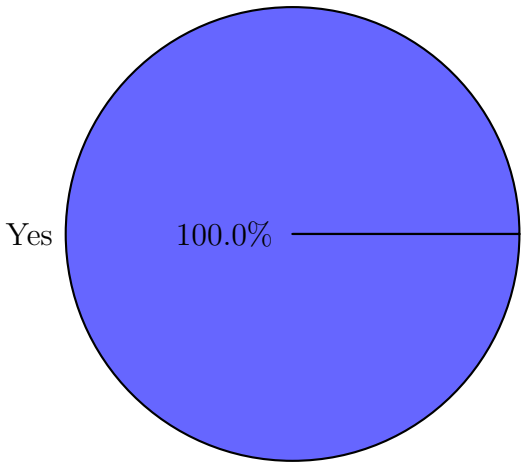

Figure 6.59: Did you hunt wild life or monsters in the game?

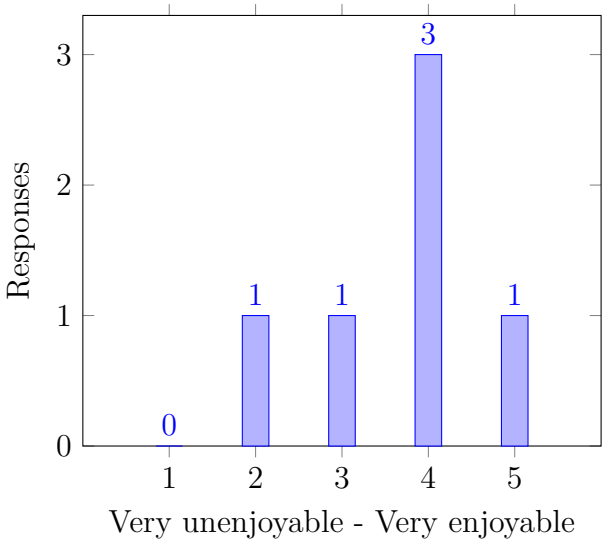

Figure 6.60: How enjoyable did you find hunting to be?

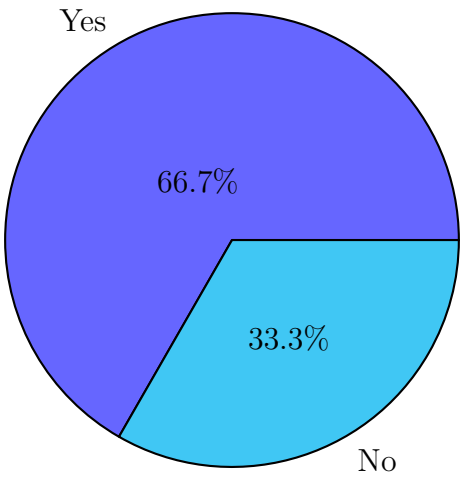

Figure 6.61: Do you think there is enough access to weapons to hunt effectively in the game?

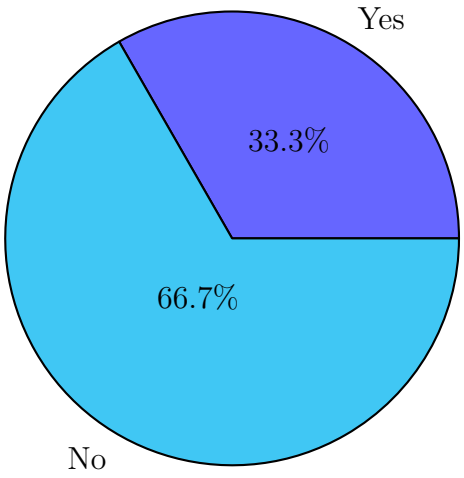

Figure 6.62: In your opinion, would your job as a hunter be facilitated if you had access to different tools to support you? (ex.: more variety of weapons)

The final set of questions related to in-game tasks was about leadership. The first question of the set, question twenty-two, was "How organized do you think the group was during the playtest session?" and got one answer in "3", two in "4" and three in "5" (Figure 6.63). At first glance this question might not seem related to leadership, but this question is here to provide us data that we can then cross-reference with the results from the leadership questions in order to establish connections between organization and hierarchical roles. This question also showed us that the group felt that they were very optimized, and this is understandable when taking into consideration the group performance improvement from the first playthrough to the second, as discussed in section 5.3.4. The next two questions from the set, questions twenty-three and twenty-four, were "Did the group have a leader?" (Figure 6.64) and "Do you think the group would have been more optimized if there was someone taking a leadership role?" (Figure 6.65), respectively. In question twenty-three we have one response saying "no", and then in question twenty-four we have one response saying "yes". When looking at the dates and individual responses, we notice that this was the only answer submitted to this question in the time between playthrough one and two, and the same individual answered both, meaning that they thought the presence of a leader was important in regard to improving optimization. The following set of questions also showed a similar consensus, question twenty-five was "How much do you think the group leader impacted the group performance?" (Figure 6.66), and question twenty-six was "What was the impact of the group leader on performance" (Figure 6.67), where a "5" meant that the leader impacted overall performance very positively. On question twenty-five, one person answered "3", one answered "4" and three answered "5". On question twenty-six, one answered "3", two answered "4" and two answered "5". Overall, we can see that most people saw benefit in having a leader. When crossing this data with question twenty-two, we observe how someone taking leadership over the group significantly improved their performance. This was a behavior we were hoping to see manifested, as we talk about in sections 5.1.1 and 5.1.2. The importance of having a hierarchical role

system was clear; it was something players understood from the first playthrough of the session and applied in the second one, playing a key role. Not only was the group commanded by a leader that knew what resources and tasks were needed at each point, but they also subdivided themselves into smaller groups, as we already mentioned, proving the effectiveness of role hierarchies distribution. This further gets supported by question twenty-seven, "Please explain why you think the leader impacted the group positively/negatively" (section A.2.6), an open-ended question where most responses alluded to the importance of the leader to organize the group and the tasks. The final question of the set, question twenty-eight, was just like the last one from previous sets: "In your opinion, would the leader's job be facilitated if they had access to different tools to support them? (ex.: a bulletin board where you can write down what materials people need to get)" (Figure 6.68), in this question everyone replied "yes". The follow-up to it was, "What types of tools would you like to see to help in leadership?" (section A.2.7) and in this question the answers were similar to the crafting ones, meaning tools that helped track resources or place requests for other players. There is a reason as to why these answers were so similar to the crafting ones; it has to do with another behavior we were expecting to see, and that was seeing the dedicated crafter also become the leader. The two tasks are deeply connected; in fact, one promotes the other. By being a crafter, the player will know exactly what resources are needed and what tasks need to be done; therefore, they are positioned to be the person best capable of handling the group.

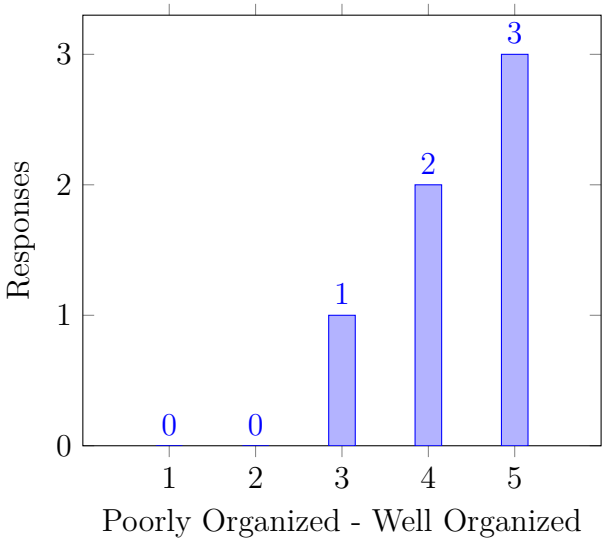

Figure 6.63: How organized do you think the group was during the playtest session?

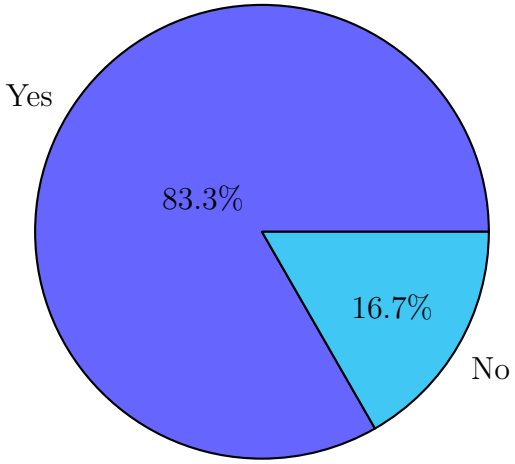

Figure 6.64: Did the group have a leader?

