Implementation and evaluation of game design patterns for a collaborative game

Bachelor's thesis in Computer science and engineering

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Cover: A rendered image of the models used in the game Parcel Pauls

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Abstract

This report explores which game design patterns can impact the aspects of meaningful collaboration between players. Using the methodology Research Through Design, we have developed a collaborative game with the aim of identifying and testing patterns that promote player interaction, engagement, and collaborative behaviour. The process involved iterative prototyping, playtesting, and analysing player behaviour through observations and interviews. Challenges addressed include reducing player frustration and ensuring widespread and equal participation. By continuously reflecting over design decisions, we have aimed to deepen the understanding of which game design patterns that may enhance social interaction, collaboration and shared problem-solving in video game environments.

Sammandrag

Denna rapport undersökte vilka speldesignmönster (game design patterns) som bidrar till och stärker samarbetet mellan spelare. För att undersöka detta användes metoden Research Through Design, och genom en iterativ process skapades ett spel. Spelets syfte var att utforska vilka speldesignmönster som främjar samarbete. Processen involverade iterativ prototyputveckling, speltestning samt analys av spelarbeteende genom observationer och intervjuer. Några av de utmaningar som hanterades var att undvika frustration och att säkerställa ett jämlikt deltagande bland spelare. Genom kontinuerlig reflektion över designbeslut strävade vi efter att fördjupa förståelsen för vilka speldesignmönster som kan stärka social interaktion, samarbete och gemensam problemlösning i digitala spelmiljöer.

Keywords: Collaboration in games, research through design, game design patterns, game development, user testing.

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Contents

Dictionary

Asymmetric Gameplay	A game design element where players have different roles or abilities.
Autonomy	The ability of each player to make independent and impactful decisions within the game.
Collaborative Elements	Game features or mechanics that promote collaboration.
Collaborative Gameplay	Gameplay where players work together toward a shared goal. Success and progression of the game depends on team dynamics and cooperative strategies.
Exergaming	A combination of the words exercising and gaming, refers to when video games need physical activity to be played.
Game Design Patterns	Recurring design elements within games that shape gameplay behaviour; used for theoretical understanding in game development.
Gameplay	The features of a video game, such as its plot and the way it is played, as distinct from the graphics and sound effects.
IDE	(Integrated Development Environment) A software application that provides tools for software development.
Interaction Patterns	The ways in which players engage with the game and each other during gameplay.
Kanban	A system for organising task and sort them into categories.
MoSCoW	(Must have, Should have, Could have, Won't have) A prioritization technique to organize and priorities task in a project.
Paper Prototype	A low-fidelity, physical presentation of an idea.
Replayability	The quality of a game that makes it enjoyable to play multiple times.

Research Through Design	A methodology involving iterative progress. Testing and iteration provide research insights.
Split screen	A visible division of a screen, often times divided into two or four parts.
Symmetric Gameplay	A game design where all players have equal roles or abilities.

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1
Introduction

Video games have been integrated into today's modern culture, evolving from just simplistic entertainment to elaborate methods of social activities, education, and collaboration. Of these, collaborative gameplay stands out as a powerful tool for both players and developers. As video games continue to integrate shared task and team-building experiences, understanding the heart mechanics of collaboration in video game design becomes increasingly relevant. This thesis explores the design elements of collaborative games. In contrast to single-player games, collaborative games require thoughtful design to ensure that all participants feel engaged, valued, and essential for success. The main question is: what game design elements best support this kind of meaningful teamwork?

1.1 Purpose

The purpose of this project is to develop a game and implement a set of game design patterns (Björk and Holopainen, 2005) in order to examine the factors that motivate player collaboration. This project focuses particularly on what game design patterns fosters collaborative behaviour among players and which ones may hinder or stall such interaction.

1.2 Scope

For this project, a target group is selected to reduce the scale of the project. The target group is people aged 18-30 years. We do not take any other sociodemographic factors other than age into consideration in our test subjects. Different people may approach collaboration in different ways, but that would simply be too much to take into consideration for the scale of our project. The focus will instead be on a more general solution to the problems we want to examine.

This report focuses on what game design patterns makes players collaborate in games, therefore it will not go into technical depth about development or implementation the code. There will also be usages of pre-made assets and sound effects to speed up the development. The main focus is on collaboration and not implementation.

1.3 Social and ethical aspects

In terms of ethical values relevant for our project, the main aspect is to work with inclusivity, accessibility, transparency, and fairness towards players and testers in our game. The game will be designed to be inclusive and accessible to players of all backgrounds. Some examples of specific precautions for people with different disabilities that are the considerations to design the game with visual and auditory clarity and with a non-frustrating and widely accessible difficulty curve. An important example of such a precaution is the usage of any known game design patterns that would make the game feel more collaborative and interesting to participate in for anyone regardless of prior experience or background. With patterns such as creating a feeling of companionship within the game, enabling intuitive collaboration and setting mutual goals for all players taking part (Eriksson et al., 2019).

For specifically the testing phase of the game's development, there is proper consent from the players before any data collection is performed and full transparency regarding what data is being collected and what it is used for. The testers is also well informed about the intentions with each test session. Much is achieved with a consent form that the testers have to sign before participation, similar to the one covered in the consent form appendix of Erik Bennerhed and Anders Sivertsson's *Reform Journey Thesis* (Bennerhed and Sivertsson, 2020).

An elaboration on efforts made during the design and development of the game to foster inclusivity and accessibility within the game is the colour of the game. The colour pallet for the visuals is chosen with regard to accessibility for players with different types of colour blindness or other struggles of perception. Another caution we make for allowing greater accessibility is the game's support for allowing different types of controllers for playing.

In addition, to continuously avoid ethical problems regarding the project, stages of development and process are planned taking into account both positive outcomes and potential negative consequences. If successful in any case, the game and the resulting report offers and explains a game design that fosters collaboration and social connectivity, and of course a media of entertainment providing a fun team-oriented and collaboration-based experience for any group of hypothetical players.

2
Background

Collaboration in games is a game mechanic that affects how players interact and play together. There are many benefits to working together with other people. Collaborative elements can provide insight into social behaviour and physiology. “Exergaming” a combination of the words exercising and gaming, refers to when video games need physical activity to be played. According to Arwen M Marker and Amanda E Staiano, collaboration in exergaming makes players more motivated, increases prosocial behaviours, and makes players put forth more effort compared to players who played competitive (Marker and Staiano, 2015). Furthermore, playing together with other people can make players gain trust in each other faster than traditional social icebreakers (Depping et al., 2016).

When examining player interactions within a game, two key concepts often appear: collaboration and cooperation. According to the Cambridge dictionary, the word collaboration means ”the situation of two or more people working together to create or achieve the same thing” (Cambridge English Dictionary, n.d.-a). This should not be confused with the word cooperation, which means ”to act or work together for a particular purpose, or to be helpful by doing what someone asks you to do” (Cambridge English Dictionary, n.d.-b). These words share significant similarity, but they have different meanings. By our interpretation, collaboration is referring to the act of working together to achieve the common goal. All team members are equal and all have ownership of the end result. Cooperation refers to working with others on one project but all members might not be equals or have ownership of the end result. In this report, we will focus on collaboration and not cooperation. What this means for the game is that the players have to work together to achieve a common goal. The team succeeds or fails together (Zagal et al., 2006). The goal is for the players to all feel equal and that they all contributed towards the end result.

2.1 A brief history of game design

The subject of video game design is closely related to traditional game theory. Many design ideas for modern video games come from traditional games such as board games, card games, and athletic games (Wood and Goddard, 1938; Zagal et al., 2006). The ideas of constructing a theory surrounding digital game design originally came about as a way to navigate the new landscape of game development in the

late 1970s (Crawford, 1984). At this point in time, game design was driven largely by the commercial interest of games which can largely be attributed to technical advancements of computers (Eimbinder and Eimbinder, 1980). An early example of game design being documented is in the book *The Art Of Computer Game Design* written by Crawford (1984), where the author, an experienced game developer, discusses good practices in game design. One of them being the design of a smooth learning curve, another being the design of increased pace of the game for increased difficulty. They also categorize the different digital games of the time and explore design aspects that govern them.

These ideas of video game design born during the early commercialization of video games have since continued evolving with technology. The state of the modern literature of game design has faced criticism for not being based in a scientifically meaningful methodology. In the article *Game Design as an Autonomous Research Subject* written by Neves and Zagalo (2021), this problem is addressed and a more scientific methodology is proposed. The article is introduced with a summary of the state of the modern game design literature:

> One of the most salient features of games as an object of study and a field of practice is their interdisciplinarity and multimodality. Another salient feature is their particular nature as a kind of second-order design, which, to a certain extent, naturally turns games into black-boxes in terms of the processes by which games produce their particular effects on their players. All of this has left game design in an awkward methodological position. (Neves and Zagalo, 2021)

Part of the solution discussed in the article is the use of the term game design pattern.

2.2 Game design patterns

In order to clearly define different aspects in a game's design, one can use something called game design patterns. This is a term introduced in the book *Patterns in game design* written by Björk and Holopainen (2005), where game design patterns are described as "semiformal interdependent descriptions of commonly reoccurring parts of the design of a game that concern gameplay". In the book, several elements found to be recurring throughout different games in existence were noted down and grouped together into game design patterns. A game design pattern can be a game mechanic like moving, jumping, shooting, but are not only limited to actions. Broader elements like storytelling or giving the players freedom of choice are also instances of game design patterns (Björk and Holopainen, 2005). One example of this is the game series The Sims (Electronic Arts, n.d.) where the player can interact with multiple objects and make many types of actions for each game element. The pattern described is *freedom of choice* (Björk and Holopainen, 2005).

We make use of game design patterns as a tool for building our game and as a

reference point for reasoning about our implementations. In the official game design pattern wiki page written and maintained by Björk and Holopainen (2024), a collection of over 600 game design patterns are listed. Each pattern is described, some example occurrences of the pattern in real games is noted alongside possible relationships with other patterns. This allows us to identify design patterns related to collaboration and related synergetic patterns to work with.

The concept of game design patterns is used in this report as a way to reason about design in an elaborate manner.

3
Preliminary study

For the purpose of guiding the development of our collaborative video game, a pre-study consisting of the three components, a literary study, brainstorming, and prototype testing was conducted. Together, these components have formed the foundation of our project, aiding in the construction of a comprehensive and informative research project. These were selected to structure and form our idea prior to development.

3.1 Literary study

In order to build a good theoretical foundation for understanding the concepts of collaborative game design, we explored elements of central literature. One such work is by Qu et al. (2016), titled *Design Patterns Applied for Game Design Patterns*, which explores how design patterns can be adapted in game development. However, the original source of the game pattern framework we use Björk et al., 2003 illustrates how design patterns influence game mechanics and player interactions. This, along with other sources, provided a necessary foundation for conducting an informative and qualitative study.

Other literature, *Collaborative games: Lessons learned from board games* by Zagal et al. (2006) in their exploration of collaborative elements in board games point out the collaborative elements of board games. As an example, the authors discuss how a game with asymmetric gameplay also encourages collaborative gameplay. An interesting observation that suggests that there is a fine line between symmetric- and asymmetric gameplay for a game to fully stimulate collaboration. These insights have been used to further improve our game and effectively foster collaboration.
These sources have provided theoretical insights that helped us understand collaboration.

3.2 Research on other games

To have a clear goal and to have developers share a vision of game development, we had to inspect the specific aspects of our research project that we wanted to evaluate. To approach the problem, we conducted individual studies on existing video games in order to identify hindering and collaboration-promoting elements. This included detailed note-taking of what we believed to have caused certain emotions when playing the game and also of how certain aspects may have promoted

collaboration. For example, mechanics that required shared efforts were noted to invoke feelings of teamwork and enjoyment, while divided tasks often resulted in player isolation.

As mentioned, *Zagal* discussed collaborative elements of collaborative board games. Before development, we decided to examine the collaborative elements of the board game "Shadows over Camelot". The game provided developers with the concepts and mechanics that foster collaboration.

To further support the claim of (Zagal et al., 2006), that asymmetric gameplay fosters collaboration, we noted that "Shadows over Camelot" had constructed a perfect balance between symmetric and asymmetric gameplay. The players had unique abilities that, when combined, gave the players an advantage. The asymmetric aspects of the game encouraged widespread participation throughout the game. The game was successful in ensuring that players do not work in isolation by enforcing a meaningful impact of all participants.

The early stage testing was carried out in small sessions to test the following:

- General interaction patterns, with the intention of getting an overview on how the game interacts with its players in a collaborative way as a whole.
- Intentional behaviours, such as the use of mechanics created to promote collaboration.

The results highlighted both successes and areas for improvement. For example, impressions were made that concluded that there was a lack of asymmetric gameplay, meaning that further improvements within that domain were left to be properly implemented.

