

Bachelor's thesis

Information and Communications Technology

2022

Marko Pakanen

# BALANCING A VIDEO GAME



Bachelor's Thesis | Abstract

Turku University of Applied Sciences

Information and Communications Technology

2022 | 44

Marko Pakanen

## BALANCING A VIDEO GAME

For many people balancing a video game brings to mind making small changes to overpowered and underpowered choices to make them more equal with other options. However, such small adjustments are only a small part of the overall balance of the game and the balancing process itself. The most important aspects of game balance and the methods used to balance are examined in this thesis. In addition to well-known types of balance, such as fairness and difficulty, less frequently considered aspects of balancing are also examined.

The aim of the thesis was to expand the reader's understanding of the different areas of game balance, their interactions, and methods of balancing games. The thesis examines the importance of considering the impact of different decisions on balancing long before the fine-tuning of the final stage of development. The thesis presents practical examples of the choices, methods, problems, and solutions that are encountered in game development.

The thesis scrutinised the development work of myTrueSound Ltd's Kilta -video game from the game balance point of view, covering the development stages from pre-production to time after the release of the game. The work describes how balancing was considered when making early decisions regarding game mechanics and technical solutions, what goals were set for the game balance, what methods were used to develop the balance, what balance challenges were encountered during development, and how the game balance was assessed and modified at various stages of development.

Keywords:

Video game, game design, game development, balance, balancing

Opinnäytetyö (AMK) | Tiivistelmä

Turun ammattikorkeakoulu

Tieto- ja viestintäteknikka

2022 | 44

Marko Pakanen

## VIDEOPELIN TASAPAINOTTAMINEN

Videopelin tasapainottaminen tuo monille mieleen pienten muutosten tekeminen yli- ja alivoimaisiin valintoihin, jotta niistä saataisiin yhdenvertaisempia muiden vaihtoehtojen kanssa. Tällaiset pelikehityksen lopulla tai julkaisun jälkeen tehdyt hienosäädöt ovat kuitenkin vain pieni osa pelin koko tasapainoa ja itse tasapainotusprosessia. Työssä tarkastellaan pelitasapainon tärkeimpiä osa-alueita ja niiden tasapainottamisessa käytettäviä menetelmiä. Laajasti tunnettujen tasapainon tyyppien kuten pelin reiluuden ja vaikeuden lisäksi tarkastellaan harvemmin huomioituja tasapainotuksen osa-alueita.

Opinnäytetyön tavoite on laajentaa lukijan käsitystä pelien tasapainon osa-alueista, niiden vuorovaikutuksista ja pelien tasapainottamisen menetelmistä. Työssä tarkasteltiin, miten tärkeää on harkita erilaisten päätösten vaikutusta pelin tasapainottamiseen jo kauan ennen kehityksen loppusuoralla tapahtuvaa hienosäätöä. Opinnäytetyössä esitetään käytännön esimerkkejä sellaisista valinnoista, menetelmistä, ongelmista ja ratkaisuista, joita pelejä kehittäessä kohdataan.

Opinnäytetyössä tarkasteltiin myTrueSound Oy:n Kilta -videopelin kehitystyötä tasapainotuksen näkökulmasta kattaen kehityksen vaiheet tuotannon alusta julkaisun jälkeiseen aikaan. Työssä kerrotaan, miten tasapainotus huomioitiin varhaisia pelimekaanisia ja teknisiä päätöksiä tehtäessä, millaisista tavoitteista pelin tasapainoa lähdettiin rakentamaan, millaisilla menetelmillä tasapainoa kehitettiin, millaisia tasapainoon liittyviä haasteita kehityksen aikana kohdattiin ja miten pelin tasapainoa arvioitiin ja muokattiin kehityksen eri vaiheissa.