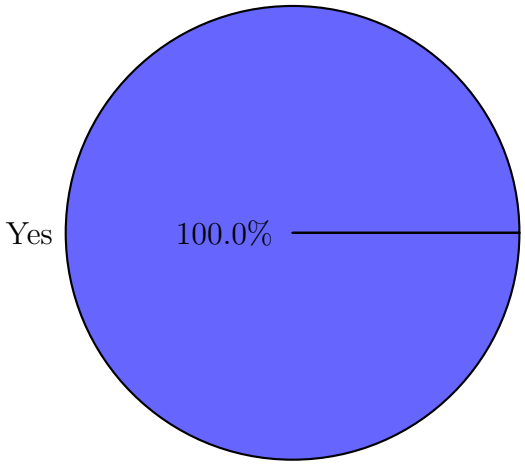

Figure 6.65: Do you think the group would have been more optimized if there was someone taking a leadership role?

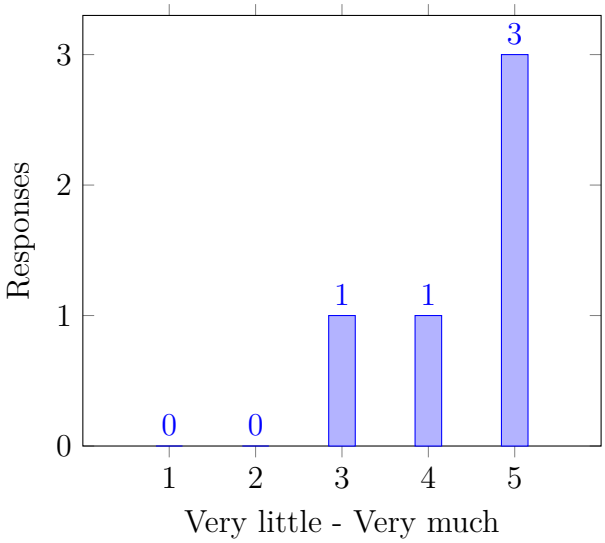

Figure 6.66: How much do you think the group leader impacted the group performance?

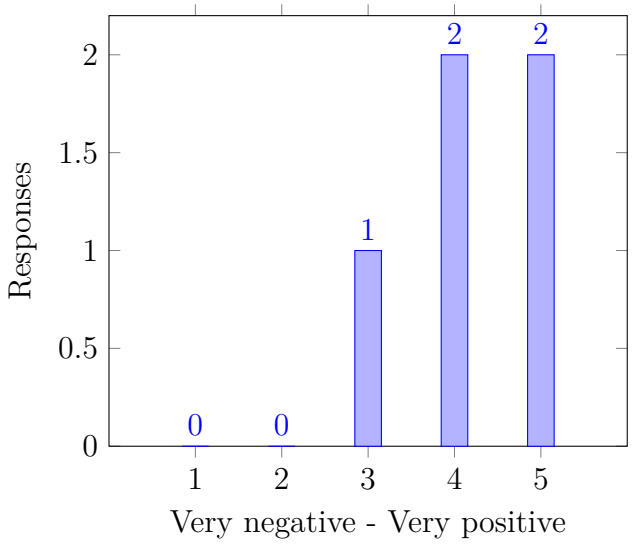

Figure 6.67: Was the impact of the group leader on performance

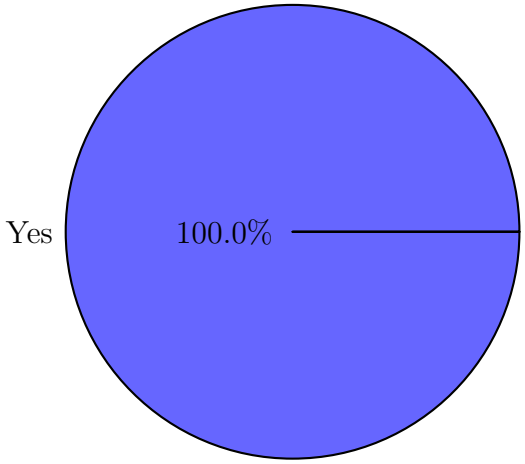

Figure 6.68: In your opinion, would the leader job be facilitated if they had access to different tools to support them? (ex.: a bulletin board where you can write down what materials people need to get)

The following two questions on the survey, questions twenty-nine and thirty, were "Do you think that the game is capable of appealing to both hardcore and casual gamers?" (Figure 6.69) and "In what ways do you think the game could appeal more to both casual and hardcore players?" (section A.2.8). To the first question, five people answered "yes" and one answered "no". This was a good result to see, as we talked about before in this section and section 5.1.1, one of the goals with the prototype and the research was to create something that both casual and hardcore players could enjoy, so seeing most people agree, especially these players, who were all **FunRoc**k game developers and so understood the difficulty of appealing to these audiences, was great. Question thirty was a follow-up to twenty-eight if you had answered "no" and therefore we only got one response. The response expressed that the game appealed well to casual players, but to properly appeal to hardcore ones, the crafting shouldn't be the only complex system in the game; for example, the combat could have had more depth to it. Although this is perfectly valid feedback, the decision to only make one system complex came from the time constraint we had with this thesis and research, and so we opted to focus on making one part of the game complex and really spend time designing it well, rather than trying to make everything complex (something that could also impact the perception of the game to casual players).

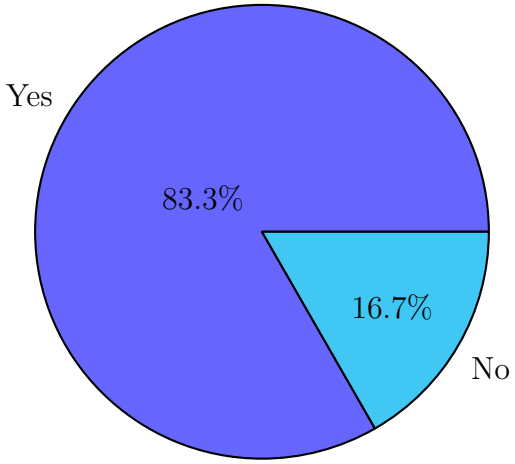

Figure 6.69: Do you think that the game is capable of appealing to both hardcore and casual gamers?

Next up we had questions related to group work. Question thirty-one was, "Do you think the lack of explanations in the game promoted group work and communication?" (Figure 6.70) and question thirty-two was, "What are your thoughts on the lack of explanations in the game/need to figure things out without guidance?" (section A.2.9). On question thirty-one, everyone replied "yes", meaning that once again we saw data proving our theory from section 5.1.1, where we wanted to use the lack of explanations in the game and the fact that it was a sandbox game to incentivize people to cooperate and figure things out. Question thirty-two was a follow-up question to thirty if testers had answered "yes" and so we got six responses. People were generally in agreement that the game did a good job encouraging group work; some, however, expressed that the sheer lack of indications was a bit much. For example, not indicating when resource nodes can be gathered from again, a concern also mentioned in section 5.3.4. Having said that, most of the criticism in the part was about mechanical issues and not the core design principle at play, which was the most important part for us.

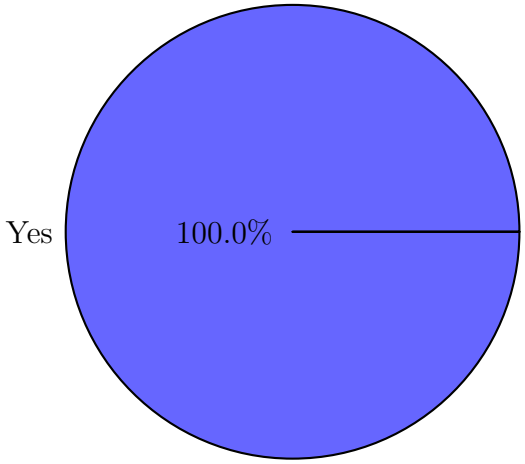

Figure 6.70: Do you think the lack of explanations in the game promoted group work and communication?

The second to last question of the survey, question thirty-three, was "In what ways do you think the game could promote further group cooperation and communication?" (section A.2.10), this question was open-ended, and we saw a variety of responses. Some people mentioned that the tools suggested in previous questions, such as the resource markers or the quest display, would help players cooperate more efficiently, as the leader could just post tasks, and the small groups would accept them and manage them within themselves. Others mentioned strong bosses that players had to get together to defeat. As talked about in section 5.2.6, we did in fact have these, but they were locked behind crafting progression, meaning players never got to see them.

The final question of the survey, question thirty-four, was "Do you have any other thoughts/feedback?" (section A.2.11). This was an open-ended, optional question that four people replied to. Overall, people expressed that they enjoyed the game, but some tweaks have to be made in terms of balancing. This, as well as all the other replies from all the questions, was reassuring to read, as we saw our work pay off and the concepts we were trying to see happening happen and work as intended.