3.3 Relevant questions

As part of our preliminary research on the game development process, we defined some important questions to answer or think about before starting work on the game. These are the questions that we found to be highly relevant when designing a collaborative game.

In what context is the game played?

The context in which the game is played may be difficult for the developer to control or fully predict, but it is something worth considering during development. The context determines the setting of the gaming experience and can greatly affect the overall experience. For example, a group of unacquainted players will probably have a completely different experience playing a game than a group of friends, even though they were playing the exact same game. Another example would be that a computer game wouldn't be designed to be played on the go as many mobile games are. Determining the overall intended context of the game helps in imagining the player's experience and needs (Schell, 2008). These aspects are highly relevant when planning playtesting sessions, which is covered later in section 5.4.

What is the purpose of playing the game?

Giving players a clear motivation and answering why the game should be played is essential for it to be interesting in the first place. The motivation for playing should be clear to the players from the get-go (Schell, 2008). One of the most central motivators in collaborative play is socialization. Participating in game activities together is in itself a motive for playing. Another motive is strategizing, coming up with new strategies together and performing them can be rewarding, especially when the strategies solve problems that would be unsolvable for one player working alone. Also, being part of a successful team effort is another common motivator. Playing collaborative games is also a great way of strengthening connections. Playing games can bring out parts of ourselves that are not present in everyday life. Collaborative games are also an opportunity for players to explore how they interact with others and how they handle complex social situations, which can also be a big motivator for collaborative play. All of the above are motivators described in (Schell, 2008).

What is the target demographic?

Like the importance of identifying the context of the play, it is also important to identify who is playing. Things such as age, gender, and other defining features of the players affect how they experience the game. Different age groups generally tend to different types of play, the same is true for gender (Schell, 2008). As mentioned in section 1.2, we decided to work with the broad target demographic of anyone between the games 18-30 since they are easy for us to relate to and more importantly find playtesters for.

4
Problems

Developing and studying a game based on collaboration comes with a set of unique challenges related to the intended collaborative nature of the game, as well as other problems common when designing any game that aims to be fun and engaging. To overcome these challenges and find effective solutions, the problems must first be identified and researched. This can be done using relevant literature and practical insights, for example, by examining the well-defined common pitfalls in collaborative game design discussed in the work of Zagal et al., 2006. In order to study and discuss strategies to overcome the problems and challenges that we are expected to face throughout the project, this chapter will explain and show consideration of the most notable and relevant problems that may arise during the design, development, and study of a collaborative game.

4.1 Finding out what is to be expected of a collaborative game

The field of theory in game design is vast and is constantly growing with the continuous emergence of new driven game developers and the new games that are constantly being developed.

It is common for different games to share aspects and themes, and even more common for different games to share core gameplay philosophies, such as being single player, player-versus-player multiplayer, collaborative multiplayer, etc. (Tanya Krzywinska, 2024). Many important design problems arise across different types of games. Over time, several of these problems have been addressed with solutions that have stood the test of time and become almost standardized in parts of the industry. An example is the use of "split screen" to allow multiple players to see different things while playing together on the same system and viewing the same screen. For different types of games to be enjoyable and to fulfill their core design philosophies, they must include features and design choices that support both player engagement and the intended gameplay experience.

An effective approach to understanding the developement of collaborative games is to analyse existing games that successfully implement collaborative mechanics and experiences. With a foreground understanding of some existing examples of working collaborative systems in games, the task of figuring out collaborative elements for one's idea of a game is vastly simplified. The development and testing

of Parcel Pauls aimed to identify the factors that encourage collaboration in games explicitly designed to be collaborative, and to explore the expectations such games must meet to fulfill their intended purpose.

4.2 Common pitfalls in collaborative game design

When designing games with collaborative themes and gameplay, there are some difficult challenges to overcome and common pitfalls to avoid. These must be addressed to ensure that collaboration remains a central and meaningful part of both the gameplay and the players' social experience, without diminishing the game's entertainment value. A practical definition of some common pitfalls was described in an extensive study by Zagal et al. (2006), in which the links and parallels between collaborative game design in digital games and board games were studied. When discussing the challenges that designers of collaborative games must overcome, the study mentions three "pitfalls" that illustrate some of the most important difficulties that must be considered when designing an interactive and collaborative game experience.

> To avoid the game degenerating into one player making the decisions for the team, collaborative games have to provide a sufficient rationale for collaboration (Zagal et al., 2006).

A common problem in collaborative game design is that players with the most experience or in-game skill may naturally assume a leadership role. Over time, this can lead to a "solitaire game" dynamic, where the leading player makes the most of the decisions, reducing the autonomy and participation of the other players. This is an important problem for developers to understand and avoid, as it helps to ensure that the intent of the game's design remains clear and that all players can engage in meaningful collaboration towards a shared goal (Zagal et al., 2006).

> For a game to be engaging, players need to care about the outcome, and that outcome should have a satisfying result (Zagal et al., 2006).

This is a pitfall to avoid in all types of games, since the outcomes and reward of a game are the core aspects that make players engaged and entertained, making the game worth playing. But it is especially important for a collaborative experience, since the game needs to feel fun and rewarding somewhat equally for all players to ensure a healthy collaborative environment(Salen and Zimmerman, 2003). If the game feels unsatisfying to participate in even for one out of a group of players, the overall experience will take significant damage from the fact that progression of the game is tied to the group's ability to collaborate, and it only takes one player to not feel engaged or very interested in succeeding for the collaboration to become unstable and unreliable, making the core philosophy and premise of this game type to not thrive (Zagal et al., 2006).

> For a collaborative game to be enjoyable multiple times, the experience

must be different each time, and the presented challenge needs to evolve (Zagal et al., 2006).

Like all games with an arcady premise, there is an incentive to make the game replayable, which forces the game to rely on some kind of variation each time it is played so that it does not incur boredom or staleness. This is commonly achieved through the introduction of features with some degrees of randomness and variation that, in some ways, change the experience each time the game is played (Zagal et al., 2006).

4.3 Avoiding frustration in collaboration

To allow for a fun and healthy collaborative environment, it is important to identify and minimize factors that may lead to negative emotional responses. Such responses can increase the risk of social conflict or discomfort , which may undermine the collaborative experience.

Frustration can be defined as the emotional response of the body that is triggered by experiencing a loss or devaluation of a desired reward or goal. It is triggered by the discrepancy between expected and actual outcomes, which often leads to accompanying feelings such as anger, disappointment, and annoyance (Amsel, 1958).

Why avoid frustration

The goal of a game as a form of media is to entertain the player. This is mostly achieved through the game being perceived as fun or in other means satisfying for a player to interact with. If the game would not be sufficiently fun, or abruptly become unfunny, or even more so if the game at any point causes frustration in the player, the player's motivation to keep playing the game lessens or even drops completely. If this happens in a single-player context, the worst thing that would happen is that the player decides to not continue playing the game and for a shorter time experience some negative emotions spawned from the game's frustration-inducing aspects. In a collaborative multiplayer setting, however, the discouragement and disinterest of just one player can majorly cause the rest of the playing group to suffer effects of frustration stemming from the underperformance or noticeable disinterest from the one originally frustrated member of the group. Because collaborative games rely on consistent performance and participation from the entire group, sources of frustration pose a greater risk to overall enjoyment, especially since the satisfaction of multiple players is affected at once (Bonk and Tamminen, 2025).

Frustration at a personal level can significantly reduce a player's motivation to collaborate and support others, as their sense of personal reward and satisfaction is diminished. Overall enjoyment is a key factor in fostering player engagement, as it reinforces the perception that the game is a worthwhile investment of time and effort. Maintaining player interest is especially important in the context where the game serves a research purpose, as it ensures that players remain motivated to play,

test, explore, and provide meaningful feedback.

Causes of frustration

To avoid the frustration-inducing aspects of a collaborative game during development, it is essential to first identify what causes frustration in a collaborative game context. The causes of frustration could be divided into parts of the game that could trigger frustration from the player with the game itself, and parts of the game that may enact frustration between players as a result of in-game caused conflicts and/ or communicative misunderstandings.

Sources of frustration can also be further categorized as making you frustrated "in-game", or frustrated "at-game" (Miller and Mandryk, 2016), where in-game frustration can be defined as a positive frustration that gets aimed at in-game challenges that are slightly beyond a player's abilities, promoting improvement in skill and further engagement to overcome such challenges. The "negative frustration", or "at-game" frustration, stems from failures in game design and unsatisfactoriness stemming from its mechanics. Examples of design that can lead to "at-game" frustration are things such as challenges well beyond a player's capabilities, unsatisfying movement, unrewarding goals, bad player controls, and much more (Miller and Mandryk, 2016).

The frustration that can occur between players playing a collaborative game together mostly stems from game-dependent mechanics and features or are entirely based on factors that stem from the players themselves. Examples of the former are as described above and are mostly about making sure the game structure and systems themselves work as promised. The game communicates its design intentions to the player through teaching systems, such as tooltips or tutorials . Alternatively, it may rely on the player's intuition and prior gaming experience to guide progression. The promise of the game to the player is that the game follows, if not explained not to, normal conventions that allow intuition and experience to suffice for a player to succeed (Karlıklı and Aker, 2024). If the game behaves as the player expects, meaning its systems are clear and fully understandable, it helps foster a smoother experience. Additionally, the absence of bugs that hinder progression or disrupt the cohesion of the game contributes to a design that minimizes player frustration by removing unnecessary obstacles and frustration-inducing elements.

The more important and possibly more difficult form of frustration-inducing factors to avoid are those that stem from collaborative game aspects where frustration can occur due to players' need of reliance on each other to perform in order to succeed. An example of things to avoid is the previously discussed risk of degeneration from a collaborative game into a "solitaire game" (Zagal et al., 2006). Other things to consider are to not create situations where the amount of distributed autonomy and responsibility among the players is unequal, as it could cause situations that might devolve in the direction of the "solitaire game"-state. In this case, frustration may stem from players not getting to fill a role where their efforts amount to the same proportional progress as the others, or perhaps from players experiencing that

other players have a lesser role in the games progression and that the responsibility of performance is not equally divided. This can be a result of a bad implementation of the concept of asymmetrical gameplay, where it's failure can cause "social loafing", or the perception thereof, where a showing of unequal contributions demotivate high effort and can inflate frustration from multiple players at once (Karau and Williams, 1993). In the case of our project, previous research suggests that the risk of "social loafing" is significantly reduced in games that incorporate elements of forced collaboration. This indicates that, due to the intent of making our game with player collaboration as a core concept, the likelihood of "social loafing" negatively affecting the collaborative experience is reduced (Riivari Elina, 2021).

A last spawn of frustration between players can occur when one player is unsatisfied with another's efforts or skills, without it being tied to a feature of the game itself. This is a harder problem to solve since it stems from a dynamic entirely remote from the design of the game and can seem a reasonable limitation to make, but should still be a case to consider.

5
Method

To investigate which game design patterns encourage collaboration, we first developed a testable prototype of a collaborative game based on the ideas brought fourth during the pre study (see later section 6). We then used that as a basis in an iterative research process. In each iteration, we noted any added and altered game design patterns and evaluated the collaborative qualities of the game through structured playtesting, analysis, and reflection. The effects could then be associated with specific implementations and changes of game design patters.

Collaborative game design patterns served as conceptual building blocks of the game from which we could implement concrete game elements. The game design patterns fulfilled two key roles:

1. They provided a shared vocabulary to describe, analyze, and discuss collaborative aspects of the game.
2. They acted as modular design components that could be added, removed, or reconfigured to our game between iterations to enhance collaboration.

By examining how implementations of different game design patterns into our game influenced collaboration, we aimed to continuously refine the design toward increased collaboration. To measure the collaborative quality of the game, the playtesting results were compiled into a single collaboration score.

The following sections go through each part of the methodology discussed above respectively.

5.1 Tools for developing the game

Game development is a complex process that involves numerous different parts including graphics and rendering, programming, sound effects and music, and much more. Trying to do this all by ourselves would simply be too much work for this project. Therefore using a pre-made platform for developing games was the best option. In today's age, there are several well recognised platforms to use such as Godot (Godot, n.d.), GameMaker studio (GameMaker, n.d.), Unreal Engine (Unreal Engine, n.d.) and Unity (Unity, n.d.).

The engine that fit the needs for this project best was Unity. Unity is a flexible platform that supports both 2D and 3D development. The programming language

used is C# which is a well known programming language with extensive documentation to get help from. Unity also has a large community and therefore there are many resources available online to learn from.