Asiasanat:

Videopeli, pelisuunnittelu, pelikehitys, tasapaino, tasapainottaminen

# Contents

<b>1 Introduction</b>	<b>6</b>
<b>2 Types of game balance</b>	<b>8</b>
2.1 Fairness	8
2.2 Challenge	9
2.3 Meaningful choices	11
2.4 Skill and chance	12
2.5 Reward and punishment	13
2.6 Length and timing	15
2.7 Competition and cooperation	15
2.8 Complexity	16
<b>3 Balancing Kilta</b>	<b>18</b>
3.1 Main types of balance for Kilta	18
3.2 Pre-production balancing related decisions	19
3.3 Balancing during early development	29
3.3.1 Heroes	29
3.3.2 Quests and items	31
3.3.3 Enemies	31
3.4 Middle development and closed testing	32
3.5 Early access feedback and development	34
3.6 Balancing during late development	35
3.7 Full release	37
<b>4 Conclusion</b>	<b>40</b>
<b>References</b>	<b>42</b>

## Figures

Figure 1. Unity editor view of a scriptable game object of a hero.	24
Figure 2. Scriptable game object of a quest with reference to the formation.	25
Figure 3. Scriptable game object of an enemy formation used by quest.	26
Figure 4. Scriptable game object of a weapon item.	26
Figure 5. Kilta management mode view.	38
Figure 6. Deployment view of the Kilta's combat mode.	38

## Tables

Table 1. Stats used in Kilta.	21
Table 2. Technical terms in Kilta.	27
Table 3. Terms regarding Kilta's overall structure.	28

# 1 Introduction

The overall balance of a video game consists of all its game mechanics and content that is not purely cosmetic or narrative and affects areas like difficulty and player decision-making. The balance in video games can be divided into several different types. In addition to the well-known types like fairness and challenge or difficulty, there are many less often thought of types of balance such as meaningfulness of choices, balance of skills and chance, of reward and punishment, of competition and cooperation. Length, timing, and complexity of a game are all subjects of balancing.

The balance and balancing of a video game can easily be thought of as being some separate step of limited scope that can be achieved at the end of game development by tweaking some values. Balancing, however, is something that should be considered right from the start of the development. If the developer has not considered and established the principles of balancing the game during the design phase, they risk wasting time creating features or systems that are inherently impossible to balance or are either themselves or render some other system redundant. If the developer has not created effective tools for fine-tuning the balance, the process will require unnecessary time and resources.

This thesis examines the production of the auto-battler video game Kilta by myTrueSound from pre-production, through early development and Steam Early Access release to full release on Steam and beyond from a video game balancing point of view. It describes how balance was one of the major considerations when the overall game design and systems were planned at the start of production. It details the change in balancing work from the technical planning and establishing principles in early development to the more practical balancing of game features and content with help of formulas and testing in later development.

The solutions to the various balancing challenges and decisions faced through the development of Kilta are described in chronological order. The successes and failures of the made solutions at all stages of development are assessed

and analysed. The sometimes unexpected effects of the various decisions made during the development are discussed as well as the decisions that were made as a result.

The thesis text will provide the reader with a better understanding of what game balance and balancing encompasses as well as demonstrate the benefits of considering balancing at every stage of the game development.

## 2 Types of game balance

### 2.1 Fairness

The best-known type of balance, which is the one people most often think of when game balance as a concept is brought up, is fairness. In a fair game, one side or player should not have an inherent mechanical advantage or disadvantage that makes them more or less likely to win than the other side.[1]

In many classic board and card games this fairness is largely achieved by making the game symmetrical. In chess, both players have the same set of pieces to work with and the outcome of the game mostly depends on which player is more skilled. However, even in a game as symmetrical as chess, there is an advantage to playing as the white side which moves first.[2]

Most video games are not designed to be symmetric, and this complicates fair balancing. For example, it is easy to determine that in a game of chess where one side does not get rooks at the start would unfairly favour the other side, but what about a game of chess where one side starts with four bishops and no knights while the other side starts with four knights and no bishops?[3]

One important aspect of fair balance that can apply to both symmetric and asymmetric game design is “Rock Paper Scissors” or RPS interactions. In the eponymous game of hand signs, the rock always wins against scissors, scissors always wins against paper, paper always wins against rock and two of the same sign always results in a draw. Even though each sign will always win, draw, or lose against a specific sign, the game itself is still perfectly balanced with each player having the same chance of winning or losing being always free to choose any of the three signs.[4]