7

Discussion

7.1 Design Recommendations

In this section, we will define design recommendations based on the data we obtained and the analysis we conducted.

7.1.1 Leverage Mechanical Ambiguity to Promote Group Communication

Description: Reduce the number of in-game instructions and allow ambiguity in mechanics to encourage players to solve problems collaboratively. In a sandbox environment without guidance, having mechanics that lack obvious solutions incentivizes players to share their knowledge and fosters a sense of collective discovery, which leads to cooperative behavior.

Example: Our playtesters responded positively to the lack of instructions, reporting that it pushed them to communicate effectively as a group. Furthermore, they have made it clear through feedback that having mechanics explained to them would hinder the cooperative social aspect of the game, as shown in our survey results in section 6.2.2.

Connection: This design recommendation supports our claims that unclear objectives in a sandbox environment (2.5) can be used as a tool to drive players to collectively experiment as a group, making them organically cooperate and self-organize, as discussed in section 5.1.1.

7.1.2 Encourage Emergent Role Hierarchies through Interdependent Mechanics

Description: Design core gameplay systems that require players to assume roles that complement each other, without the need to explicitly assign them. By having distinct gameplay options that are dependent on each other to progress, players are driven to organically assume roles and are motivated to diversify their group's role distribution to ensure cooperative efficiency.

Example: In our prototype, players have organically divided themselves between tasks such as crafting, gathering, and hunting, as discussed in sections 6.1 and 6.2. During our playtests, particularly in the second (6.1.2) and third (6.1.3) sessions, we observed that players were capable of inventing new logistic roles for themselves, such as resource transporter, to enhance the team's cooperation efficiency.

Connection: This player behavior aligns with research showing that players have the tendency to create structure based around gameplay roles when systems are cooperative in nature, as described in section 2.4.

7.1.3 Encourage Dedicated Leadership Roles through Task Parallelization

Description: Design cooperative gameplay tasks that can be optimized through parallelization to naturally promote the need for role organization, thereby incentivizing players to voluntarily take on the responsibility of leadership roles. If there are enough interdependent gameplay tasks that can be performed concurrently, it will organically push individuals to organize other players and assign relevant tasks to them, creating objectives for the group as a whole to synchronize cooperation.

Example: As discussed in the playtesting behavior analysis sections 6.1.2 and 6.1.3, we have observed that certain individuals that have taken up the responsibility of crafting were organically driven to coordinating the tasks of other teammates since they were able to create objectives for the group based on the progression dictated by relevant crafting recipes. Additionally, we have received survey feedback proving that players have unanimously agreed that having a dedicated leader made their group more optimized and improved their performance greatly 6.2.

Connection: As presented in section 2.4, our conducted research showed that dedicated leadership roles, based solely around handling the logistical and strategic needs of the group, emerge when the team's success is dependent on synchronized cooperation.

7.1.4 Design Flexible Cooperative Systems to Foster Pre-Existing Social Structures

Description: Instead of enforcing rigid team compositions with predefined roles, provide flexible and scalable cooperative systems that adapt to the group's dynamics and previous experiences. Such an approach allows for teams to create new social hierarchies through the game while enabling the seamless integration of pre-existing social structures.

Example: During the second playtesting session (6.1.2), we observed that players who had previous experience with our prototype were able to leverage their pre-existing knowledge to help new players and optimize their team by organically becoming leaders of the group, creating new social hierarchies in the process (2.4).

Furthermore, in the third playtesting session (6.1.3), we have seen that a pre-existing social structure such as the **FunRock & Prey Studios** development team was able to seamlessly translate their pre-existing social dynamics into our prototype, instantly giving them a head start in their effective cooperation and organization.

Connection: As we have previously claimed in section 2.4, we aimed to create systems that promote the creation of organic hierarchical social structures that are suited for easy adoption by preexisting social structures, making our game concept capable of leveraging a sense of community engagement, discussed in section 2.2.

7.1.5 Balance System Complexity to Appeal to Both Casual and Hardcore Players

Description: Complexity should be centralized on specific systems, allowing others to be more accessible. This appeals to both casual and hardcore players without overwhelming or underwhelming any of the groups. Furthermore, if all the subsystems are tied to the complex system, then everyone involved is likely to feel a sense of accomplishment when doing their tasks.

Example: As shown by the survey results from sections 6.2.2.1 and 6.2.2.2, players expressed that the game was capable of appealing to both hardcore and casual players 2.3, due to the different levels of complexity it offers in its different systems. Furthermore, in section 6.1, the observed behaviors in all of the playtest sessions demonstrated that players wanted to replay the game regardless of where they fit in the casual-to-hardcore player spectrum, and we knew where they were in the spectrum due to the survey they would fill out, described in section 5.3.1.1.

Connection: This design recommendation aligns with the design principles we discuss in sections 5.1.1 and 5.1.2. Crafting was prioritized as the complex system in the game, while all other systems were tied it and were easier to grasp.

7.1.6 Use Environmental Framing to Guide Player Progression

Description: Structure the sandbox environment in a way that subtly directs player movement and interaction, especially during the early stages of gameplay. Furthermore, by reducing the potential locations players can see at the start of the game, it helps prevent players from feel overwhelmed with options.

Example: In our prototype, the island exploration 5.2.6 was designed in such a way that, although players had access to most biomes from the start, they would first go to the forest and mountain. This behavior was observed and described in section 6.1 throughout all the playtest sessions. This limitation led players to explore the areas that we designed to teach them about gathering and hunting without physically putting a barrier on where they could go, organically and subtly using the environment to guide their progression.

Connection: This design recommendation combines the openness of a sandbox environment 2.5 with subtle environmental cues, assisting players in building momentum without explicit objectives. It supports our core design principles described in sections 5.1.1 and 5.1.2, while making use of our findings of player psychology in sandbox games, discussed in section 2.5.2.

7.1.7 Use Environmental Challenges to Catalyze Cooperation

Description: Introduce scalable obstacles that require group effort to overcome, motivating collaboration through shared adversity. Furthermore, adversities can create a sense of urgency in players, incentivizing them to become more efficient.

Example: During the second and third playtest sessions, talked about in sections 6.1.2 and 6.1.3, players developed optimized strategies, such as people going around collecting resources from gatherers and delivering them to base, in order to progress as much as possible within the time constraint. This time constraint was represented by a meteor, created to act as a visible adversity that threatens to destroy everything, as described in section 5.2.4.

Connection: This design recommendation resulted from the observed behavior in the playtest sessions 6.1. In addition, as seen in titles like 2.6.3, external challenges can intensify internal group dynamics and role differentiation. Lastly, this concept also ties to section 5.1.2, where we discuss having the meteor act as a countdown timer, and section 5.2.6, where in multiple biomes we placed strong bosses that needed multiple players to cooperate in order to defeat them.

7.1.8 Implement Minimal but Functional Communication Tools

Description: Provide players with lightweight in-game coordination tools without undermining the need for real-time communication.

Example: In the third playtest survey results, discussed in section 6.2.2.2, players expressed their desire to have access to specific tools for each task in the game, such as a quest board for the crafter to place down gathering requests or specialized markers for miners to identify mining zone locations. These tools do not substitute communication but rather facilitate it.

Connection: This design recommendation resulted from the observed behavior in the playtest sessions 6.1 and thesis feedback received from our meetings with **FunRock & Prey Studios**. It also ties down to our findings on community engagement in section 2.2 and our core design principles explained in section 5.1.1.

7.2 Limitations and Challenges

Although we are overall satisfied with the design and implementation of our prototype as well as the feedback we received from playtesters, there are a number of limitations and challenges that emerged during our research and development process that have influenced the direction and outcome of this project. While these constraints do not make our findings invalid, they do represent limits within which our conclusions should be interpreted.

The most important factors limiting our work on this project were time and scope. Since we only had around four months for research and implementation, only one of which was dedicated purely to prototyping, it meant that most of our ambitious design ideas 5.1.1 needed to be simplified or excluded. These limitations inherently restricted the scale and complexity of our final prototype 5.2.4 and made it so we couldn't possibly implement and observe certain concepts as much as we wanted. This limitation is especially apparent in topics relating to emergent social dynamics stemming from large-scale cooperation and deep community engagement (2.2, 2.4). Additionally, the time pressure limited our ability to implement updates and features based on user feedback during and after playtests.

We were also limited on a technical level by restrictions present in the platforms and tools we chose to develop in. Although we believe that making our prototype within Unreal Engine for Fortnite (UEFN 5.2.1) was the right decision and saved us an enormous amount of development time because of its rapid prototyping capabilities and built-in multiplayer infrastructure, it also introduced a multitude of technical constraints. These constraints heavily influenced the design of our game, as discussed in sections 5.2.4 and 5.2.3, and didn't allow us to implement certain features the way we wanted to. Some features, like the crafting system, lack a certain desired depth, which is caused by the fact that we couldn't have multiple recipes on a single crafting station or exceed more than three different materials for a recipe. In certain cases, other features, like persistent world states or gathering tool upgrades, were either too time-consuming or outright impossible to implement in UEFN, causing us to pivot in our game design to try to circumvent their absence in our prototype.