Unity was the main platform used in this project, supplemented by some additional tools to support various different aspect of development as well. In order to program we used Microsoft Visual Studio (Microsoft, n.d.), a code IDE that supports C# and Unity (Unity, n.d.). To develop the assets, the latest version of the program MagicaVoxel was used (MagicaVoxel, n.d.). Git was the version control system we used for development (Git, n.d.). GitHub was the platform used to access and managing the code (Github, n.d.).

5.2 Game development process

An iterative, agile approach was used in development of the game. The game's design went through continuous testing and re-designing throughout the process with a focus on improving its collaborative elements (Asana, 2024). By continuously refining the design and using it to test the effect that it had on user collaboration, we gained more insight into what combinations of game design patterns lead to engaging collaboration. The game development process is visualized in figure 5.1. The process started with coming up with a game idea and continued with the iterative part which consisted of three steps. First, a design was conceptualized according to the end goals, current needs and previously attained results. Then, the concept was implemented in a prototype which was then tested. Following the testing phase, a new iteration of development was started, this time allowing for agile adaptations of the design depending on needs. The results of the playtesting sessions were evaluated to identify which design aspects worked well and where the current design lacked in contributing to collaboration. After having established the appropriate modifications, a new design was brought forth and the cycle started anew. This iterative process was repeated until a final prototype was reached. This game development process was heavily inspired by the traditional game design model presented in the paper about playtesting educational games written by Grogorick et al. (2018). This approach was fitting since it allowed for several iterations to be compared with one another.

5.3 Research methodology

In this work, testing served a two-fold purpose. First, it was a crucial step in the iterative game development process presented in section 5.2. Second, it was an opportunity to carry out iterative research through design, which is a research approach that uses design as the primary tool of generating knowledge and answer questions about a given problem (Foundation, 2024). In this case, the problem constituted the main purpose of this project, namely, answering the question of which game design patterns encourage collaboration in video games. After testing an iteration, a qualitative result was conceived consisting of questionnaire answers

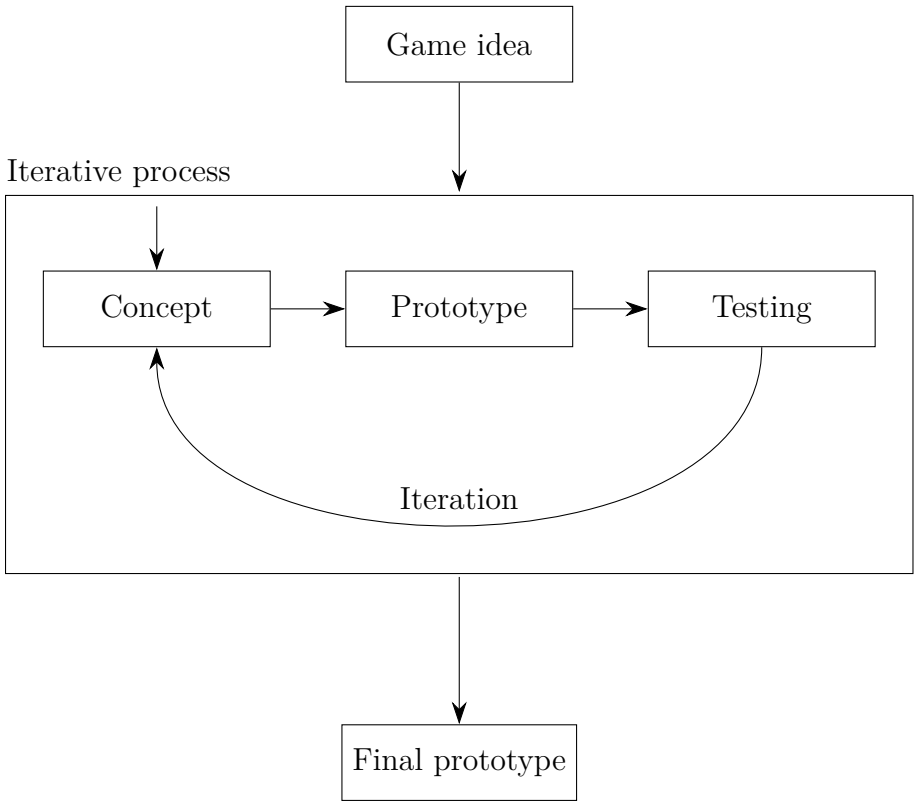

Figure 5.1: Game development process

and assessed observations of collaboration. The results were then used to reason about the design and to generate scores of different metrics relevant to collaboration. These scores were then used to compare prototypes with each other as a way to measure the effect changes in design had on different aspects of collaboration. An overall collaboration rating was also compiled to get some sense of the overall results. Details of how this was done are covered in the following section.

5.4 Playtesting

Playtesting sessions were performed throughout each iteration in our game development process. Each iteration consisted of two separate playtesting sessions involving four players each. Although, the last iteration was only tested once since we couldn't find enough playtesters in time. In every session, all players played the game for an equally long time, ensuring fairness and consistency across sessions, since the results were directly dependent on the duration of gameplay.

Due to the short time frame and lack of resources for conducting continuos playtesting from the get go, we decided that playtesting sessions in early iterations of the game development process would be performed with only the developers present. This enabled us to quickly test early ideas, features, and implementations without having to go through the whole playtesting procedure which can be hard to do when working with limited resources. Once a prototype was interesting enough to

test with actual playtesters, sessions were done following the playtesting procedure presented in 5.4.3.

5.4.1 Selection of playtesters

As stated in section 3.3, it's important to consider who is playing, therefore the selection of playtesters play a crucial role in the results of the tests. Ideally, the playtesters would be everyone in the target audience, but that's not realistic. Therefore, a subsection of the target audience, a small group representing the target audience is usually selected as appropriate playtesters (Schell, 2020). Ideally, playtesters would also be compensated for their time which would also be hard to make happen with our resources. Our selection of playtesters was limited partly because it would be hard to gather true representatives of the target audience but also because the time frame did not allow for any lengthy recruitment process. Because of these limitations, we decided to select playtesters from people we know and people from campus. To make the measurements of collaboration as accurate as possible, we grouped together people who were not well acquainted with each other. The reasoning behind this decision is derived from the pilot study section 3.3 where we found that well acquainted people may have already established ways of playing or strategising together which may affect playtesting results. We chose to perform playtesting sessions in groups of four, since that was the number of players the game was being targeted to support. Furthermore, the number of playtesters were kept the same between sessions in order for the results to be comparable.

5.4.2 Selection of playtesting environment

According to the importance of the context of play when playing games as discussed in section 3.3, it can be concluded that the choice of where the playtesting sessions take place can have a great impact on the experience and therefore also the results of the sessions. For us, it was important that the playtesting environment fulfilled the basic requirements for being able to play our game. This meant that it had to be an environment that fit all 4 players and allowed them to communicate easily while playing on the same screen. For that to work, the screen should be big enough for them all to see what's happening. For these purposes, we chose a group room in the library as our playtesting environment. This group room was easily accessible for us and the playtesters because of it's location being on campus. It was also equipped with a TV that the computer running the game could be connected to, which made it a good fit for our purposes. To generate reasonably consistent and comparable results, we tried to reuse the same room in all playtesting sessions.

5.4.3 Playtesting procedure

Through testing, we wanted to note the effect our current design had on the level of collaboration between the participants. By then analyzing this effect, we could more clearly identify what changes in the design were needed for increasing collaboration.

To make qualitative assessments of our design's effect on collaboration, we first needed to measure collaboration. Since collaboration is a broad and somewhat abstract concept, measuring it is not straightforward. However, the collaborative experience is closely related to some concepts that are measurable through established questionnaires. These concepts are social presence, flow and co-presence, each measured through its own questionnaire (Poels et al., 2007; Rheinberg et al., 2023; Casanueva and Blake, 2000). Furthermore, we observed player behaviour in order to gain insight into the level of collaboration during playtesting sessions. Certain actions – such as strategic communication or task division – were classified as instances of collaboration and noted. To support consistent identification of such behaviours, we used a set of predefined collaboration metrics that outlined the types of observable actions we considered indicative of collaborative activity. Our playtesting procedure was inspired by the one presented by Mirza-Babaei et al. (2016) in their research article about playtesting for indie studios where they explore strategies for playtesting with limited resources. The procedure was also designed to fulfil the specifications of the different questionnaires used. The playtesting procedure shown in figure 5.2 shows the five stages of each session. The sections below go through each step in order.

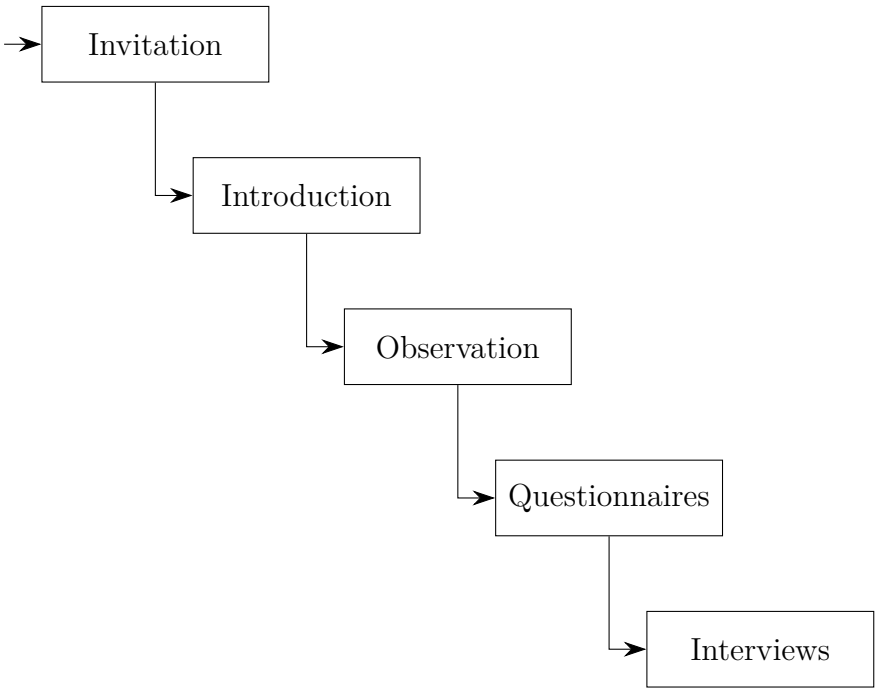

Figure 5.2: Playtesting procedure

Invitation

First off, an invitation was sent via email to 4 participants containing the time and place of the session, a short description of how to navigate to the place and a brief introduction to who we are and our purpose was also included.

Introduction

The playtesters were welcomed to the playtesting session. The organizers explained to the playtesters what was going to happen and gave them a brief on how to use the controls and if needed, the basic mechanics of the game. Before beginning the session, playtesters gave written consent to be videotaped during the session. The consent form is found in A.1;

Observation

To measure the level of collaboration among the participants during gameplay, we videotaped and screen recorded each playtesting session. After each session, the recordings were analyzed with a predefined set of collaboration metrics in mind. The metrics represent specific types of social or in-game behaviors that can be interpreted as instances of collaboration. The set of collaboration metrics used is listed below in table 5.1.

Table 5.1: Collaboration metrics

#	Collaboration Metrics	Description/Example
1	Shared Laughter or Excitement	Participants laugh at the same time due to a specific game event, express enjoyment verbally (e.g., 'sweet', 'this is fun'), or show nonverbal signs of excitement such as head shakes or facial expressions.
2	Worked Out Strategies	Participants talk aloud to solve a shared challenge, divide zones for 'divide and conquer' tactics, or navigate the world while consulting with each other.
3	Helping Each Other	Instances where one player directly assists another.
4	Global Strategies	Players assume complementary roles that align with their abilities and responsibilities, contributing to a unified team effort.
5	Waiting for Each Other	One player waits for another to catch up or acknowledges the importance of sticking together.
6	Collaborative Actions	Actions done for the benefit of others, such as retrieving the wagon for the team.
7	Co-ordinated Actions	Players synchronize their actions to complete a task together.
8	Advice	Verbal instructions or tips given to teammates, e.g., 'It's probably more effective if you try to throw the package to the delivery zone instead of running to it'.
9	Questions	Players ask each other for help or clarification, e.g., 'Guys, is the delivery zone on the right completed?'.
10	Clarification	Player provides extra explanation to another, e.g., 'Guys, the delivery zone on the right side is completed now'
11	Strategizing	Explicit discussion of strategies to overcome a challenge.
12	Joint Decision-Making	Players make group decisions, e.g., 'Let's all go left.' or 'We should finish the right part first, right?'.
13	Expressions of Trust or Reliance	Statements that show confidence or reliance on others, such as 'You got this!', 'I'll cover you.', or 'I'm counting on you!'.
14	Celebrations of Success Together	Joint celebrations such as cheering, high-fives, or shared laughter after achieving something together.
15	Apologies or Ownership of Mistakes	Players acknowledge their errors to maintain group harmony, e.g., 'Oops, that was my bad.' or 'Sorry, I didn't mean to push you off.'.
16	Monitoring/Checking on Each Other	Players check on each other's status, e.g., 'Do you need help?' or 'Are you done over there?'.
17	Recovery Together	Players collaboratively recover from mistakes, such as helping when someone drops an item or fails a task.