Comparable mechanics are often utilised in video games but often in a less absolute manner and with a large number of other factors involved. RPS interaction can apply to countless different concepts but the entity that has an inherent advantage against some other entity is often called a “counter” to that



entity. In the strategy game Age of Empires, the infantry typically has an advantage in a fight against the cavalry, the cavalry has an advantage against the archers, and the archers have an advantage against the infantry. This is, however, not absolute as in a game of RPS. For example, superior numbers can still overcome a counter unit, the archers will still lose to infantry if forced into close combat, the cavalry will still lose to archers if they cannot reach them, and the high speed of cavalry means they can often pick their fights and arrive where they are needed fast.[5]

Measuring fairness is further complicated in single player games where the player and the computer might operate with completely different rules and resources. In XCOM: Enemy Unknown's tactical combat, the computer-controlled aliens have greater numbers and are often more powerful than the player's XCOM operatives. Furthermore, while any damage and losses suffered by the player carry over and can hinder them in following battles, the aliens have an endless supply of resources and troops. Despite the game being seemingly unfair towards the player, most players do not actually experience it to be so. In XCOM, the player can overcome the advantages of the computer with skilful planning, and the unfair advantage of the aliens fits the theme and narrative of the game.[6]

## 2.2 Challenge

Another well-known type of game balance is that of the challenge, also referred to as the difficulty of the game. If a game is too easy the player will become easily bored with it, if the game is too challenging, the player may become frustrated and anxious. The challenge in a balanced game should constantly remain between the two extremes where the players feel most rewarded by earned successes. However, some variance in difficulty is also often desirable to produce a cycle of raising and lowering tension. Balancing the difficulty in competitive multiplayer games is particularly tricky since the skills of other players affect how challenging the game is. [1]

What makes balancing the difficulty particularly challenging for the game developer is that every player has different skills and different standards for what is too challenging or too easy for them. The desired level of challenge varies significantly depending on the genre and target audience of the game.[1]

In roguelike games, where the player can lose all their progress to an unbeatable enemy or bad luck, a challenging difficulty is often expected and even considered a selling point. In *Darkest Dungeon*, the chance of defeat is high for an average player and the cost of defeat can even be starting the game over. In many cases, this could be considered excessively punishing but in the case of *Darkest Dungeon*, the game being punishing is considered a feature, and the roguelike genre is among the first information mentioned on its store page. It is clearly targeted at players who specifically desire an especially challenging game and the anxiety inducing level of difficulty is an important part of the game experience.[7]

At the other end of the spectrum, there are games that are targeted to players who want a minimal level of challenge. In *FarmVille* games, the player cannot lose the game or suffer setbacks. The player can expand their farm and fulfil tasks that offer little challenge. *FarmVille* games are targeted at people who do not necessarily play any video games from other genres, and they focus on rewarding the player for playing the game regularly rather than overcoming challenges.[8]

Games can challenge the player both physically and mentally. Physical challenge in most video games means executing fast and precise inputs with the mouse, keyboard, or some other controller to move, shoot, drive or perform other actions in the game. Mental challenge means using one's brain to solve, create, memorise, or plan something.[1]

*One Finger Death Punch 2* is an example of a game that focuses on the physical challenge of hand-eye coordination. The game requires rapidly and precisely pressing one of two different buttons at the right time. Many turn-based games represent the other extreme. *Panzer Corps* is a strategy game

where every decision can have far reaching consequences so the player must consider all the risks and options before making a move. Physically the game requires only basic use of the mouse with unlimited time for making decisions and even an option to undo erroneous moves. [9][10]

Mental and physical challenges are not mutually exclusive or competing and the boundary between the two is often fluid. Fighting games such as Street Fighter or Tekken simultaneously require fast reflexes and quick execution of complex inputs as well as complex decision-making based on deep knowledge of the game mechanics.[11][12]