For our project, playtesting was an essential way to evaluate emergent player behaviors stemming from our designed mechanics (5.3). Because of our limited ability to realistically organize large-scale and varied playtest environments, the findings we obtained from our playtests are necessarily limited, which is caused by multiple factors. Firstly, since our playtesting sessions consisted of small groups of participants drawn either from university classmates or professional colleagues, it means that there is a certain demographic homogeneity and shared familiarity with gaming inadvertently influencing the data we gathered. This has the real potential to reduce the realism of our observations and results, additionally strengthened by the fact that our players' behavior could have been influenced by the artificial nature of the playtesting environment. Secondly, the short nature of the playtesting sessions made it difficult to fully observe long-term social dynamics, such as the successful

persistence of efficient cooperative role hierarchies (2.4). This inconvenience was thankfully at least alleviated by the fact that participants were interested in playing multiple times consecutively. Lastly, our game concept was designed to thrive in a large-scale collaborative community setting (2.2, 5.1.1); however because of practical constraints, it was unable to be tested in such a situation, making our estimates about its success in that area still theoretical.

One of the main goals of our project was to create a game that is capable of appealing to both casual and hardcore players (2.3). While we obtained empirical evidence from our playtesters that points to the real possibility that we have succeeded in the endeavor of creating an experience that appeals to both of these groups, the limited scope of testing and the homogeneity of our playtesters make it difficult to fully evaluate whether both of these demographics felt equally engaged and rewarded by our game's mechanics.

Finally, it is important to recognize that the conclusions we have drawn from our observations and player feedback are highly contextual to our specific prototype. Our specific game mechanics, environment, and testing circumstances may not be directly translatable to other sandbox or multiplayer settings. While the concepts we have identified in our research are broadly applicable, such as the value of self-directed cooperation 2.4 and the importance of designing scalable game systems 5.1.2, their implementation must be carefully tailored to each game.

7.3 Ethics

The research and prototype created raise some potential ethical concerns that we will discuss in this section. Firstly, in the prototype, players have a time limit of one hour to complete their experience. This can cause stress to some players, and in doing so, exclude them from the playtest, which would go against our concept of appealing to a wide demographic. However, we designed the prototype around replayability; this concept is incentivized with our core game loop, further explained in section 5.1.1. The players should not feel the anxiety of clearing the challenge within the hour, but instead they should focus on gathering as much information as possible within the time frame and then establishing a plan to tackle the experience in-between playthroughs. In this way, the one-hour timer is not seen as a daunting mechanism, but rather as the amount players have to collect information and gain experience of the island.

Secondly, the crafting stations display a red or green color around the resources needed to craft something when the amount is missing or is complete. This can potentially be an issue for colorblind players, as they wouldn't be able to discern them. The color system is but an extra support tool for players to help them realize they have the right amount of resources without opening their inventory; even without it, they can still check the resource amounts they carry. Nonetheless, this issue can be solved by adding a pattern or symbol to the color system, so, for example, when a player has the right amount of resources, not only will it turn green but also display

a check mark on it.

On the topic of resources, the inventory system is another potential issue for players. As they collect more and more resources, the icons on the inventory keep getting smaller. This is a UEFN built-in mechanic that we couldn't change. This can be problematic for people with eyesight problems, and it becomes harder to differentiate what they have in the inventory. To solve this, we could either rework from the ground up how the inventory system worked, keeping the icons always normal size but adding a scroll wheel/tab to see other resources, or we could add some of the suggestions talked about in section 6.2, such as adding chests or a quest board to keep track of resources.

The lack of guidance in the game can also be overwhelming for players. We noticed during the playtests that some people don't fare well when they don't have a clear task in mind; the sheer amount of things they have access to can be too much at times. This concept is part of our core design 5.1.1, but it potentially goes against another core design aspect, which is to make the game appeal to a wide demographic, as it can alienate some players. One of the designed mitigations we have for this is the incentive for the group to have a leader; by having someone take the reins and create tasks, others can solely focus on their objectives and not have to worry about the massive amount of tasks in the world. This subdivision and parallelization of tasks is meant to solve this issue and make a sandbox world more digestible. Furthermore, by having constant communication, players can assess the situation better and get information on other parts of the island without needing to be there. Another way in which we mitigate this is by adding the overall objective in the loading screen of the game; while they load, players immediately get a sense of what they should be aiming to achieve. Finally, we could potentially also add optional guidance mechanics for those who really struggle with it.

Fortnite also has voice chat by default; one ethical issue that can arise from this is the moderation of this chat. For example, we strive to promote cooperation in the prototype, but by using the voice chat, players can potentially bully others. Fortunately for us, Fortnite by default already has tools for voice chat moderation; and by using them, we can control what can be said in the prototype session, creating a more welcoming and peaceful environment for everyone. Fornite also includes tools to ban or block specific users, meaning that if somehow an offensive comment gets past the moderation system, people can still report it and block the user.

In the playtest sessions, there were a few ethical issues associated with them. As we mentioned in section 1.6.1, we made sure to tell everyone involved about how we were going to collect data and what we were going to use said data for. Transparency from us to the testers was vital for a smooth session to occur. We also tried getting a variety of different testers to avoid any type of bias in the groups playing the prototype, but there were limitations on the people we could get, as we talk about in sections 6.2 and 7.2.

Finally, there is an ethical concern with a potential biased interpretation of the data we obtained to align with our wanted results. To mitigate this, we employed three different methods of data collection: observing the playtests, interviewing the testers, and anonymous surveys. By cross-checking the results from all three methods, we aim to eliminate any bias and extract results only from the factual data.

8

Conclusions and Future Work

8.1 Conclusions

The purpose of this thesis was to explore the key factors that contribute to the successful design of engaging, community-centered, cooperative multiplayer sandbox games with wide demographic appeal. Over the course of this project, we have successfully developed a functional game prototype by combining theoretical research, industry collaboration, iterative prototyping, and empirical playtesting. The goal of this prototype was to test our core hypotheses regarding player cooperation, role hierarchies, and emergent player behavior through gameplay dynamics.

Our findings suggest that developers can enhance cooperative behavior and foster community engagement by promoting player interdependence through complementary gameplay roles, minimizing explicit instructions to encourage organic group communication, and facilitating the emergence of natural leadership roles through the inherent value of synchronized cooperation. Additionally, providing players with lightweight in-game communication tools can further support these efforts. We have also observed that creating scalable obstacles motivates players to collaborate due to a shared sense of urgent adversity. Furthermore, mechanical complexity should be centralized within specific systems to ensure that other aspects of the game remain accessible, effectively making the game appeal to a wider demographic and creating engagement for both casual and hardcore players.

While the limited capabilities and technical constraints of our chosen platform, UEFN, restricted the design of our implementation in some aspects, it allowed us to create a feature-complete prototype capable of supporting seamless large-scale multiplayer. By organizing playtests and gathering player feedback, we were able to observe player behaviors and social dynamics that validated many of our assumptions. Our playtesters naturally gravitated toward organic role specialization, recognized the value of leadership, responded positively to design elements that encouraged teamwork and agency, and unanimously expressed the sentiment that they felt a sense of accomplishment by contributing to their group.

We acknowledge the shortcomings of our prototype, primarily time constraints, platform restrictions, and playtesting sample size, which affected the depth of our

implementation. However, the insights we gained from it allowed us to build a strong empirical foundation to develop actionable design recommendations for future games seeking to cultivate deep social interaction and self-sustaining player communities that extend beyond the sum of their individual mechanics.

8.2 Future Work

The prototype we developed is now officially published in Fortnite and can be played by anyone at any time. This published version includes analytics devices; these devices are connected to crafting stations and other mechanisms tied to progression and will report back whenever someone unlocks them in-game. This means that we will continue to get new data as time progresses and more players try our game.

We are also planning on implementing some of the feedback we received in section 6.2.2. Namely, we would like to reinvent the inventory system in order to accommodate large amounts of resources without compromising its UI and in-game visibility. In addition, we plan to implement task-oriented tools, such as a quest board or custom markers, based on the suggestions in section 6.2.2.2. Furthermore, we plan on changing the crafting machines so they display their crafting outcome; this way, players will know what they will get out of a station after they craft the item once. We also plan on making the cool-down on resource nodes noticeable to players to avoid confusion and to make sure players know which resources they can gather from and which ones they need to wait on. Finally, we will research further into the topic of emergent role behaviors and their psychological patterns in order to improve the game design when a large number of players are active at the same time.