This set of metrics was inspired by the framework presented by El-Nasr et al. (2010), who in their work identified observable indicators of collaboration in cooperative games. The core set of collaboration metris described in their work (the first five collaboration instances in the above list) was adopted and extended with additional context-specific behaviors relevant to our game's design and mechanics.

Another reason for having a fixed set of collaboration metrics, other than constituting a reference point for identifying acts of cooperation, was that it allowed us to more easily compare the measured level of collaboration in between playtesting sessions if we had a uniform way of measuring it.

Questionnaires

To get additional insights into the collaboration experienced by the participants, we made use of three questionnaires that each give a score relevant to collaboration.

The GEQ-Social Presence Module gives a score representing the social presence experienced by players (IJsselsteijn et al., 2013). The term social presence was originally introduced by communication researchers Short et al. (1976) as being the perceived "realness" of other persons in interactions where the other part(s) are not necessarily physically present. However, the term has since become unambiguous because of several different definitions emerging (Kreijns et al., 2022). In the presentation of the development of the social presence module, it is stated explicitly that the social presence measured by the questionnaire is inclusive of co-located social experiences, making it highly relevant for our purposes. With this in mind, and in context of the playtesting session, social presence is interpreted as the degree to which players perceive their teammates "realness" when playing the game. This includes the perceived sense of connection, awareness of others' presence, and mutual responsiveness while playing together. A high social presence enables players to think as a team and work together in collaboration.

The Co-Presence questionnaire are made up of 4 question brought fourth as a suggestion for measuring the experienced co-presence of players. Co-presence is here defined as the feeling of being present in the virtual space with other players. This definition is closely related to that of social presence and therefore the short questionnaire we constructed out of the 4 questions should yield similar results to the GEQ-Social Presence Module (Casanueva and Blake, 2000). This score is used to support the score from the social presence module and give further hints about the perceived social experience playtesters had during the sessions.

Lastly, the Flow Short Scale doesn't directly consider collaboration (Rheinberg et al., 2023). However, it is still relevant because it is an indication of the players' immersion and engagement with the game, and one could argue that without a base threshold of gaming enjoyment/immersion, collaboration might not be easily attained. Moreover, flow can be tied to Collaborative Flow (Ohrankämmen et al., 2021). From our personal experiences playing collaborative games in the beginning phase of the project, we felt that collaboration was at its highest when everyone

Table 5.2: Questionnaires

(a)

GEQ-Social Presence Module	
#	Statement
1	I empathized with the other(s)
2	My actions depended on the other(s)' actions
3	The other(s)' actions were dependent on my actions
4	I felt connected to the other(s)
5	The other(s) paid close attention to me
6	I paid close attention to the other(s)
7	I felt jealous about the other(s)
8	I found it enjoyable to be with the other(s)
9	When I was happy, the other(s) was/were happy
10	When the other(s) was/were happy, I was happy
11	I influenced the mood of the other(s)
12	I was influenced by the other(s)' moods
13	I admired the other(s)
14	What the other(s) did affected what I did
15	What I did affected what the other(s) did
16	I felt revengeful
17	I felt schadenfreude (malicious delight)

(b)

Flow short Scale	
#	Statement
1	I feel just the right amount of challenge.
2	My thoughts / activities run fluidly and smoothly.
3	I don't notice time passing.
4	I have no difficulty concentrating.
5	My mind is completely clear.
6	I am totally absorbed in what I am doing.
7	The right thoughts / movements occur of their own accord.
8	I know what I have to do each step of the way.
9	I feel that I have everything under control.
10	I am completely lost in thought.

(c)

Co-presence	
#	Question
1	To what extent did you have a sense that you were in the same place as the others?
2	To what extend did you have a sense that the others was in the same place as you during the course of the experiment.
3	To what extent did you have a sense of the emergence of a group/community during the course of the experiment?
4	To what extent did you have a sense of being "part of the group" ?

involved were immersed together and entered some kind of shared experience where actions and reactions were automatic and everyone seemed to work as one unit. (how well it's going for someone else becomes as important as how it is going for oneself) Therefore, since we believe that a heightened state of flow leads to higher levels of collaborative activity, we decided to include flow as one of the aspects to measure and try to optimize in between playtesting sessions.

All the above questionnaires were answered directly after gameplay in order to capture the feelings of the experience as accurately as possible (IJsselsteijn et al., 2013). The total scores were calculated by taking the average of the scores from the associated questions / statements.

Interviews

Lastly, we presented a set of more specific questions about the game to the playtesters. These could be flexibly constructed in any way we wanted according to what we felt was relevant. A set of recurring questions that we asked the participants to get an idea of where in the game they experienced the most collaboration were:

- What part of the game did you feel you had to collaborate the most?
- What part of the game did you feel the most immersed in?
- What part of the game did you feel the most connected together?
- What did you feel was missing from the game to make it a more engaging experience?
- What did you feel was missing from the game to make it feel like you were playing together and "sharing an experience"?

The interviews were followed by a group discussion, which gave us an opportunity to have a conversation with the playtesters about their experience and about our game. Suggestions on improvements or modifications could be brought fourth during these interviews.

5.5 Analysis and Improvement

To analyse and make inferences from the data collected from the playtesting sessions to come up with relevant improvements, as well as to be able to compare different iterations of the game, it helps to use a compiled data metric. This section covers the methodology used when compiling the results.

5.5.1 Game design pattern groupings

To structure our game's collaborative design and support analysis throughout the development process, we worked with a select few game design patterns related to collaboration which we divided up into groups. Each group was constructed to represent semantically different, higher-level collaborative game aspects. This means that the presence or frequent use of collaboration through one group should not inhibit the potential for collaboration through another, because each one represents a different reason for collaborating. This independence allowed us to reason about the effect of each group individually. Working with larger, semantically distinct "chunks" made analysis more manageable since it was easier to reason about clear, distinct collaborative aspects, rather than through individual design patterns in isolation (where several patterns might support the same underlying cooperative function). The groupings are as follows:

Group 1: Foundation Layer

- **Mutual Goal** – All players work toward the same overall objective.
- **Time Pressure** – Players must act within a time limit, encouraging urgency and interdependence.
- **Synchronous Gameplay** – All players play in the same space simultaneously.

These patterns establish the fundamental conditions of the game. Mutual goal and synchronous gameplay make collaboration both possible and necessary for success. Time pressure serves as a fundamental motivator to perform and gives the game a fundamental difficulty.

Group 2: Shared Resources

- **Shared Resources** – Resources shared by multiple players.

This pattern encourage collaboration by requiring players to work together around shared game objects or mechanics.

Group 3: Role/Task Division

- **Role Fulfillment** – There are natural opportunities for players to take on different responsibilities, which results in each player serving their own role in the gameplay. Role fulfillment is experienced when being successful in a role.
- **Competence Areas** – Players can specialize in certain tasks based on preference or context, leading to more efficient coordination.

These patterns support collaboration through the possibility of players having different roles or taking on different tasks within the joint group effort.

Group 4: Collaborative/Synchronizing Actions

- **Collaborative Actions** – Actions that require multiple players to contribute simultaneously, with each player performing a distinct but interdependent input.

This group includes patterns that require players to coordinate their actions in real-time to achieve a common outcome. The emphasis lies in simultaneous participation and timing, encouraging players to act as a unit rather than individually.

5.5.2 Game Design Pattern Groupings Analysis

In order to analyse the effect of the different game design pattern groups on collaboration, we developed a methodology that measures the proportion of collaboration instances "caused" by each design pattern group.

The first step is calculating the frequency of collaborative instances by referring to the collaboration metrics from table 5.1. This is done by carefully watching the video and screen recordings of each playtesting session and noting each collaboration instance. For each instance, it is determined and noted which gameplay design pattern group was most likely the cause of that instance. The final count (number of instances within each gameplay design pattern group), are then used as basis in the calculation of the final scores. This allows us to reason about which game design pattern groups result in collaboration instances during the sessions. Observations are divided up into those from the video recording, where focus is on the physical and vocal interactions between players, and those from the screen recording, where focus is on in-game events and interactions. An example of this calculation step is shown in table 5.3.

Table 5.3: Calculation example 1

Group	Video Count	% of Video	Screen Count	% of Screen
Shared Resource	8	40%	20	66.7%
Foundation Layer	7	35%	7	23.3%
Role/Task Division	5	25%	3	10%
Total	20	100%	30	100%

A weight is applied to the final result to make in game interactions weigh more. The weigh applied is: $(Screen\% * 0.6, Video\% * 0.4)$. The screen recording represents a direct observation of actual in-game cooperative behaviour while the video recording captures intent, coordination, and communication that may not always result in actual in-game collaboration. Because we are more interested in the in-game aspects, the weight is shifted in favour of the screen recording.

Table 5.4: Calculation example 2 : total percentages

Group	Final % Calculation	Final%
Shared Resource	$(40 * 0.4) + (66.7 * 0.6) = 16 + 40.02$	56.02%
Foundation Layer	$(35 * 0.4) + (23.3 * 0.6) = 14 + 13.98$	27.98%
Role/Task Division	$(25 * 0.4) + (10 * 0.6) = 10 + 6$	16%

5.5.3 Deducing Areas of Improvement

To try to identify which areas of the game need improvement for additional collaboration, as well as what the improvements should be, we take into consideration both the aforementioned questionnaire ratings, the interview answers, and the frequency percentage of caused collaborative instance per design pattern group.

We begin by examining design pattern groups with the lowest number of collaboration instances for the given iteration, as these indicate which collaborative aspects may be underperforming. We then consider the questionnaire ratings to identify which specific dimensions of collaboration may be lacking. Finally, we analyze player interviews and group discussions to gain additional insight and context. By cross-referencing all these sources, we aim to form an understanding of where and how the game's collaborative potential can be improved. After having done all this, we create a list of improvements to be implemented for the next iteration.

It is worth noting that throughout the iterative testing and improvement phase of the game's development, we not only considered collaboration-specific adjustments, but also smaller improvements aimed at enhancing the general playability and user experience of the game. These changes were based on observations and feedback gathered during the group discussions following each playtesting session. For instance, as discussed in the section on frustration (see Section 4.3), certain

adjustments were made to reduce potential sources of player frustration. The rationale behind addressing such issues is that, for collaboration to emerge naturally and effectively, the game must first be sufficiently playable and enjoyable. However, these general improvements are not covered in the result section, as the primary focus there is on changes that directly affect collaboration.

5.5.4 Total collaboration rating

A total collaboration rating is finally compiled as a hint to the overall collaboration experience. First, results are normalized to a value between 0 and 1. Questionnaire averages are normalized by multiplying the score with $1/max$. The collaboration metrics are normalized by dividing the number of collaboration moments with an assumed max of 60 for the video and screen instances respectively. The normalized scores are multiplied according to the weights presented in table 5.5 and summed up. This sum will add up to a value between 0 and 1. Multiplying this with 100 and rounding to 1 decimal gives us the total collaboration rating.

Table 5.5: Weights used in calculation of the total collaboration rating.

Source	Weight	Reason
Screen Recording	40%	In-game collaboration is the clearest indicator of design effectiveness.
Video Recording	25%	Captures social/verbal coordination that reflects cooperative intent.
Questionnaire Average	35%	Reflects players' emotional and perceptual experience of cooperation.

6

Developing the game ”Parcel Pauls”

The game we choose to develop is a game about delivering post to different houses. The clock is ticking and to deliver as much packages as possible the players have to work together. The game has different collaborative elements, which is a wagon that all players has to push together, a gate that require multiple players to open at the same time and power ups. We call the game ”Parcel Pauls”. One big portion of this project is the development of our game. Throughout this period, there have been different stages to the development of the game.

In this chapter, the structure of the sections is as follow for the iterations that would be play tested:

- Firstly, some key features will be introduced and described. These features were an important part of the iteration but might not be the key element the playtesting sessions wanted to test.
- Secondly, the key element that we believed would contribute to collaboration is highlighted and describes what game design patterns that it might contribute to.
- Lastly, a figure of the game is presented.