### 2.3 Meaningful choices

Most games expect the player to make decisions on which options they choose. Depending on the game, these can include choices such as which way they go, what character class they choose, whether they play aggressively or defensively, how they use their limited resources etc. For all these choices to be meaningful, they must be balanced.[1]

A game could offer a player 10 different options to choose from, but if one option is clearly superior to all the others, it is not really a meaningful decision as there is only one correct choice to make. At worst, an unbalanced option can make large parts of the game meaningless. For example, one could make an action game with deep melee combat mechanics, which nobody would ever experience because ranged weapons were made more effective in all situations.[1]

The amount of meaningful choices and options are also a subject for balancing. Players can be frustrated or bored by having too few meaningful choices to make. On the other hand, too many choices can overwhelm the player and result in them becoming bored or frustrated examining all the options before choosing, choosing at random, or choosing without considering all the options. What is perceived to be the right amount of choices varies by player.[1]

Connected to the meaningful choices is the balance of freedom and controlled experience. Games can be very controlled, as in the on-rail light gun shooter Time Crisis II, where the resources and movement of the player as well as placement of enemies is strictly controlled. The developer knows accurately how and when the player progresses in the game and the various aspects of the game can be easily fine-tuned to accommodate this. At the other end of the spectrum, in games such as Minecraft or Legend of Zelda: Breath of the Wild, the player is released into an open world where they are free to do whatever they wish so developers have no way of knowing how experienced and prepared the players are when they reach specific parts of the game. [1] [13][14][15]

High degree of freedom in a well-balanced game means more meaningful decisions for the player but it also makes other aspects of the game more difficult to balance. In an unbalanced game, freedom may result in bad challenge progression, pointless choices, and meaningless rewards, which add no value to the game. A more controlled game experience makes balancing easier but may not offer player as many meaningful choices as they would wish.[1]

## 2.4 Skill and chance

The importance of skill and luck in the game mechanics is another subject of balancing. Skill is something that a player can learn and improve while chance, also known as luck, is the same for every player regardless of prior experience.[1]

Heavily skill-based games tend to favour an experienced player. Chess is an example of a purely skill-based game with no random elements. Each player always knows what they can do themselves and what their opponent can do in their next turn. Winner is decided by skill with luck not being a factor beyond possibly luck involving method of determining the first moving player.[2]

Luck-based games reduce or remove the effect of skill and depend on random chance. Roulette is an example of a purely luck-based game where chance determines the outcome. There is no skill involved in the betting as the ball is completely random and any bet has the same expected pay-out. Experienced and inexperienced roulette players are just as likely to lose money at the roulette table in the long run. [16]

Most games involve both skill and chance, often alternating between the two. Emphasising chance as a game mechanic reduces the impact of skill and vice versa. In a competitive game, the element of chance can help inexperienced player have a chance at winning against a better player.[1]

Chance does not automatically remove skill as a factor, however. In poker, the cards are dealt at random, and a skilful player is just as likely to receive bad cards as a bad one. A good poker player can still better understand the odds and possibilities based on the cards they know and make better decisions than a less skilled player. In a game of minesweeper, all players are just as likely to hit a mine on their first click and even the best player can end up in a situation where they only know a mine is in one of two spaces and must make a guess. A skilled player is still more likely to win a game of minesweeper than an unskilled one. [17][18]

The right mixture of skill and chance depends on player preference, so the genre and target audience of a game are key factors in balancing the two. Games with much chance are often more relaxed and casual while games with heavy emphasis on skill are considered more serious.[1]

## 2.5 Reward and punishment

A game must judge the player. Players want to be rewarded for doing well and the risk of punishment for failing makes a game more exciting. Without any kind of reward and punishment, a game would be boring and purposeless.[1]

There are countless ways of rewarding the player in a game. A reward confirms to the player that they have done well and achieved something. Rewards can be obvious and direct such as adding to points, unlocking cosmetic rewards, or simply praising the player. Rewards can be part of the game's structure and narrative e.g., allowing the player to progress to the next area, granting the player powers and resources, or completing the game. Rewards can also be more subtle like satisfying sounds or visual effects, and spectacle.[1]