Bibliography

[1] M. T. Imboden, "Belonging: An essential human and organizational need," *American Journal of Health Promotion*, p. 08 901 171 241 255 204, 2024.

[2] R. F. Baumeister and M. R. Leary, "The need to belong: Desire for interpersonal attachments as a fundamental human motivation," *Interpersonal development*, pp. 57–89, 2017.

[3] J. Zagal, M. Nussbaum, and R. Rosas, *A model to support the design of multiplayer games*, 2000. [Online]. Available: https://direct.mit.edu/pvar/article-abstract/9/5/448/18365/A-Model-to-Support-the-Design-of-Multiplayer-Games.

[4] A. K. Przybylski, N. Weinstein, K. Murayama, M. F. Lynch, and R. M. Ryan, *The ideal self at play: The appeal of video games that let you be all you can be*, 2011. [Online]. Available: https://journals.sagepub.com/doi/abs/10.1177/0956797611418676.

[5] M. Álvarez-Mozos, R. van den Brink, G. van der Laan, and O. Tejada, *From hierarchies to levels: New solutions for games with hierarchical structure*, 2017. [Online]. Available: https://link.springer.com/article/10.1007/s00182-017-0572-z.

[6] L. Saldanha, S. Marques da Silva, and P. D. Ferreira, *Minecraft design build: Teaching teamwork and project planning in a virtual world*, 2022. [Online]. Available: https://journals.sagepub.com/doi/full/10.1177/15554120221150058.

[7] L. Saldanha, S. Marques da Silva, and P. D. Ferreira, *"community" in video game communities*, 2023. [Online]. Available: https://journals.sagepub.com/doi/full/10.1177/15554120221150058.

[8] R. Staewen, P. Trevino, and C. Yun, *Player characteristics and their relationship to goals and rewards in video games*, 2014. [Online]. Available: https://ieeexplore.ieee.org/abstract/document/7048088/authors#authors.

[9] P. Cody, D. Johnson, M. Klarkowski, M. Jade W., and L. Hides, *The impact of rewards and trait reward responsiveness on player motivation*, 2018. [Online]. Available: https://dl.acm.org/doi/abs/10.1145/3242671.3242713.

[10] J. Gavin, B. Kenobi, and A. M. Connor, "Social play spaces for active community engagement," in *Proceedings of the 2014 conference on interactive entertainment*, 2014, pp. 1–5.

[11] A. R. O. Cuaycong, *The importance of community engagement in modern gaming*, 2024. [Online]. Available: https://megacatstudios.com/blogs/game-culture/importance-community-engagement-modern-gaming.

[12] G. A. M. R. Team, *Game developers and player communities: Building engagement*, 2024. [Online]. Available: https://moldstud.com/articles/p-game-developers-and-player-communities-building-engagement.

[13] P. Levy, *Collective intelligence: Mankind's emerging world in cyberspace*, 1997.

[14] J. L. Neys, J. Jansz, and E. S. Tan, "Exploring persistence in gaming: The role of self-determination and social identity," *Computers in Human Behavior*, vol. 37, pp. 196–209, 2014.

[15] R. Kowert, E. Domahidi, and T. Quandt, "The relationship between online video game involvement and gaming-related friendships among emotionally sensitive individuals," *Cyberpsychology, Behavior, and Social Networking*, vol. 17, no. 7, pp. 447–453, 2014.

[16] J. C. Turner, R. J. Brown, and H. Tajfel, "Social comparison and group interest in ingroup favouritism," *European journal of social psychology*, vol. 9, no. 2, pp. 187–204, 1979.

[17] N. Ducheneaut, N. Yee, E. Nickell, and R. J. Moore, "The life and death of online gaming communities: A look at guilds in world of warcraft," in *Proceedings of the SIGCHI conference on Human factors in computing systems*, 2007, pp. 839–848.

[18] P. J. Adachi and T. Willoughby, "Do video games promote positive youth development?" *Journal of Adolescent Research*, vol. 28, no. 2, pp. 155–165, 2013.

[19] R. P. Griffiths, M. S. Eastin, and V. Cicchirillo, "Competitive video game play: An investigation of identification and competition," *Communication Research*, vol. 43, no. 4, pp. 468–486, 2016.

[20] R. M. Ryan, C. S. Rigby, and A. Przybylski, "The motivational pull of video games: A self-determination theory approach," *Motivation and emotion*, vol. 30, pp. 344–360, 2006.

[21] R. Kowert, R. Festl, and T. Quandt, "Unpopular, overweight, and socially inept: Reconsidering the stereotype of online gamers," *Cyberpsychology, Behavior, and Social Networking*, vol. 17, no. 3, pp. 141–146, 2014.

[22] H. Cole and M. D. Griffiths, "Social interactions in massively multiplayer online role-playing gamers," *Cyberpsychology & behavior*, vol. 10, no. 4, pp. 575–583, 2007.

[23] N. Yee, "The psychology of massively multi-user online role-playing games: Motivations, emotional investment, relationships and problematic usage," in *Avatars at work and play: Collaboration and interaction in shared virtual environments*, Springer, 2006, pp. 187–207.

[24] B. D. Schutter and S. Malliet, *The older player of digital games: A classification based on perceived need satisfaction*, 2014. [Online]. Available: https://www.degruyter.com/document/doi/10.1515/commun-2014-0005/html.

[25] J. H. Schiller, *Distribution of online hardcore player behavior: (how hardcore are you?)* 2006. [Online]. Available: https://www.researchgate.net/

publication/221391368_Distribution_of_online_hardcore_player_behavior_how_hardcore_are_you.

[26] J. Sudbo and P. Darmer, *Creating experiences in the experience economy*, 2008. [Online]. Available: https://www.e-elgar.com/shop/gbp/creating-experiences-in-the-experience-economy-9781847209306.html.

[27] C. M. Bateman and R. Boon, *21st century game design*, 2006. [Online]. Available: https://books.google.se/books/about/21st_Century_Game_Design.html?id=IdRqQgAACAAJ&redir_esc=y.

[28] K. A. Kapalo, M. A. Rupp, A. R. Neigel, and J. L. Szalma, *Individual differences in video gaming: Defining hardcore video gamers*, 2015. [Online]. Available: https://www.researchgate.net/publication/283793880_Individual_Differences_in_Video_Gaming_Defining_Hardcore_Video_Gamers.

[29] D. Bress, *Player types: Casual and hardcore*, 2009. [Online]. Available: https://www.gamedeveloper.com/design/player-types-casual-and-hardcore.

[30] G. C. Klug and J. Schell, *Chapter 7 why people play games: An industry perspective*, 2006. [Online]. Available: https://www.taylorfrancis.com/chapters/edit/10.4324/9780203873700-9/chapter-7-people-play-games-industry-perspective-christopher-klug-jesse-schell.

[31] S. Björk, *Non-player characters*, 2024. [Online]. Available: http://virt10.itu.chalmers.se/index.php/Non-Player_Characters.

[32] K. M. Smed, *The barrier of entry for casual players*, 2020. [Online]. Available: https://projekter.aau.dk/projekter/files/363737003/Master_s_Thesis___Michelle_Larsen_and_Michael_Kaul_Jorgensen.pdf.

[33] D. E.L. and G. M., *Self-determination theory and work motivation. journal of organizational behavior*, 2005. [Online]. Available: https://selfdeterminationtheory.org/SDT/documents/2005_GagneDeci_JOB_SDTtheory.pdf.

[34] M. Dye, C. Green, and D. Bavelier, *The development of attention skills in action video game players*, 2009. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0028393209000657.

[35] N. M. Hill and W. Schneider, *Brain changes in the development of expertise: Neuroanatomical and neurophysiological evidence about skill-based adaptations*, 2006. [Online]. Available: https://www.cambridge.org/core/books/abs/cambridge-handbook-of-expertise-and-expert-performance/brain-changes-in-the-development-of-expertise-neuroanatomical-and-neurophysiological-evidence-about-skillbased-adaptations/0C32C620315150F52079141AA0E8F3C4#access-block.

[36] Y. Poels, J. H. Annema, M. Verstraete, and B. Zaman, *Are you a gamer?:a qualitative study on the parameters for categorizing casual and hardcore gamers*, 2012. [Online]. Available: https://www.researchgate.net/publication/288864192_Are_you_a_gamerA_qualitative_study_on_the_parameters_for_categorizing_casual_and_hardcore_gamers.

[37] T. Greitemeyer and C. Cox, "There's no "i" in team: Effects of cooperative video games on cooperative behavior," *European Journal of Social Psychology*, vol. 43, no. 3, pp. 224–228, 2013.

[38] E. Sociology, *Digital collectivism in multiplayer video games*, 2024. [Online]. Available: https://easysociology.com/sociology-of-media/sociology-of-gaming/digital-collectivism-in-multiplayer-video-games/.