6.1 Predevelopment phase

6.1.1 Brainstorming

The first stage of developing the game was the brainstorming part. The topics of 2D or 3D graphics, whether we should create our own assets or buy, and art style were discussed.
This stage had some different approaches. Firstly, we came up with ideas on our own. Some ideas were as follows:

- An escape room game: A 3D voxel based puzzle game where you play as a group of children on their escape from their angry parents.
- Post delivery game: A 3D management game where you and your friends try to deliver as many packages as possible in a given time frame.
- Boat crew game: A fast-paced game where you play as the crew on a boat that is trying to keep the boat from breaking or tipping over.
- Moosic game: A top down 2d game where 4 cows get the news by a family

of farmers that they will be made into hamburgers. To convince the family otherwise, they have to form a band and play music for the family.

All ideas were written down in separate document, explaining the idea and what different element the game should contain. Secondly, all ideas were discussed together and further developed. Pros and cons where discussed and taken into consideration in the next step.

Lastly, we voted for what idea the group wanted to continue working on. In this stage the game idea were rough and bare. Many details were not developed and in this stage there were a rough outline for the project.

6.1.2 Sketches

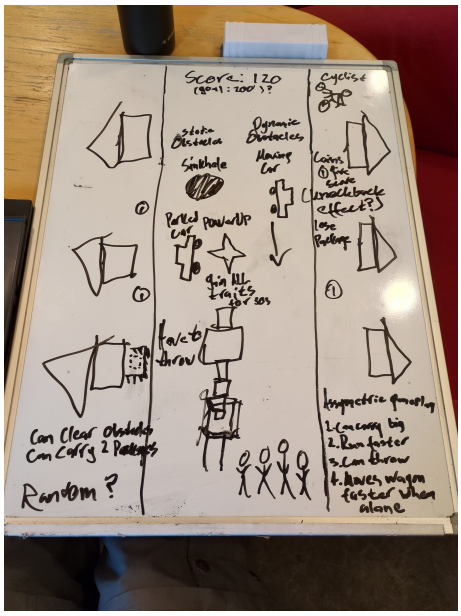

Figure 6.1: Sketch of level

In the next stage, we drew sketches to get a simple idea what everyone thought was a good outline for the game. Details were discussed further and a clearer image of what the game should be was formed.

6.1.3 Early prototype testing

In order to test the game idea and assess whether the core game mechanics encourage collaboration, we created and tested a paper prototype. The prototype resembled a post-delivery game and mechanics such as the shared steering mechanism were evaluated.

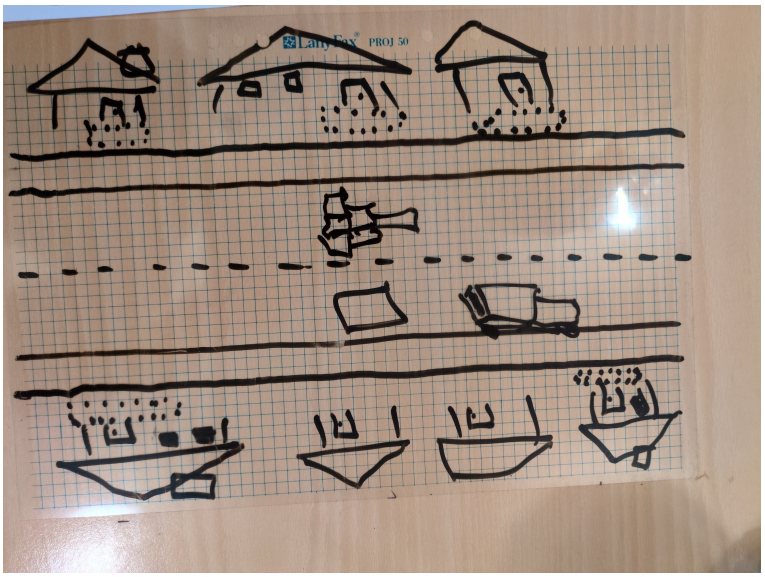

Figure 6.2: Paper Prototype Testing

Upon testing the initial prototype, players often ignored the aspect of collaboration and focused on individual responsibilities. The conclusion was drawn that tasks were too simple individually, giving the idea of implementing more collaborative features. An answer to the problem we came up with was to implement a collaborative movement mechanic. Upon further refinement, a wagon system was implemented, which allowed players to participate in a single coordinated activity. The wagon, equipped with four designated spots, allows all players to hold on, enabling them to combine their efforts and steer the wagon as one unit.

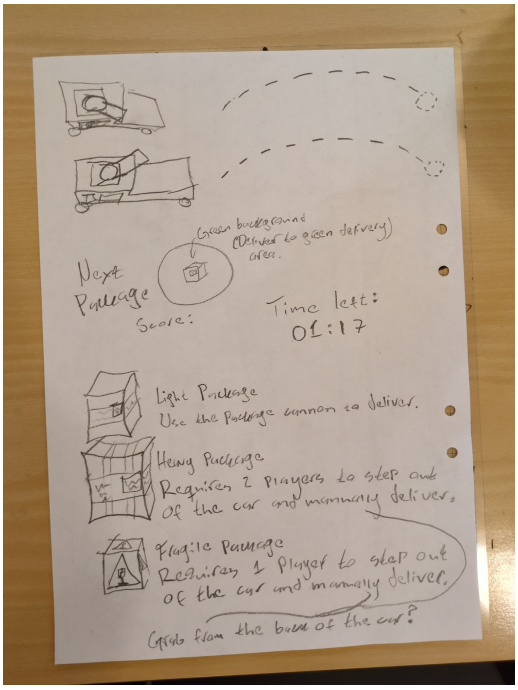

Figure 6.3: Objects Mechanics

6.2 Development phase

6.2.1 MoSCoW and Kanban

Before implementing features into the game, they must be established and organized. To do this, we used a prioritization technique called MoSCoW which stands for must have, should have, could have and won't have. Firstly, features were established and written down. When all the details and parts of our idea were covered, prioritization could start. Categories have different priorities, Mo(Must have) has the highest, S(Should have) has the second highest priority and so on. In the end, a structure of what features should be implemented first and what could wait, were produced. Below is the different features that we planned to add to the game in the beginning of this project.

Must-Haves

- Road with houses

The game must have a road with houses around it (what a level looks like) where players can move around and interact with objects

- Wagon

A wagon must be able to move and the movement must be controlled by players.

- Players must
  - Grip objects
  - Move
  - Jump
  - Carry packages
  - Drop packages
- Score

Delivering packages gives the team score.

Should-Haves

- Player

Should be able to throw packages to other players or the ground.

- Level

Should have static obstacles like roadblocks.

- Packages
  - Have different weights
  - Have different classifications(fragile for example)
- Timer

The level ends when the timer runs out.

Could-Haves

- Level
  - External collaberative elements(Gate that 2 players have to open, etc)

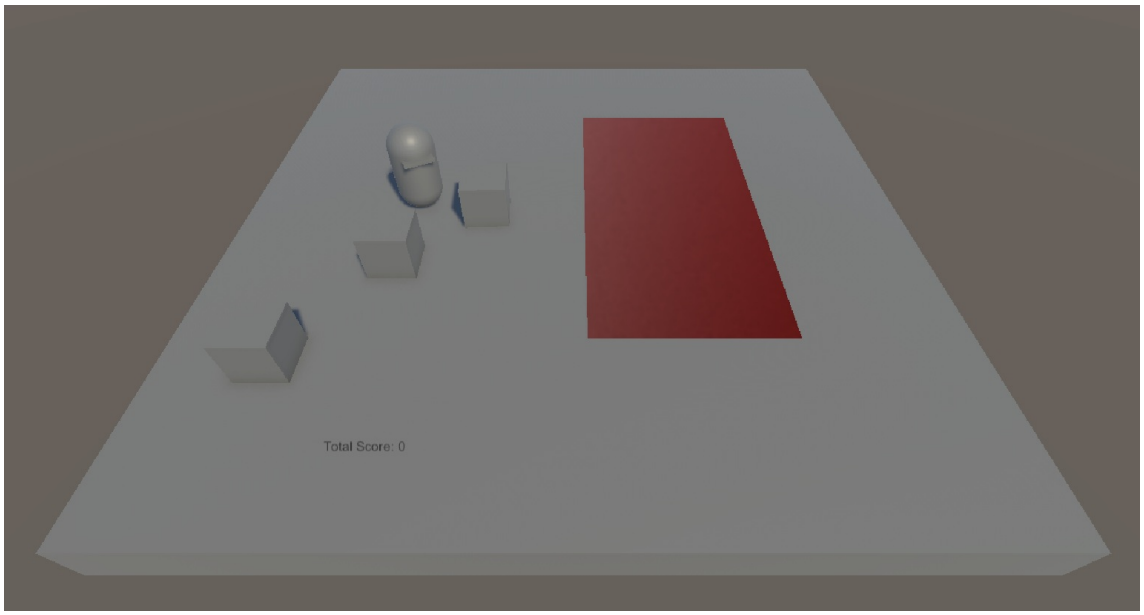

Figure 6.4: An early implementation of must have features

  - Moving obstacles (dogs that steal packages, cars, etc)
- Wagon

Drop packages when crashed into something.

- Sound & Music
  - Background music
  - Sound effects
  - UI sound effects
- Start menu
- Pause menu
- UI elements
- Score indicator
- Different levels

Won’t-Haves

We did not have any.

The features were then added to a kanban for easy overview and organisation.
In all iterations of the game, there was one or some key element that we wanted to test in the playtesting sessions.

6.2.2 Iteration 1

This is the first iteration that was made. Here the must have features from our MoSCoW prioritisation system were implemented to create a framework of the game. In this stage there were players, they could move and push boxes into delivery zones. Players could also pick up boxes and drop them. The game was very bare bones but playable. There was not really a goal to work towards for the players.

6.2.3 Iteration 2

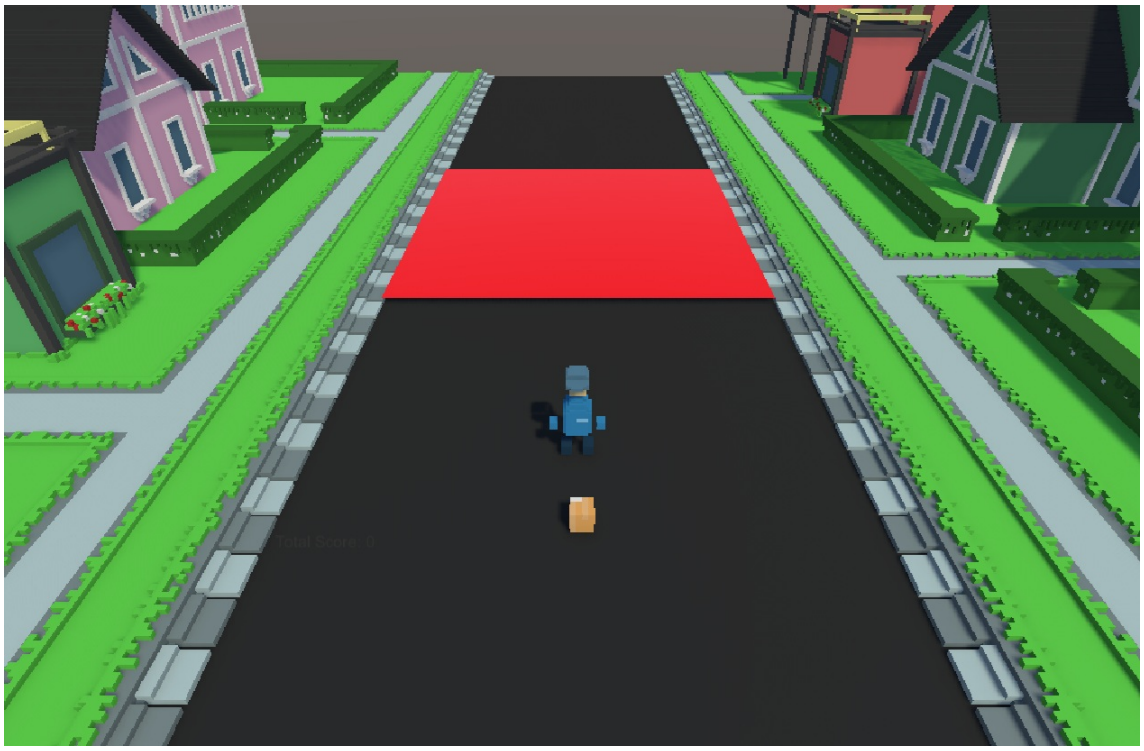

Figure 6.5: Iteration 2: A replayable game

In this next iteration the game starts to come together a bit more. Models for the environment, packets and players were created and added. A timer and score was also implemented, which made a big impact on the replayability of the game.
Even though this iteration of the game was not tested, there was still some elements we believed contributed to some game design patterns:

- **Time pressure:** The timer and score elements might contribute to the players feeling stressed to complete the tasks.
- **Mutual goal:** The score element might contribute to make the players feel like they have a mutual goal to work towards.