Punishments are the opposite of rewards. Psychologically rewards are a more effective tool of reinforcement than punishment, but punishment still has important uses in game design. Punishment is used to increase the challenge of a game and the possibility of failure makes success meaningful. The methods of punishment are often the opposite of rewards. Players can lose score, gain negative score, or be shamed by the game. The punishment can be loss of resources, power, or progress in the game.[1]

The multiplayer of Call of Duty: Modern Warfare 2 uses many rewards and punishments to motivate the players. When a player shoots an enemy player, they see the added score in the centre of the screen. The dying player must watch their own death, see their killer's name, and wait for a moment before being able to continue playing. The entire server is informed of the kill which means praise for the killer and shame for the victim.

If the player achieves anything noteworthy, they receive additional score, accompanied by sound and visual effects. Killing several enemies without dying rewards the player with use of powerful "kill streak" rewards but the player is also punished for dying by resetting progress towards those rewards.

At the end of a round, a scoreboard shows the best and worst players. Players are then rewarded by resources and progress in the form of experience points that go towards unlocking new weapons, abilities, and cosmetic customization options. The better the player did, the greater rewards they received. Multiple layers of rewards and occasional punishments are an important and integral part of the experience. [19]

People easily become acclimated to rewards they receive. Constantly and easily rewarding the player will lead to a loss of the perceived value of the rewards. A reward that felt significant the first time it was received will not feel as significant after it has been received a hundred times. Failing to reward the player sufficiently for success will cause disappointment and frustration. Punishing the player for something they do not feel warrants a punishment can be even more frustrating for the player.[1]

## 2.6 Length and timing

Another area that must be balanced for every game is the length of the game and timing or pacing of its components. If a game is too short the player may not have a chance to learn the game and make meaningful use of its systems and possibilities. Too short a game can also leave the player feeling they did not receive enough value for their money. When a game is too long the player feels they have seen everything the game has to offer and is likely to stop playing the game before completing it.[1]

Even more important than the overall length of the game is the pacing, or timing, of its elements. For example, 40 hours could be a suitable overall length for a computer role-playing game. However, if the game consisted of 10 hours of dialogue, followed by 10 hours of character equipping, followed by 10 hours of travelling and finally 10 hours of combat, players would be less likely to finish the full game and see all it has to offer. This would not be the case if the game was constantly switching from one type of gameplay to another through its whole duration.

## 2.7 Competition and cooperation

Other noteworthy areas of balancing include the balance between competition and cooperation. This balance is most relevant to multiplayer games with human players but there are still competitive and cooperative elements in most

solo games. Mixing the two together is common, as in games where two cooperating teams compete against another team, but there will often be some conflict of interest even inside a team.[1]

In well-designed games, these conflicts between competition and cooperation can be an interesting gameplay element. In the board game *Nemesis*, the players must cooperate to survive, but each player has their own secret objectives which are mutually exclusive with some of the other players' objectives. Figuring out what the others are trying to do, which players can be trusted, and what needs to be done for anyone to survive, while each player is trying to win the game themselves, is a huge part of the game's overall design and core experience.[20]

On the other hand, a badly balanced mix of competition and cooperation can have undesirable effects on a game. If a game designed for cooperation rewards an individual player better if they pursue their personal goals, or punishes them for taking risks for the team, the game can become extremely frustrating as some players will ignore the team's goals.