[39] A. Badatala, J. Leddo, A. Islam, K. Patel, and P. Surapaneni, "The effects of playing cooperative and competitive video games on teamwork and team performance," *International Journal of Humanities and Social Science Research*, vol. 2, no. 12, pp. 24–28, 2016.

[40] K.-E. Paananen, "Designing a game for emergent gameplay: Developing gatedelvers," 2020.

[41] B. Entertainment, *World of warcraft*, 2024. [Online]. Available: https://worldofwarcraft.blizzard.com/en-us/.

[42] R. Games, *League of legends*, 2024. [Online]. Available: https://www.leagueoflegends.com/en-gb/.

[43] J. Putzke, K. Fischbach, and D. Schoder, "Power structure and the evolution of social networks in massively multiplayer online games," 2010.

[44] A. Mateo-Orcajada, L. Abenza-Cano, and R. Vaquero-Cristóbal, "Analyzing the changes in the psychological profile of professional league of legends players during competition," *Computers in Human Behavior*, vol. 126, p. 107 030, 2022.

[45] M. Mora-Cantallops and M.-Á. Sicilia, "Team efficiency and network structure: The case of professional league of legends," *Social Networks*, vol. 58, pp. 105–115, 2019.

[46] Y. Kou, "Toxic behaviors in team-based competitive gaming: The case of league of legends," in *Proceedings of the annual symposium on computer-human interaction in play*, 2020, pp. 81–92.

[47] A. Lyngstad, *Sandbox games. a way to promote deeper learning in cross-curricular teaching? example scenarios for classroom implementation*, 2017. [Online]. Available: https://munin.uit.no/handle/10037/11538.

[48] S. O. Barriales and J. A. Lopez Brugos, *Multi-agent systems and sandbox games*, 2009. [Online]. Available: https://www.researchgate.net/publication/228740692_Multi-agent_Systems_and_Sandbox_Games.

[49] S. Björk, *Levels*, 2024. [Online]. Available: http://virt10.itu.chalmers.se/index.php/Levels.

[50] M. Charity, D. Rajesh, R. Ombok, and L. Soros, *Say "sul sul!" to simsim, a sims-inspired platform for sandbox game ai*, 2020. [Online]. Available: https://www.alphaxiv.org/abs/2008.11258.

[51] M. Studios, *Minecraft*, 2024. [Online]. Available: https://www.minecraft.net/en-us.

[52] E. Arts, *The sims*, 2024. [Online]. Available: https://www.ea.com/games/the-sims.

[53] R. Audige, *Trying to innovate? embrace constraints.* 2023. [Online]. Available: https://rachelaudige.medium.com/trying-to-innovate-embrace-constraints-4d8853186c45.

[54] V. Shute and S. Rahimi, *The effects of video games on creativity*, 2021. [Online]. Available: https://www.semanticscholar.org/paper/The-Effects-of-Video-Games-on-Creativity-Rahimi-Shute/d36b0ca83008750a4ce5d2959452066ff9928f

[55] O. J. Griffith and B. T. Sharpe, *Investigating psychological disparities across gamers: A genre-based study*, 2024. [Online]. Available: https://journals.humankinetics.com/view/journals/jege/2/1/article-jege.2023-0040.xml.

[56] C. Russoniello, K. O'Brien, and J. Parks, *The effectiveness of casual video games in improving mood and decreasing stress*, 2009. [Online]. Available: https://www.researchgate.net/publication/289131468_The_effectiveness_of_casual_video_games_in_improving_mood_and_decreasing_stress.

[57] K. E. Pearce, J. C. Yip, J. H. Lee, *et al.*, *"i need to just have a couple of white claws and play animal crossing tonight": Parents coping with video games during the covid-19 pandemic.* 2021. [Online]. Available: https://psycnet.apa.org/record/2021-97499-001.

[58] M. Beale, M. McKittrick, and D. Richards, *"good" grief: Subversion, praxis, and the unmasked ethics of griefing guides*, 2016. [Online]. Available: https://www.tandfonline.com/doi/abs/10.1080/10572252.2016.1185160.

[59] C. Drew and M. Ellison, *Using digital sandbox gaming to improve creativity within boys' writing*, 2019. [Online]. Available: https://www.tandfonline.com/doi/full/10.1080/02568543.2019.1675823.

[60] Y. Yin Lin and C.-H. Chung, *Online 3d gamification for teaching a human resource development course*, 2022. [Online]. Available: https://onlinelibrary.wiley.com/doi/abs/10.1111/jcal.12641.

[61] J. Uke, *What are mmo games?* 2024. [Online]. Available: https://gametree.me/gaming-terms/mmo/.

[62] S. Enix, *Square enix global*, 2024. [Online]. Available: https://www.square-enix.com/.

[63] J. Fynch, *What is a "raid" in multiplayer online video games?* 2020. [Online]. Available: https://www.howtogeek.com/687527/what-is-a-raid-in-multiplayer-online-video-games/.

[64] L. E. Team, *Guild*, 2024. [Online]. Available: https://www.larksuite.com/en_us/topics/gaming-glossary/guild.

[65] Fandom, *Healer*, 2024. [Online]. Available: https://wowwiki-archive.fandom.com/wiki/Healer.

[66] Fandom, *Tank (game term)*, 2024. [Online]. Available: https://wowwiki-archive.fandom.com/wiki/Tank_(game_term).

[67] J. Uke, *What does dps mean in games? definition, use cases, examples*, 2024. [Online]. Available: https://gametree.me/gaming-terms/dps/.

[68] Reddit, *R/place*, 2024. [Online]. Available: https://www.reddit.com/r/place/.

[69] Reddit, *Reddit*, 2024. [Online]. Available: https://www.reddit.com/.

[70] C. Games, *Eve online*, 2024. [Online]. Available: https://www.eveonline.com/.

[71] C. Games, *Ccp games*, 2024. [Online]. Available: https://www.ccpgames.com/.

[72] S. Björk, *Pve*, 2024. [Online]. Available: http://virt10.itu.chalmers.se/index.php/PvE.

[73] S. Björk, *Pvp*, 2024. [Online]. Available: http://virt10.itu.chalmers.se/index.php/PvP.
[74] A. G. Studios, *Helldivers 2*, 2024. [Online]. Available: https://helldiverscompanion.com/.
[75] A. G. Studios, *Arrowhead game studios*, 2024. [Online]. Available: https://www.arrowheadgamestudios.com/.
[76] F.-m. Project, *Helldivers: Galactic war status*, 2024. [Online]. Available: https://helldivers.io/.
[77] A. Jovanée, *In helldivers 2, i'm doing my part*, 2024. [Online]. Available: https://www.polygon.com/24084721/helldivers-2-impressions-community-doing-my-part.
[78] M. Studios, *Mojang studios*, 2024. [Online]. Available: https://www.minecraft.net/en-us.
[79] G. T. Games, *Overcooked*, 2024. [Online]. Available: https://store.steampowered.com/app/448510/Overcooked/.
[80] G. T. Games, *Ghost town games*, 2024. [Online]. Available: https://ghosttowngames.com/.
[81] T. Ritchey, *Wicked problems: Modelling social messes with morphological analysis*, 2013. [Online]. Available: https://www.researchgate.net/publication/236885171_Wicked_Problems_Modelling_Social_Messes_with_Morphological_Analysis.
[82] A. Alliance, *What is agile?* 2024. [Online]. Available: https://www.agilealliance.org/agile101/#:~:text=Agile%20is%20the%20ability%20to,an%20uncertain%20and%20turbulent%20environment..
[83] Scrum.org, *What is scrum?* 2024. [Online]. Available: https://www.scrum.org/resources/what-scrum-module.
[84] M. Rehkopf, *User stories with examples and a template*, 2024. [Online]. Available: https://www.atlassian.com/agile/project-management/user-stories.
[85] Atlassian, *What is a gantt chart? a practical guide for project managers*, 2024. [Online]. Available: https://www.teamgantt.com/what-is-a-gantt-chart#:~:text=A%20gantt%20chart%20is%20a,each%20task%20in%20the%20project..
[86] T. de Bono Group, *Six thinking hats*, 2024. [Online]. Available: https://www.debonogroup.com/services/core-programs/six-thinking-hats/.
[87] T. U. of Adelaide, *Mind mapping*, 2014. [Online]. Available: https://www.adelaide.edu.au/writingcentre/sites/default/files/docs/learningguide-mindmapping.pdf.
[88] A. Raeburn, *Swot analysis*, 2024. [Online]. Available: https://asana.com/resources/swot-analysis.
[89] P. Lankoski and S. Björk, *Swot analysis*, 2024. [Online]. Available: https://asana.com/resources/swot-analysis.
[90] C. Fanchi, *Rapid prototyping: A practical guide for application development teams*, 2023. [Online]. Available: https://backendless.com/rapid-prototyping-a-practical-guide-for-application-development-teams/.