6.2.4 Iteration 3

In this stage the game was ready to be tested with actual players. Here all necessary implementations for a functional game were implemented. In the figure further down in this section, the progress made with iteration 3 can be seen. Some key features implemented in this stage were:

- The interaction system is in charge of showing player what things that could be interacted with, with the help of text.
- A system for generating an endless street which make the game even more replayable. The players cannot move on to the next area without completing the first area. To complete an area players must deliver packages to all houses

delivery area(red squares in figure: 6.6). Each delivery area has a certain number of packages that must be delivered before it is satisfied.
- A wagon that all players have to work together to steer. In order to steer the wagon all players must work together to go in the right direction. The wagon uses vector addition to combine all forces, meaning that if one player is steering left and another player is steering right, the vectors cancel each other out and the wagon wont move.

Key element to test: Wagon
The key feature we wanted to test in this iteration of the game was the wagon. We hypothesized that it will contribute to the design patterns:

Shared resource: The packages storage in the wagon are shared between all players.

Collaborative action: The movement of the wagon is controlled by multiple players, making it easier to steer.

Mutual goal: The wagon helps the players fulfil their goal by delivering as many packages as possible in the given time frame.

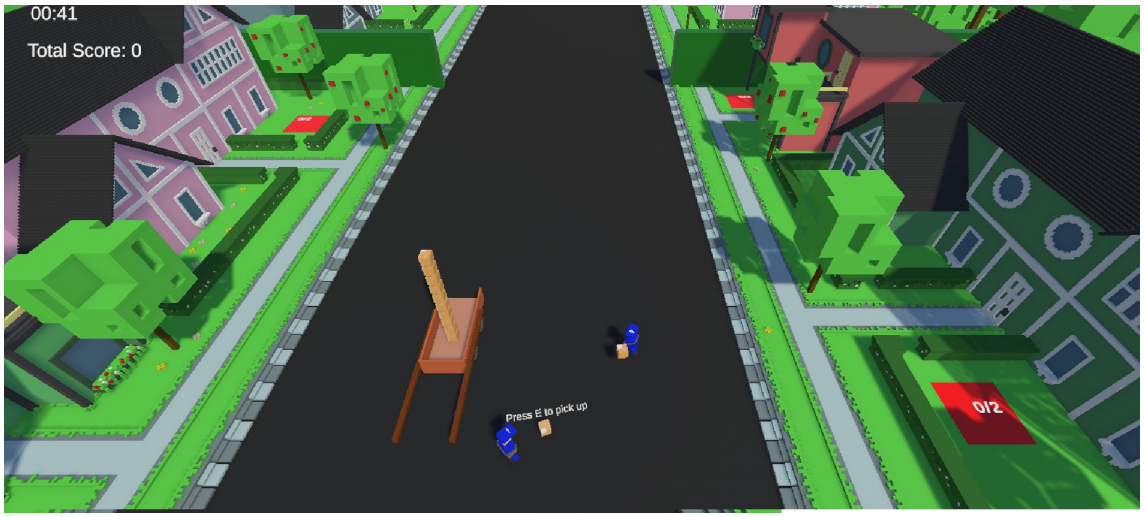

Figure 6.6: Iteration 3: A testable game

6.2.5 Iteration 4

In this iteration more features were added to make a better game experience. In the figure further down in this section,the progress made with iteration 4 can be seen. Some key features that were implemented in this iteration were:
- The players could throw packages, making it easier to deliver packages faster.
- At the end of each neighbourhood we implemented a gate that multiple players had to work together to open. This is an asymmetrical action that required players to do different things in order to complete the quest.

- In order to make the game more challenging we added obstacles in to the street. These obstacles were in the form of cars that forced the players to think about the placement of the wagon and how they move in the game level.

Key element to test: Gate
The key feature we wanted to test in this iteration of the game was the gate. We hypothesized that it will contribute to the design patterns:

Role fulfilment: Different player have to take on different roles in order to open the gate, some might push the buttons and some might steer the wagon through.

Competence area: Different players might take on different roles and become better, and ultimately faster at preforming some tasks, like pressing the button.

Collaborative action: To pass by the gate all players has to work together in order to open the gate and move the wagon forward.

Figure 6.7: Iteration 4

6.2.6 Iteration 5

This was the final iteration that was implemented. In the figure further down in this section,the progress made with iteration 5 can be seen. Some key features implemented in this stage were:

- Power ups, player could collect stamps that gave the players different advantages. There were two different power ups, one that affected the players speed for a set time interval and one that gave the players some extra time. This also gave the game a more asymmetrical gameplay.
- Big packages, element required more than one player to deliver the big package to a drop off zone. The reward for great collaboration is worth 5 points instead

of 1, compared to the regular packages.
- Music and sound effects. To make the game more alive and intractable, sound effects and music were implemented. This made a huge difference in order to make the game feel more complete.
- Tutorial scene, a tutorial scene was added to make players that have not played the game before learn about the controls. In this scene players could also change the name of their character to make the game experience a bit less confusing.
- Better camera movements. Feedback from the previous playtesting session revealed that if players was to far away from each other, the camera could not show all the players in the same image. Therefore we decided to implement a better camera that zoomed out more the further away players were from each other, and zoomed in if players were closer together.
- Better UI elements. To make the gameplay experience even better different fonts and placements of the UI elements was implemented. A text bubble describing different elements was also added to clarify the purpose of that element.

Key element to test: Power ups and Big packages
The key feature we wanted to test in this iteration of the game was the power ups and the big packages. We hypothesized that they will contribute to the design patterns:

Role fulfilment: Players can pick up power ups and get different advantages that can make them better in some roles.

Shared resource: Power ups and big packages are shared resources for all the players to use.

Collaborative action: In order to deliver the big packages the players has to work together to move it.

Figure 6.8: Iteration 5: The final game

Figure 6.9: Iteration 5: Tutorial scene

7
Results

In this chapter, we present the results of the research through design process discussed in section 5.3. Since the methodology used is iterative, and tied to the iterations presented in chapter 6, results are divided up between the iterations. Since iteration 0, 1 and 2 didn't have enough collaborative gameplay in them to test in a meaningful way, those iterations were not researched on and hence not included in this chapter. The following sections present the results of the research done on each iteration during playtesting sessions.

During each playtesting session, the participants played 7 rounds with a timer counting down from 1 minute for each round. During each round, they tried to deliver as many packages as possible before the time ran out. In the last iteration, because we had implemented time bonuses, the total time a given round could last could differ. Therefore, to keep the measurement time consistent with the first two iterations, we only based our analysis on the first 7 minutes played for the last iteration.

7.1 Iteration 3

Iteration 3 was tested through 2 playtesting sessions with 4 persons each. During each playtesting session, participants played 7 one-minute rounds.

Playtesting 1

Data:

Table 7.1: Percentages by Design Pattern Group

Group	Frequency
Shared Resources	30%
Role/Task Division	36%
Collaborative/Synchronizing Actions	18%
Foundation Layer	16%

Table 7.2: Questionnaire Results (Normalized 0–1 Scale)

Metric	Normalized Score
Social Presence	0.58
Flow (Short Scale)	0.76
Co-Presence	0.76

Table 7.3: Interview Summary

Category	Repeated Responses
Area of most collaboration	Dragging the wagon
Most immersed moments	Delivering the packages
Most connected moments	When strategising and planning

Collaboration Rating:

Final Score: **49 / 100**

Most collaborative instances in this playtesting session were associated with the Role/Task division design pattern group. Players, for example, frequently divided themselves into roles where two players took care of delivering packages to the left side of the road, and two took care of the right side, before then dragging the wagon up the street.

The Shared Resources group also encouraged a significant amount collaboration, which is further highlighted by the interview responses (see specific interview questions in section 5.4.3), where three out of four playtesters answered that they saw the wagon-dragging (which is part of the Shared Resources collaboration element) as the area of the game where they felt that they had to collaborate the most.

The Foundation Layer group, where collaboration happens by means of the foundational terms of the game, such as strategizing how to deliver as many packages as possible knowing the game's settings and terms, did not "directly cause" as many collaborative instances as the other groups.

As for the Questionnaire answers, Flow and Co-Presence got the highest rating scores, with a (normalized) rating of 0.76. This suggests that the participants experienced a solid level of immersion of the game, as well as were well aware of each other during gameplay (see explanations of the questionnaire modules in section 5.4.3).

The Social Presence average rating of 0.58 was significantly less, suggesting a lack of connection felt between the participants.

Playtesting 2

Data:

Table 7.4: Percentages by Design Pattern Group

Group	Frequency
Shared Resources	42%
Role/Task Division	16%
Collaborative/Synchronizing Actions	25%
Foundation Layer	17%

Table 7.5: Questionnaire Results (Normalized 0–1 Scale)

Metric	Normalized Score
Social Presence	0.63
Flow (Short Scale)	0.68
Co-Presence	0.91

Table 7.6: Interview Summary

Category	Repeated Responses
Area of most collaboration	Dragging the wagon
Most immersed moments	When dragging the wagon
Most connected moments	When dragging the wagon

Collaboration Rating:

Final Score: **58 / 100**

In this playtesting session, the design pattern group which encouraged the most collaboration was the Shared Resources group. Again, this can be reflected in the interview responses of the participants, where three out of four participants felt that the wagon-dragging was the area of the game where they had to collaborate the most, and where they felt the most connected.

The Role/Task Division and Foundational Layer groups gave rise to significantly less collaboration, with both "causing" around 20% of all observed collaboration instances each.

The high average rating of 0.91 from the co-presence module from the questionnaire answers suggests that the participants of this playtesting session were very aware of each other during gameplay. Meanwhile, the average rating of the Flow module was not as high during this playtesting session as the first one, but still on a level (0.68) that suggests a decent level engagement/immersion.

Once again, the Social Presence average rating was the lowest of them all, and again with a value of around 0.6.

Results and Insights from Combined Playtesting Sessions

Collaboration Rating:

Final Score: **54 / 100**

The total collaboration rating for the whole of iteration 1, that is taking into consideration both playtesting 1 and 2, was 54/ 100.

In both playtesting sessions, collaboration happened mainly through the design pattern groups Shared Resources and Role/Task Division. To strengthen collaboration by means of the other design pattern groups, we decided that a new means of collaborating should be introduced to the game.

From both playtesting sessions, the area of the game that the participants felt that they had to collaborate the most was when dragging the wagon together, which offers the collaborative act of syncing up with each other. Therefore, a relevant new collaborative aspect would be one that lets participants synchronize with each other. The solution we decided upon was that we should introduce a barrier on the road that comes up from time to time, that requires two players to sync up in order to open so that the rest can pass through. This would also introduce the new task/role of having to open up the barrier. This modification strengthened the "Collaborative/Synchronizing Actions" pattern group.

Another common observation from both playtesting sessions was that the average rating of the Social Presence module was significantly lower than the average rating of the other questionnaire modules. As mentioned in section 5.4.3, the Social Presence Module partly measures how well the player are connecting together while playing the game. We therefore came to the conclusion that something needs to be added to the game's design that should increase the level of connection experienced by the players. From the interview responses from playtesting 1, players felt the most connected when they made strategies and planned ahead what they were going to do. Therefore, increasing the opportunity for players to strategize should be something to add to the game.

One way to increase opportunities for strategy is to increase the number of possible routes that the players can take, as well as the number of things that they can do, because then the total number of imaginable scenarios, or strategies, increases. The solutions to this that we thought would be reasonable are to change the number of packages per house and to give the players the ability to throw packages. Giving the players the ability to throw packages contributes by increasing the number of things that they can do—for example, they can attempt to throw a package to a house delivery zone, instead of running to it (although with the risk of missing the zone)—as well as introduces the potential "task" of throwing out packages for the other team members to pick up. In any case, it contributes in increasing the number of courses of action the players can take, and thereby the number of potential strategies.

Changing the number of packages per house contributes in increasing the number of possible routes that they can take. In the first playtesting session, we noticed that the participants very early on came up with the seemingly "ideal" strategy of dividing themselves up so that two players deliver packages to the house on the left side, and the two remaining players take the house on the right side, before all joining together again to move the wagon up the street (which moves faster the more players that drag it). While this is a clear indicator of collaboration among the players, repeating the same strategy over and over again (across new game instances as well), might become repetitive and boring after a while. Therefore, our reasoning was that changing the number of packages per house so that it is a random number between 1 and 3 (which also change randomly in between game instances) would open up the number of possible ideal courses of action, and therefore the number of possible strategies. This solution is also in line with Zagal's pitfall mentioned in our problem section (see problem section), which states that for a collaborative game to be enjoyable multiple times, the experience needs to be different each time and the presented challenge needs to evolve. Moreover, changing the number of packages per house to a randomized number introduces the potential "task" of monitoring and sharing the information on how many number of packages a given house requires, since players do not automatically know that 2 packages are required every time; opening the door for an additional strategy.