## 2.8 Complexity

The right balance between mechanical simplicity and complexity is something that must be figured out for every game. A game that is mechanically too simple can be easy to figure out and quickly becomes boring to play. On the other hand, a game that is unnecessarily complex for no good reason can be confusing and frustrating experience. A mechanically simple game can still have a lot of depth through smart design. The classic board game *Go* uses remarkably simple elements and rules but is still an incredibly deep game thanks to the emergent complexity of its elegant design.[1]

Complexity that does not serve a purpose in a game's design, or only has extremely limited purpose, is usually something to be avoided. Fulfilling several purposes with a single rule or system is something to be pursued and is characteristic of simple but deep games. A game having many exceptions and



special rules can be a warning sign of unnecessary complexity. However, there are still cases where a high degree of complexity in a game is warranted. For example, in a flight simulator or historical strategy game, the purpose of the game can be to be as detailed and close to reality as possible. In cases like these, a complex set of rules and mechanics can be necessary and desirable. Learning to play and mastering a complex game can be rewarding to players.[1]

Closely related to the simplicity and complexity, is finding a balance between showing details and leaving them to the player's imagination. An abstract and simple system leaves more to the imagination and can sometimes be just as immersive as a more complex and detailed system.

This also applies to the narrative side of games. For example, a game can have fully voice-acted dialogue and motion captured facial animation which leaves little room for interpretation, it can have a written dialogue that leaves the voices and details to the player's imagination, or it can have no written dialogue at all which leaves it all to the player to interpret. Budget and resources are often factors in this kind of decision.

## 3 Balancing Kilta

### 3.1 Main types of balance for Kilta

The prominence of different types of balance varies by genre and game. Fairness is almost always important in games and so it is for Kilta. In practice this means that the game should not put the player in a situation where they cannot beat a run due to not having had a chance to accumulate the necessary resources, or in a situation where they lose the run due to some unpredictable event that they could not prepare for.

Challenge is another universally important area of balancing. Kilta is not intended to be an especially easy or difficult game and the challenge level should be consistent. Difficulty spikes or trivially easy battles are something to be avoided. Due to its auto-battler genre, chosen in part for accessibility's sake, Kilta's challenge comes from thinking and planning in advance. There are few inputs that the player needs to do in a hurry.

Meaningful choices are at the core of the Kilta game experience. Player has little control after the combat starts so offering the player meaningful decisions outside of combat forms the bulk of gameplay. Player chooses the heroes, their abilities, quests, and rewards, all of which must be balanced to keep the decisions meaningful.

Finding a balance between skill and randomness is especially important for Kilta. Randomization is used in many systems of Kilta for increased replay value and the combat system is also based on randomised but weighted selection of targets for different attacks and abilities. Ensuring the player has enough decisions to make for managing that randomness is important for an enjoyable game experience.

Rewarding and punishing the player is necessary in any game. Players must be rewarded both during a single run as well as over multiple runs to keep them motivated and invested in the game.[1] Rewards are also used to encourage

the player to use different tactics while punishment is used to discourage relying too much on the same solutions. Punishment is also necessary for creating a sense of risk and excitement.

Length and pacing are always crucial factors in a game. For Kilta, a game that consists of many individual runs, the overall length comes from replay value or how many times the run can be finished before there is nothing new to experience. Length of a single run, as well as the pacing of dialogue, management, planning, and combat components must be in balance for the game to be as enjoyable as possible.

The goal with Kilta is to make it easy to learn and play so unnecessary complexity is to be avoided. The game being designed to be accessible to visually impaired also adds some special requirements in this field.

As the Kilta is a single-player game with clear division between the player and the opponent, competition and cooperation are not major considerations.

### 3.2 Pre-production balancing related decisions

After the basic idea of the game was decided, that it would be a tactical auto-battler with strong story and RPG elements, balancing was one of the main considerations in many design decisions.

The overall goal of the balancing is of course producing an interesting and entertaining game, with a multitude of viable and interesting strategies for the players to figure out.

When the basic data structure and flow of the game systems related to management and combat was being decided, the most important question was how much complexity would be needed for interesting gameplay. If there are not enough mechanics and variables, there would not be enough room to differentiate the heroes, items, enemies, and battles, which is imperative for providing the player with enough meaningful choices. On the other hand, too

much complexity would lead to a game that is harder to understand for the player and more difficult to balance for the developer.