[91] A. Hudaib, R. Masadeh, M. H. Qasem, A. Alzaqebah, *et al.*, "Requirements prioritization techniques comparison," *Modern Applied Science*, vol. 12, no. 2, p. 62, 2018.
[92] D. Inc., *Discord*, 2015. [Online]. Available: https://discord.com/.
[93] S. Technologies, *Slack*, 2013. [Online]. Available: https://slack.com/.
[94] Z. Communications, *Zoom*, 2011. [Online]. Available: https://www.zoom.com/.
[95] Microsoft, *Microsoft teams*, 2017. [Online]. Available: https://www.microsoft.com/en-us/microsoft-teams/group-chat-software.
[96] J. Hammersley and J. Lees-Miller, *Overleaf*, 2012. [Online]. Available: https://www.overleaf.com/.
[97] Google, *Google forms*, 2008. [Online]. Available: https://workspace.google.com/products/forms/.
[98] Atlassian, *Trello*, 2011. [Online]. Available: https://discord.com/.
[99] J. Ltd, *Draw.io*, 2011. [Online]. Available: https://www.drawio.com/.
[100] Microsoft, *Microsoft 365*, 2011. [Online]. Available: https://www.microsoft.com/microsoft-365/.
[101] Google, *Google drive*, 2012. [Online]. Available: https://workspace.google.com/products/drive/.
[102] P. J. H. Tom Preston-Werner Chris Wanstrath, *Github*, 2008. [Online]. Available: https://github.com/.
[103] Unity, *Unity cloud*, 2005. [Online]. Available: https://cloud.unity.com/.
[104] Unity, *Unity*, 2005. [Online]. Available: https://unity.com/.
[105] J. Linietsky and A. Manzur, *Godot*, 2014. [Online]. Available: https://godotengine.org/.
[106] E. Games, *Unreal engine 5*, 2022. [Online]. Available: https://www.unrealengine.com/unreal-engine-5.
[107] E. Games, *Unreal engine for fortnite*, 2024. [Online]. Available: https://dev.epicgames.com/community/fortnite/getting-started/uefn.
[108] E. Games, *Fornite*, 2024. [Online]. Available: https://www.fortnite.com/?lang=en-US.
[109] B. Foundation, *Blender*, 1994. [Online]. Available: https://www.blender.org/.
[110] Autodesk, *Fusion 360*, 2013. [Online]. Available: https://www.autodesk.com/products/fusion-360/.
[111] I. S. S.A, *Aseprite*, 2014. [Online]. Available: https://www.aseprite.org/.
[112] Adobe, *Photoshop*, 1990. [Online]. Available: https://www.adobe.com/products/photoshop.html.
[113] Serif, *Affinity designer 2*, 2014. [Online]. Available: https://affinity.serif.com/designer/.
[114] I. Figma, *Figma*, 2016. [Online]. Available: https://www.figma.com/.
[115] Microsoft, *Microsoft paint*, 1985. [Online]. Available: https://www.microsoft.com/en-us/windows/paint.
[116] teamgantt, *Scrum board basics: Getting started with agile*, 2024. [Online]. Available: https://www.atlassian.com/agile/project-management/

scrum-board#:~:text=The%20scrum%20board%20is%20an,workflows%2C%20and%20optimized%20task%20management..

[117] S. Enix, *Final fantasy 14*, 2024. [Online]. Available: https://www.finalfantasyxiv.com/.

[118] S. Björk, *Invisible walls*, 2024. [Online]. Available: http://virt10.itu.chalmers.se/index.php/Invisible_Walls.

[119] E. Games, *Epic games*, 2024. [Online]. Available: https://www.epicgames.com/site/en-US/home.

[120] R. Corporation, *Roblox*, 2024. [Online]. Available: https://www.roblox.com.

[121] X. Wiki, *Xenoblade chronicles*, 2024. [Online]. Available: https://xenoblade.fandom.com/wiki/Xenoblade_Chronicles.

A

Appendix

A.1 Post-Session Survey University Answers

A.1.1 Q2: Please explain how you have contributed to the group during the playtest.

A.1.1.1 Playtest 1

- I offered some ideas on organization and then targeted specific resources to personally gather/hunt
- Mostly returning with new resources from more distant parts of the map that most people don't go
- Explored and found resources which I then gathered and brought back
- I gathered many of the starting resources and explored to discover new resource types
- I have contributed by exploring and gathering materials necessary to advance to the next stages. Either wood, resin, minerals, etc ...

A.1.1.2 Playtest 2

- I mainly explored areas ahead of time, getting items that weren't requested yet but we may have needed in the future.
- I was telling people what resources to gather and directing the map design
- Just collecting the resource base on the leader's order
- I contributed by collecting resources based on whats needed. I mainly did hunting.
- While the others started by collecting the base resources I went ahead by

collecting more advanced resources to prepare for the next platform. My previous playtest helped me do this because I knew what we needed.

- Gather items that were kinda close to the built and that were currently needed.
- Grind materials mostly close by

A.1.2 Q10: What is your opinion on the map's design?

A.1.2.1 Playtest 1

- Distances were a little high, but that was also because of the low stamina. The distinct areas were clear with what resource was found there. A few spots on the terrain were a little hard to navigate (the hole)
- Think it's cool with different structures on different far areas, but didn't have that much to do there (maybe we didn't progress far enough yet for it to be useful).
- Besides the one pit area it was good, could maybe use a little more obvious resource zones but this would make the game easier
- Pretty good diversity, but at times distances can feel fairly long with limited transportation options
- The map design is really cool, maybe some more landmarks would be alright

A.1.2.2 Playtest 2

- I liked the towers feeling important by being far away from everything.
- The map is fine, but since I don't know how many players you recommend, but I think even if there are 10 people, it will be difficult to complete it within the specified time. It is too big, the materials required are divided into many layers, and the most important problem I think is that I don't feel the flow curve. There is no essential difference between the early and late stages of the game, which makes players quickly return to the cycle of collection-synthesis-collection after accepting this gameplay.
- I think it works well. The deeper you go the more 'late game' resources you find works well, as well with more challenging enemies. I think the size of the map works well too, having to consider how far you have to run back with resources, without it being too much
- Some parts are hard to explore, especially some slopes
- I personally do not really enjoy exploring. It would have been nice to have

some kind of landmarks or resource locations on the map to make it more enticing. Or some kind of section like swamp or mines that are more visible on the map.

- I never went too far away due to timer and my role of mostly grinding basic stuff, but it seemed interesting to explore if I had time to.

A.1.3 Q20: In what ways do you think the game could appeal more to both casual and hardcore players?

A.1.3.1 Playtest 2

- Add some late-game content, such as making the map smaller as time goes by, or increasing the player's movement speed, and providing more powerful enemies to speed up resource collection.

A.1.4 Q22: What are you thoughts on the lack of explanations in the game/need to figure things out without guidance?

A.1.4.1 Playtest 1

- I think finding things out with a lack of explanation was good, it encouraged exploration/discovery. However once something is discovered, it would be nice if this was communicated to the group to promote more teamwork rather then "I know where/what it is I'll do it"

- That was fine, but it would have been nicer if it was clearer wat the required items were during the crafting process. Otherwise you barely have an idea what you're actually trying to gather/craft

- For first time discovery it's good, but with the amount of craftable materials it can become too overwhelming to remember what makes what

- It made things a bit hard but it invoked a sense in better communication between the group

- It worked well, but the crafting unlocks felt quite linear and guide-like

A.1.4.2 Playtest 2

- It's nice as word-of-mouth sort of discovery, but once that wonder of discovery is gone, I'm not entirely sure.

- The main problem is not having clear feedback on what was crafted

- It just need more time for exploration, it's fine for me, but for those who try playing the game at the first time they might need more teaching.

- I think it works well and is a bug suggestion for someone to step up as a leader and tell the team what they need to progress. Any explanations would take away from the social aspect of the game. Although a quick explanation of what you need to do in the game in general would be beneficial I believe.

- It helps with communication between players, but some of the crafting mechanics were very counter intuitive.

- It made the game more interesting because you did not know what to expect but we also lost a lot of time at the beginning because of that.

- As a gatherer I didn't mind too much I had all the information I needed and the rest I got from other people, I had no issues.

A.1.5 Q23: In what ways do you think the game could promote further group cooperation and communication?

A.1.5.1 Playtest 1

- logistics like cars and other transport that can move multiple players. Crafting that requires more people at once. Better communication tools (like a little request for a certain resource in chat or something)

- Having it clearer what the required resources/ingredients are during the crafting process, so that people can specialize into being responsible for specific types of resources more effectively

- Maybe some challenges that require multiple people for it to be either easier or accomplished. A more detailed ping system/beacon. Maybe role system would be easier to organize.