The Foundation Layer design pattern group contributed to the least number of collaboration instances in both playtesting sessions. Since players making up plans and strategies counts as a collaboration instance by means of the Foundation Layer group, we believed that increasing the opportunities for strategy would also help in increasing the number of collaboration instances "caused by" the Foundation Layer group.

As for the flow and co-presence questionnaire modules, since they had decently high average ratings in both playtesting sessions (see tables 7.2 and 7.5), we decided to focus our attention for improvements on the aforementioned areas. The final list of changes to make to our game's design for the next iteration that we decided on is:

Improvements for Next Iteration

- **Give the players the ability to throw packages** – for increasing strategic potential.
- **Change the number of packages per house to a randomized number** – for increasing strategic potential. Introduces the design pattern "Dynamic Goal Characteristics" which refers to goals that evolve during gameplay (see Björk and Holopainen (2024)). In this case, the subgoal of delivering a certain number of packages to a given house varies in quantity from one house to another.
- **Implement barriers that require two players to open** – for adding a collaborative element that encourages player synchronization. Strengthens the design pattern group "Collaborative/Synchronizing Actions".

And the new set of design patterns for the next iteration:

Foundation Layer
- Mutual Goal
- Time Pressure
- Synchronous Gameplay
- Dynamic Goal Characteristics

Shared Resources
- Shared Resource

Role/Task Division
- Role Fulfillment
- Competence Areas

Collaborative/Synchronizing Actions
- Collaborative Actions

7.2 Iteration 4

Iteration 4 was tested through 2 playtesting sessions—playtesting 3 and 4—with 4 persons each. During the playtesting sessions, the players played 7 one-minute rounds.

Playtesting 3

Data:

Table 7.7: Percentages by Design Pattern Group

Group	Frequency
Shared Resources	27%
Role/Task Division	28%
Collaborative/Synchronizing Actions	25%
Foundation Layer	20%

Table 7.8: Questionnaire Results (Normalized 0–1 Scale)

Metric	Normalized Score
Social Presence	0.6
Flow (Short Scale)	0.68
Co-Presence	0.75

Table 7.9: Interview Summary

Category	Repeated Responses
Area of most collaboration	Dragging the wagon and opening the gates
Most immersed moments	Throwing packages (to the delivery zones)
Most connected moments	Dragging the wagon and opening the gates
Missing aspect for engagement	Some type of time bonus
Missing aspect for group feeling	More task opportunities and collaborative moments that require several players working together simultaneously

Collaboration Rating:

Final Score: **72 / 100**

Playtesting 4

Data:

Table 7.10: Percentages by Design Pattern Group

Group	Frequency
Shared Resources	24%
Role/Task Division	27%
Collaborative/Synchronizing Actions	21%
Foundation Layer	28%

Table 7.11: Questionnaire Results (Normalized 0–1 Scale)

Metric	Normalized Score
Social Presence	0.56
Flow (Short Scale)	0.65
Co-Presence	0.73

Table 7.12: Interview Summary

Category	Repeated Responses
Area of most collaboration	Dragging the wagon and strategizing
Most connected moments	Dragging the wagon and opening the gates
Missing aspect for engagement	Some type of time bonus and more task variety

Collaboration Rating:

Final Score: **70 / 100**

Results and Insights from Combined Playtesting Sessions

Collaboration Rating:

Final Score: **71 / 100**

The total collaboration rating for the whole of iteration 2, that is taking into consideration both playtesting 3 and 4 was 71/ 100, indicating a clear increase in overall

collaboration.

For this iteration, all design pattern groups were responsible for a roughly equal amount of collaboration instances, as can be seen in tables 7.8 and 7.11. Since there was no clear "weak" design pattern group, the changes made for the following iteration were solely based on the questionnaire average ratings.

In this iteration too, the Flow and Social Presence average ratings were significantly lower than the Co-Presence rating; especially the Social Presence rating.

As mentioned before, Social Presence is related to the connection felt between players. In this iteration, the interview answers suggested that players felt most connected while performing some kind of action where they had to coordinate and synchronize—in this case, while dragging the wagon together or opening the gates. Therefore, we decided that an appropriate new element to the game would be heavy "special delivery" packages that are faster to carry if several players carry them at the same time, but very slow to carry alone. These heavy packages lie around randomly on the street (as opposed to the regular packages which have to be retrieved from the wagon), and give the players 5 extra points if delivered to a delivery zone. In this way, there is a new means in the game through which the players can coordinate and synchronize. Moreover, these new heavy packages offer a new task or strategy—namely to choose to deliver them at the cost of the extra time that it takes. Players can still choose to not waste time delivering them, if they believe that the extra time delivering the regular packages will ultimately lead to more points.

To attempt to improve the flow aspect of the game, we based our implementation decision on several participants' expression—through interview answers and group discussion—that some kind of time bonus would make the game more engaging. They expressed that there was not enough time for them to properly explore strategies, or even feel calm while delivering packages, and that adding some way to increase the total time remaining would help improve overall engagement. Therefore, we decided to implement time bonuses for the next iteration in the form of power-up cards that randomly appear on the street for a few seconds, and that the players can pick up by running into them before they disappear. If picked up, a time bonus power-up card adds an additional 10 seconds to the remaining time. To increase strategy options, we also decided that some of these power-up cards should, instead of giving bonus time, give the player that picked it up increased speed for a limited amount of time. This introduces new possibilities for coordination, as the temporarily faster player can take on tasks that involve longer distances for example. Similarly to the big packages implementation, the power-up cards introduce a new implicit role or strategy into the game: assigning a player to power-up collection.

The final list of changes to make to our game's design for the next iteration that we decided on is:

Improvements for Next Iteration

- **Implement big "special delivery" packages that move faster when carried by multiple players** – for adding a new synchronizing/coordination element to the game. Strengthens "Collaborative/Synchronizing Actions" as well as "Role/Task Division" design pattern groups.
- **Implement time bonus and speed increase power-up cards** – for improving the flow/engagement aspect of the game. Introduces the "Power-Ups" design pattern, which is defined as "game elements that provide instant benefits or advantages when collected" (see Björk and Holopainen, 2024). Also strengthens "Role/Task Division" design pattern group.

The set of design patterns for the next iteration looks the same as

Foundation Layer
- Mutual Goal
- Time Pressure
- Synchronous Gameplay
- Dynamic Goal Characteristics
- Power-Ups

Shared Resources
- Shared Resource

Role/Task Division
- Role Fulfilment
- Competence Areas

Collaborative/Synchronizing Actions
- Collaborative Actions

7.3 Iteration 5

Iteration 5, our final game version, was tested through 1 playtesting session with 4 persons. Because of limited remaining time in the project, and difficulties in finding additional participants, we decided not to spend time trying to schedule a second session and instead based the final iteration on this single playtesting session. During the playtesting session, 7 rounds of gameplay was played, and some rounds lasting more than 1 minute; the first 7 minutes of recorded gameplay was used for analysis.

Playtesting 5

Data:

Table 7.13: Percentages by Design Pattern Group

Group	Frequency
Shared Resources	12%
Role/Task Division	44%
Collaborative/Synchronizing Actions	21%
Foundation Layer	23%

Table 7.14: Questionnaire Results (Normalized 0–1 Scale)

Metric	Normalized Score
Social Presence	0.59
Flow (Short Scale)	0.65
Co-Presence	0.8

Table 7.15: Interview Summary

Category	Repeated Responses
Area of most collaboration	When having to coordinate how to deliver packages under the time pressure
Most immersed moments	When planning and having to make fast decisions together
Most connected moments	When strategizing and planning

Collaboration Rating:

Final Score: **72 / 100**

For this iteration, where we tested the final version of our game, the design pattern group through which the most collaborative instances occurred was the Role/Task Division group (see table 7.13). Unfortunately, because of a lack of awareness among the participants that the wagon could move faster the more players that drag it—they only realized this after the playtesting session—part of the possible collaboration through the "Shared Resources" and "Collaborative/Synchronized Actions"

was completely unutilized (several players dragging the wagon together counts as a collaboration instance "caused" by means of both of these two groups). This can be reflected in the frequency percentage of the "Shared Resources" group, which is much less than it has been in previous playtesting sessions.

The questionnaire averages did not change significanlty from previous playtesting sessions.

8

Discussion

This study was conducted to explore game design patterns that encourage collaboration. Through iterative development of the video game Parcel Pauls, and structured playtesting, we have attempted to evaluate and design a game by finding out how different game design patterns impact collaboration. In this discussion, we will evaluate the validity of our study and discuss possible improvements and flaws. We will point out strengths, weaknesses, and offer suggestions for future work.

8.1 Interpreting results

When interpreting the result obtained from the testing phase of the three different iterations, one immediate observation was that the only changes that we made from iteration to iteration were to add collaborative elements to the game. That is to say that from iteration to iteration, the game contained increasingly many collaborative elements. Therefore, the fact that the overall collaboration rating increased for every iteration could easily be attributed to the fact that there were simply more collaborative elements for the players to take part in. The reason for this was that the game was put through testing already very early in its development, and the best improvements were often exclusively to add elements to it. To therefore gain insight into what was especially effective in contributing to collaboration, we can look at the changes made to the game between iterations that caused the biggest improvement in collaboration.

The jump of the collaboration rating from iteration 3 to 4, from 54/100 to 71/100 was significantly larger than the jump from iteration 4 to iteration 5, from 71/100 to 72/100. This tells us that, based on our testing, the changes implemented into our game from iteration 3 to 4, were especially effective in raising the level of collaboration. The changes that were made were to give the players more opportunities for strategy, as well as introducing a collaborative aspect that promotes player synchronization. And this was done by giving them the ability to throw packages and to change the number of packages required per house, as well as by implementing road barriers.(see Result Section 7).

Judging the following playtesting sessions, however, is seems like it was specifically the increase in strategic opportunities change, achieved through different design patterns that promote strategy formation and task assignment, that was mainly responsible for the collaboration increase. For example, the “role” or “task” of mon-

itoring and communicating the number of packages required for some specific house to the other players became a recurring collaboration instance. So did coordinating when and who should open the road barrier. Therefore, an important aspect seems to let there be enough freedom through possible choices, or courses of action, in the game to give the group opportunities to make up their own strategies and take their own initiatives. For example, significantly less collaboration instances, and as a result a significantly smaller collaboration rating, occurred in playtesting 1 of the first iteration, when 2 packages were required for each house and playtesters repeated the same strategy of dividing themselves up so that 2 players take the left side of the road, and 2 the right side. The regularity in the number of packages per house left little room for the players to come up with different strategies. We mostly achieved this variety in possible choices through implementing collaborative elements that supported many different possible tasks to take on: dragging the wagon (Shared Resource and Collaborative Actions patterns), opening the barriers (Collaborative Actions pattern), monitoring and communication a house's required number of packages (Dynamic Goal Characteristics pattern), for example, all provided specific tasks that the players could take on in any order. This can be especially noted in the last iteration—which had the highest collaborative rating out of all iterations—where the "Role/Task Division" design pattern group gave rise to the highest frequency of collaborative instance.

For the players to even want to work together and strategize as a group in the first place, though, first requires a level of dependency on each other. This aligns with Zagal's suggestion that a successful collaborative game needs enough rationale for collaboration to begin with, as mentioned in the "Problems" section (see section 4.2). The way in which we tried to achieve this dependency was through game design patterns that make up the terms and main goal of the game: specifically, through the Mutual Goals and Time Pressure design patterns (part of the Foundation Layer design pattern group). What specific design patterns are used to achieve this purpose will depend on the context of the game. It is not so much about what specific design patterns are chosen, but rather that the chosen set is able to achieve the collaboration-inducing purpose sought out. In the context of our game, in any case, these were the design patterns used to establish dependency. The basis of the game is that players try to get as high a score as possible (the mutual goal) by delivering as many packages as possible before the time runs out (the time pressure aspect).

It was clear from playtesting sessions that, under the limited time, players *had* to all work together to get a respectable score. Communication and synchronization were key. If 2 players initially aimed for the same delivery zone, for example, and one turned around after a while, when realizing the other was going for the same delivery zone, precious seconds were lost that could have contributed to a higher score. There was a clear distinction between the overall effect of individual behaviour and collaborative behaviour on the mutual goal, where collaborative behaviour led to higher scores. Moreover, the high score and the number of collaborative instances, especially the in-game collaborative instances from the screen recordings, of the playtesters consistently increased the more rounds that had been played across all

playtesting sessions, indicating that once they had become more familiar with collaborating with each other, they managed to get higher and higher scores. Another example of this is that, when testing out the first iteration version of the game (prototype 3), the developers played the game as three people and achieved a high score of 7, which was easily surpassed by the playtesters when playing the game as four.