At this point in development, it was decided that the game would be divided into three main modes: Management mode where the player select their battles and equip their heroes for combat; combat mode where the player deploys their heroes on the field, then observes the battle and finally chooses possible reward items; and dialogue mode where story of the game is told through text based interactive dialogue between the player's avatar and other characters. Bulk of the balancing work would come from the management of the player's heroes and items, the enemies that the player's team faces in different formations, and the combat mode itself.

It was decided that units, which means individual heroes and enemies, would have the following integer variables, collectively referred to as stats. The stats are listed and explained in Table 1. The stats struct would be part of a unit and it would also work as part of items and anything that would modify or override the base stats of a unit. In addition, there would be a stat modifier struct that would allow making percentage changes to base stats.

Table 1. Stats used in Kilta.

<b>Stat name</b>	<b>Description</b>
Maximum health	The amount of damage the unit can suffer in combat before being incapacitated.
Physical power	Unit's capacity to deal physical type damage.
Magical power	Unit's capacity to deal magical type damage.
Physical defence	Unit's capacity to reduce incoming physical damage.
Magical defence	Unit's capacity to reduce incoming magical damage.
Physical mitigation	A percentage change to the physical damage after physical defence is applied.
Magical mitigation	A percentage change to the magical damage after magical defence is applied.
Speed	Value that determines the frequency of the unit's actions.
Aggro	Value that influences the probability of the unit being targeted by enemy attacks.

With the stat values each unit would have survivability determined by number of hit points, probability of being targeted, and two different resistance values for each of two different damage types. Offensively a unit would have two power values for two different damage types. These values would allow for different units to have unique approaches to both offence and defence without redundant or rarely used values.

Having more different damage types was considered, but it was determined to be undesirable. More damage types would have meant a larger number of values for each unit, which would have required more items in the game, and in

the player's inventory at any time, to cover all the damage types. Alternatively, all items could affect several of the damage types, which could have easily resulted in the differences between the values being negligible and therefore redundant, increasing the game's innate complexity without adding new types of meaningful choices that would not already exist with just the two different damage types.

Units could receive statuses from various sources which could have a variety of effects like adjusting or setting their stats, dealing damage over time, or they could be part of some more complex interaction.

Every unit would also have an ability, a special action, that they perform once after having done a specified number of normal auto-attacks, then repeating the cycle. Abilities would use custom scripts to perform various actions which would be affected by the performing unit's stats. Abilities could do a variety of things from damaging enemies to healing allies or applying statuses to units on the field. Abilities would be where the greatest uniqueness of individual heroes and enemies comes from.

Each unit would also carry two items into battle: one weapon, and one equipment. The items can increase or reduce the unit's stats by amount and percentage. Weapon also determines the unit's damage type, physical or magical, and targeting, melee or ranged. Items can also have a scripted unique property which can affect the units in the game in numerous ways.

Decision to divide the items into weapons and equipment was made for balancing reasons. Allowing any item, or even two of the same items, in either item slot would have more severely limited what could have been done by any one item. Instead, a decision was made that weapons would provide the main part of a unit's offensive stats and unique properties, while equipment would bring most of units' defensive stats and unique properties. This effectively prevents the player from combining multiple items that would greatly increase the same values that could result in balance issues. This limitation allows for

bigger stat values and stronger effects on individual items, and it prevents potential conflicts with the unique properties of items.

Early in the development it was decided that both heroes and enemies would be hand crafted rather than randomly generated. This was done both to support the story elements of the game with memorable and fully developed characters, but also for the sake of future balancing work. With more controlled experience it would be easier to fine tune the difficulty curve and ensure the player always has meaningful decisions to make with well-balanced options.

At any point in the game the player would choose from randomly selected quests with random reward items, but both the quests and items would be pre-made and limited to certain parts of the game so the difficulty of combat and strength of rewards would be easier to control than in a completely random system but offer more variety on subsequent playthroughs than entirely static quests and rewards.

All the heroes, items, enemies, enemy formations, and quests would be coded into Unity scriptable game objects which makes it easy to create and change those objects directly in the Unity editor. It was not the fastest or easiest system to set up, but it makes both balancing and content creation easier in the long run. Switching to a system like this from something else later in development would have wasted a lot of resources so considering and planning it in advance was vital. Figures 1 to 4 are examples of the scriptable game objects inside Unity editor.