- A way to assign more clear instructions for each person. With many people in one server, it can be overwhelming to know who does what, so people instead just do their own thing

- Marking discoveries either on the minimap or in a sort of shared journal would be nice. Or a coordinate system could be used if more self organization was desired

A.1.5.2 Playtest 2

- Leading roles. A leader for crafting, a leader for exploration. Maybe leaders per area.

- Making it hard for one person to know everything means that everybody has special information

- Add some late-game content as I said.

- I guess ways to assign roles to people that give visual feedback to the rest of the team, 'hunter' for instance, could possibly help in organization and teamwork between members.

- Add a better method to manage resources so multiple people can do crafting

- Maybe markers for the location of resources. People might split up and discuss who gets what resource. This could lead to a better dynamic in the team. We had people that kind of knew the area and could redirect people where to go. Otherwise people would have gone off on their own which would cost time and lower the communication in the team.

- In the limited time I had I felt it was more like most people were working for the leader rather than working together, due to the leader never being able to give anything back (at the end he crafted a bow but it was too late, I wish they could build more tools or useful stuff to let gathered move around faster on the map or something)

A.1.6 Q24: Do you have any other thoughts/feedback?

A.1.6.1 Playtest 1

- The overall idea is fun with the meteor coming in and the overall map design, but the current Fortnite crafting system needs some adjustments to make it more enjoyable. E.g., being able to see the names of the crafting materials, easier group item storage, crafting machine outputs.

- Gaining better equipment would be huge. A lot of survival games have this flow where in the beginning you're mostly working towards tools to optimize your work. Finding more efficient tools on like the islands or crafting them would add some progression to the resource gathering, which felt kind of monotone.

- I think all my points were talked by the group during the pos-playtest inquiry, better movement or navigation system, craft recipe result after a craft has been done

A.1.6.2 Playtest 2

- Weapon upgrades should come in earlier.

- The feedback on the more complex crafting with two different possible outputs is not clear because it looks like a pass fail system, maybe changing the colors

would make it look less like a pass/fail system

- sometimes the screen will become black, please fix the bugs.

- Some of the answers such as weapons, consumables, and crafting I personally did not get to experience, so they were hard to answer

- I am just gonna leave a comment here about my answers about the crafting cost and the amount of resources each resource nodes give you. With the amount of players we had the crafting cost seemed high. If the resource nodes gave more resources then it would maybe balance it out. However that could also change with more players. With more players both the current crafting cost and the current resource nodes could be just right.

- I wish there was more to the basic resource gatherer role, didn't feel the progression because all the progression was happening at home base where I never spent time. The limited time and large map made me want to not explore very much because we needed so many resources.

- Also, overall to make it maybe a little more fun to fight enemies, it would be nice to have some weapons or something you can find around the map. Maybe as a reward from exploring? (perhaps this was already implemented, but we didn't progress far enough or something)

A.2 Post-Session Survey FunRock Answers

A.2.1 Q9.1: Do you have any other thoughts/feedback?

- UX for knowing what you will craft with the ingredients. Possibility to deposit partial ingredients. Chests.

- Notebook with crafting recipes; Tools upgrader, for example upgrading the axe; Craftable Teleporter; Stash at the base; One button stash the whole inventory; Craftable Tracker to track rare mobs.

A.2.2 Q12: What is your opinion of the map's design?

- Its alright, a bit small to warrant all those biomes. The post processing in the swamp biome was very annoying, dark and dizzying.

- needs more instruction like hints for each place and resources.

- The overall map design is very good! Visually pleasing adn engaging to explore. However I dont know if it exists but I expected to find more meaningful items in unique or hard to reach locations, so I was slightly disappointed in that regard.

- Generally it is good and fun how the map is divided giving variety of different locations; Sometimes I could get under the ground. Map colliders need to be set more safely. Also some mobs spawn under the ground; Some areas and Islands felt not as rewarding or not much content on it like the desert, the island with volcano in the center; Some areas are visible but not reachable "even though it felt reachable at the beginning"; Sometimes passing certain areas instantly turns from day to night or vise versa which felt weird; Some areas in the map requires stuff to unlock "Like the ascender" I had no idea what the requirement is by looking at the image of the requirement or even guess how to craft it.

- Resources in biomes further away didn't seem useful: probably because they would be needed in later stages of the game that we did not reach in time.

A.2.3 Q13.1: What is your opinion of the map's design?

- Naming for markers to make communication easier.

- if i have eagle vision or satellite access it will be perfect.

- An upgrade to travel faster in water, an upgrade to run faster, or simply unlimited mounts. Potentially ways to indicate the location or certain resources for other people to find (like a ping, but labelled).

A.2.4 Q17.1: What types of tools would you like to see to help you in gathering?

- environment scanner.

- I didnt feel any specific needs. Maybe something in the game that indicates which materials are currently most needed or prioritized. Like a system that shows resource weighting or current demand.

- Stash; Upgradable gathering tools.

- Labelled pings for easier communication.

A.2.5 Q21.1: What types of tools would you like to see to help you in hunting?

- SHOTGUNS, flame thrower.

- Generally hunting weapons were very limited; No idea how to craft more items "We could craft 1 bow the whole run"; I'd like it more if it had easier access to weapons and making it with limited ammo rather than very limited access with unlimited ammo, the ammo could be craftable as well.

A.2.6 Q27: Please explain why you think the leader impacted the group positively/negatively

- Organization is always positive.
- he divided the tasks and prioritized resources to gather.
- It helped to guide and assign gatherers to specific resources.
- It was very important to have someone responsible for reporting and asking for which type of resources to focus on. Also to keep track who does what to avoid wrong allocation of resources.
- The leader could give us a "job", so that we know what to focus on, and when.

A.2.7 Q28.1: What types of tools would you like to see to help in leadership?

- Some way to automate orders on what to gather directly to individuals.
- a device informing the manager the amount of resources with each player.
- As I mentioned before, a system that shows resource demand.
- Notebook for crafting recipes; Board for assigning jobs; Board for showing urgently needed resources; Ability to track HP of other players and call others for rescue; Key to stash.
- A way to broadcast the things you need. A way to distribute "roles" with flexibility. A way to place stronger pings (more visible than others).

A.2.8 Q30: What types of tools would you like to see to help in leadership?

- I think it could work for casual just fine. I think it lacks complexity in its systems to attract more hardcore. Like deeper combat systems, less linear tech progression, more survival elements as now you just died and started over and could pick up your stuff again without penalty, making you careless and not really feel threatened by the world.

A.2.9 Q32: What are you thoughts on the lack of explanations in the game/need to figure things out without guidance?

- I think that it will be harder getting into in the beginning when you dont know what its about but fine later on. I will say that the lack of explanations

in combination with lack of general feedback on world actions (like trees not disappearing on chopping them down) made it a bit too much though. So lack of textual information can be interesting but not lack of visual information making you make mistakes in vain, wasting time.

- It has a certain appeal. I think the important thing for people is to know beforehand that they will have to figure everything out themselves.

- it was fun and good idea.

- I think the lack of explanation is a core part of the concept. It's fun do figure out small stuff and share with your team!

- Sometimes that was good giving sense of exploration and communication between team members. And sometimes it was hard to figure out some stuff even with communication.

- It does encourage guidance a lot. It could be useful to write the name of the resources on the crafting platforms (without saying where to find it) just to ease communication.

A.2.10 Q33: In what ways do you think the game could promote further group cooperation and comunication?

- Named map markers as mentioned earlier and maybe an easier way to see where everyone around you are. Maybe even assign in-game roles so you know what people are up to, because not everybody communicates properly, and its easy to talk over each other when in a large group.

- Not sure.

- collaborating in killing strong monsters.

- Maybe a boss or something with mechanics that makes you call for the group and directly work together. Or experiment with kiting strategies to farm in groups. Or some kind of puzzle that binds to different parts of the map.

- Give more access to the leader and sub leaders with ability to reward/banish players. There must be a competition between the players so everyone do their best following the orders. In that case players will be forced to communicate and try to understand more.

- Maybe globally-displayed objectives, so that you can follow in real time how close you are from the objective. The objective to display globally could be picked by someone and replaced at any time.

A.2.11 Q34: Do you have any other thoughts/feedback?

- The monster spawning was too frequent in comparison to the benefits you gained from killing them. Either make it lower or more rewarding.
- As a concept it was really fun! Thanks.
- Keep building that up. The idea is awesome and if it scales correctly it can be a very popular mode in the game.
- Obviously balance was quite off. Maybe the number of resources in total was a little bit too much (like too varied). It could have been good to visually differentiate better the crafts that are QoL from those that are "main objectives".