An additional collaboration element that contributed to the dependency between players was actions that required several players to perform successfully, through the Collaborative Actions pattern. The wagon, which moved faster the more players that collaborated in dragging it, and the barriers, which required two players to open, were both elements that enabled this. The Task/Role Division design patterns, like the Role Fulfilment pattern, also encouraged dependency by offering the players opportunities to be useful to each other to achieve the common goal through tasks. Players dragging the package-filled wagon closer to the others, or monitoring and communicating the number of packages required for a given house to the others, were a few examples of this. Finally, the Shared Resource design pattern, through the package-filled wagon, also seemed to play a part in contributing to dependency between the players. Since all packages had to be retrieved from the same place, players had to regularly gather around this wagon and collaborate in moving it upwards the street to continue being able to deliver packages. As a result, many collaborative instances came through this shared wagon. This can be seen in the frequency percentage tables in the result section, where even though the Shared Resources design pattern group was only made up of the wagon element, it consistently caused a comparable number of collaborative instances as the other design groups, sometimes even causing the most collaborative instances.

Another successful collaboration aspect suggested by our results is the widespread participation among players. During our playtesting sessions, all participants appeared to be equally needed. Each player consistently took on different tasks and contributed to the verbal coordination with teammates. While some players spoke more than others, there were no cases where a few individuals dominated decision-making while others passively followed instructions. The absence of outliers in questionnaire responses across all modules further supports this observation, suggesting a relatively uniform collaborative experience and comparable level of involvement among participants. This is in accordance with Zagal's first pitfall of a successful collaborative game needing to avoid a game where one player makes all the decisions (Zagal et al., 2006).

Part of the reason our game was successful in widespread participation is because of the collaborative elements and design patterns that contribute to there being a dependency between players, creating enough rationale for collaboration. The more important reason, though, is that we created the game in such a way that authority and responsibility are divided amongst the players. No player can do everything, but everyone can do a little bit of everything. Specifically, it is the many available task opportunities, and variety in these, that contribute to this by creating an asymmetry in task fulfilment. The design patterns relevant to this were the ones making

up the Role/Task Division aspect, especially the Role Fulfilment design pattern. Since every player has the same abilities as the others, providing enough different task opportunities makes it hard for one player to do everything and "dominate" the group; along with the fact that coordination of several players doing different tasks is needed for success, as mentioned earlier. Moreover, since there are so many task opportunities and available choices, along with the time constraint (Time Pressure design pattern), it is also hard for one player to dominate verbally through dictating what everyone should, because there is no one clear ideal course of action, and certainly not enough time to find one.

The final collaborative element that the results suggest was efficient in contributing to collaboration, was enabling players to directly coordinate and synchronize, which was achieved through the Collaborative Actions design pattern (part of the Collaborative/Synchronized design pattern group). This was especially noted through the interviews, where, across many playtesting sessions of different iterations, a large part of the playtesters expressed that the area where they felt that they had to collaborate the most, as well as the area where they felt that they connected the most with the others, was when performing such coordinating/synchronizing actions, such as dragging the wagon or opening the gates together. Apart from enabling direct collaboration, a theory we have is that, since this type of action forces the players to work together by having to synchronize, they also facilitate collaboration elsewhere in the game, since they get players accustomed to working together. In the playtesting sessions of iteration 4 and 5, after the barriers had been implemented (which enabled more of this synchronizing action) and players recurrently had to open the barriers together, overall coordination between the players seemed more effortless. This was especially noted verbally, where players were updating each other more often on which one takes which house, for example, than during the playtesting of the first iteration. There is no way of determining if the increase in coordination was truly linked to the implementation of the barriers, however, and including questions about the effect of the barriers in the participant interviews could have helped clear this out.

To conclude, what specific design aspects and patterns needed to successfully encourage collaboration will depend on the context of the game. Based on the research of our game, however, where the goal was for players to deliver packages simultaneously, the aspects that seemed the most effective in inducing collaboration were: to enable enough freedom for the group to take their own initiatives; create dependency so that there is incentive to work as a group to begin with; enable widespread participation among players; and include actions where players are forced to directly synchronize.

To achieve the first aspect; to enable enough freedom for the group to take their own initiatives, allowing for a variety of possible courses of action was key. In our context, the Dynamic Goal Characteristics design pattern (through the different number of packages per house) was important in achieving this, but also the patterns involved in Role/Task Division aspect (such as the Role Fulfilment design pattern) as they

presented players with different tasks that could be dealt with in any order.

To achieve the second aspect; to create dependency so that there is enough incentive to work as a group to begin with, the patterns that made up the basic terms of the game were key. In our case, the Mutual Goals and Time Pressure design patterns helped create a foundation where dependency was needed. The design patterns connected to Role/Task Division were also important in this aspect by offering the players tasks through which they could be useful to each other. The Collaborative Actions design pattern, through the wagon and barriers elements, contributed to dependency by presenting challenges where players needed each other to advance. The Shared Resources pattern, finally, also played a part in creating dependency, by basing the team around the wagon.

The third aspect; to enable widespread participation among players, was mainly achieved through the design patterns which make up the Role/Task Division aspect. Namely, by presenting the players with enough tasks, and variety in tasks, so that nobody can do everything, but everyone can do a little bit of everything.

Finally, the fourth aspect; coordinating/synchronizing actions, was directly enabled by the Collaborative Actions design pattern. Specifically through the wagon, the barriers, and the big "special delivery" packages.

8.2 Common pitfalls and frustration

The common pitfalls in collaborative games and the avoiding of frustration in collaboration were brought forth in chapter 4 as problems to be solved in our game's design. We tried to avoid the common pitfalls and frustration in collaboration during the design and development of the game. Playtesters gave us feedback to indicate how well we accomplished that.

The pitfall about avoiding one player making all the decisions was avoided through designing a very simple main gameplay loop that everyone could adopt. During playtesting, it was common for some playtesters to take leader roles, but this never seemed to result in that player singlehandedly making all decisions. This was true even when some playtesters had more experience than others, since they had playtested before, which indicates that we successfully avoided this pitfall. One of the other pitfalls was that all players should care about the outcome for the game to be engaging. This was avoided through making sure the goal was mutual and that the means of achieving the goal was also mutual. Furthermore, during playtesting sessions, players were motivated to beat the previous high score, which worked well enough to get players motivated to engage in the game, hone their skills and strategize with their teammates. The last pitfall was that the game should be different each playthrough with evolving challenges. This pitfall was not completely avoided. Random game elements such as the random number of packages that each package delivery zone required, or the randomly spawning power ups provided some difference in each playthrough. Where our game failed to avoid this pitfall is in the

fact that the challenge did not increase with time. We had planned to implement more stages as a could have which would've given us the opportunity to fix this pitfall, but we didn't have time to implement them.

Frustrating aspects of the game were evaluated during playtesting sessions by verbally asking playtesters if they noticed any feelings of frustration towards something in the game. This question was answered differently between iterations. One recurring answer was that it was frustrating having to walk around the handles of the wagon each time you stopped steering it and wanted to deliver packages, this frustrating moment wasn't solved since it was too minor to be a priority. Another recurring frustrating moment was that we had one controller that randomly would disconnect. We didn't manage to replace the faulty controller so this frustration was also present throughout all playtesting sessions. One frustrating moment we did solve was that the wagon was hard to interact with in iteration 3. This was solved by increasing its hit boxes for iteration 4 and 5. Another frustrating moment we solved was that players would disappear off screen after moving far apart, this was a problem present in iterations 3 and 4 before we updated the camera functionality. Even though the game had minor frustrating moments present throughout all iterations, playtesters seemed to perceive the game as fun. This is an indication that we managed to keep the level of frustration low enough for the collaborative experience to be enjoyable. One could speculate that the lower collaboration score of iteration 3 compared to iterations 4 and 5 may have been partly caused by the fact that the game contained more frustrating moments in that iteration.

8.3 Limitations

The results of our research is highly dependant on how the game design patterns were implemented. Since we only provide example implementations of game design patterns we cannot conclude whether or not implementing these game design patterns in other ways would yield similar results. This has highlighted the intricacy of design and implementation of digital video games.

The small number of participants and playtesting sessions conducted on each iteration limits the accuracy of the results. One observation made when looking back on the playtests is that the personalities of the people involved and overall mood in the room seemed to play a large part in how the players interacted with the game, which in turn may have affected results. Groups where one person was quick to take a leader role seemed to foster more communication, whilst groups where there were no apparent leader role, seemed to foster less communication. Since we didn't have a manuscript for the introduction of the playtesting sessions, there were some differences in how the game was introduced and things like differences in enthusiasm while introducing the game may have had an effect on the behaviour of the playtesters.

Another clear limitation was that we had to reuse some playtesters across sessions. This meant that the mix between new and returning players was not consistent.

Returning players may have encouraged sticking to previously established strategies, which could have limited more authentic, spontaneous strategy discussions that might otherwise have emerged in a group of entirely new participants.

8.4 Future analysis and development

This study was restricted in size, time and available resources. A larger-scale study with a dedicated playtesting team, more test results and a selection of playtesters more representative of the target audience would produce more accurate results. A more refined and tested method of compiling the playtesting results would also aid in producing more accurate results.

One question that was raised when examining results was whether or not more implementations of collaborative game design patterns always lead to improved collaboration. Our results were not enough to conclude more about this than that more collaborative game design patterns seems to lead to improved collaboration in the beginning phase of a game's development. We couldn't conclude anything about what happens in the later stages of a game's development when several game design patterns are already implemented. Another question raised was whether or not the compiled collaboration rating is truly representative of how well a game fosters collaboration.

9
Conclusion

The primary objective of this study was to develop a game and implement a set of game design patterns (Björk and Holopainen, 2005) in order to examine the factors that motivate player collaboration. Through the development of our game, we applied iterative methodologies like research-through-design, combining theory, prototyping, and user testing to investigate the dynamics of collaborative gameplay.

The project resulted in a video game, Parcel Pauls, where up to four players collaborate in a parcel environment, delivering packages while simultaneously strategising together to work as efficiently as possible. The game was developed using Unity's game engine and was designed using the MagicaVoxel tool to support a user-friendly visual approach.

The game includes multiple forms of "forced collaboration" (Sedgwick and Lemaire, 2024), such as the wagon that requires multiple players to steer in order for it to move effectively, and the gates that force two players to simultaneously focus on opening them for the whole group to progress. The game also leaves plenty of room for more dynamic forms of collaboration, stemming from the strategising of the group playing and different role-dividing behaviours based on skill, preference, or efficiency. The game's goals and mechanics were aimed to create a collaborative dynamic among participating players, promoting communicative behaviours and a prosocial environment.

The study showed that, in the context of our game, the most effective design strategies for fostering collaboration were those that enabled player dependency, offered diverse task opportunities, and introduced mechanics requiring synchronization. Through our iterative design and playtesting process, we observed that collaboration increased when players were given the freedom to take initiative, while still relying on one another to succeed. Design patterns such as Mutual Goals and Time Pressure established the foundational dependency, while Role Fulfilment, Dynamic Goal Characteristics, Shared Resources, and Collaborative Actions enabled open-ended strategies through task specialization and coordinated efforts, and reinforced interdependence among players. Our findings suggest that, rather than relying on any single pattern, it is the combination of complementary design patterns—tailored to the context of the game—that creates the conditions for engaging and meaningful collaboration

The academic contribution of the project lies in the iterative design of the game,

the continuously documented testing process, and the thorough analysis of the tests results and their eventual connections and/ or implications relative to the current iteration of the game that was being tested on. Although the study was limited in sample population and scope, the findings still pave the way for further future research with a broader demographic that could offer deeper insight into collaboration in game design.

This project demonstrates how game design patterns can strengthen collaborative aspects in video games, offering a foundation and a reference point for future development and study of collaboration games.

Artificial Intelligence statement of disclosure

During the preparation of this work the authors used ChatGPT in order to check and review grammar. After using this tool/service, the authors reviewed and edited the content as needed and takes full responsibility for the content of the publication.

Jonatan Cederberg, Alexander Lisborg, Anna Majberger, Marco Speziale, Leopold Wahlbeck, Adrian Wirthgen, Gothenburg, June 2025

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A
Appendix

Playtesting Participation Agreement

Thank you for participating in our playtesting session.

By signing this form, you agree to the following:

1. Your gameplay session will be screen recorded.
2. You will be video recorded during the playtest.
3. Your responses to the questionnaire will be used for research purposes.
4. Your input and recordings may be referenced or quoted in the project's final report.

All collected data will be handled confidentially and used strictly for academic and development-related purposes.

Name: _____

Signature: _____

Date: _____

Figure A.1: Playtesting participation agreement.