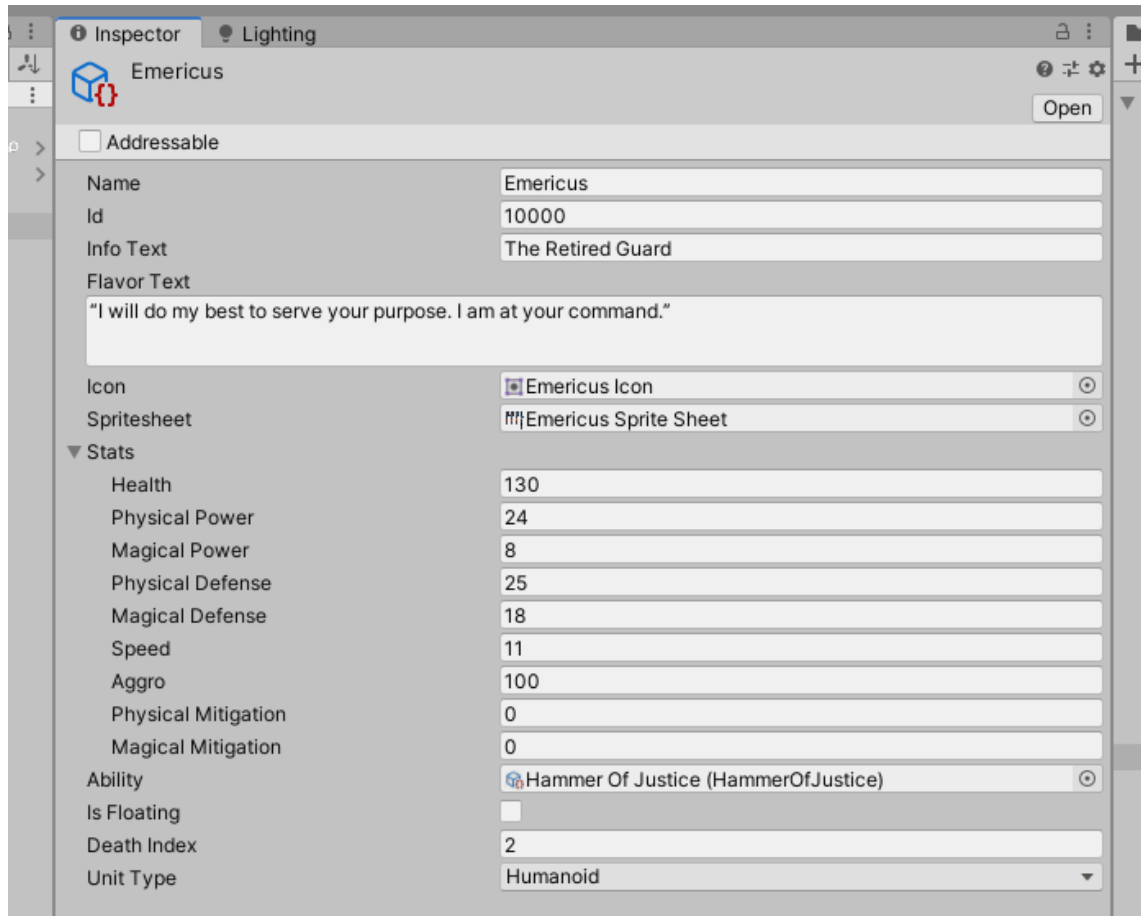


Figure 1. Unity editor view of a scriptable game object of a hero.

The Scriptable Game object of hero allows directly changing the base Stats of the hero itself from the normal Unity Inspector view of the hero's Scriptable Game Object. A limitation of Scriptable Game Objects is that anything stored in the object itself cannot be modified in runtime as the changes would be made directly and permanently to the Scriptable Object Itself. Instead, the stats from Scriptable objects will need to be copied so that they can be safely modified and adjusted in runtime.



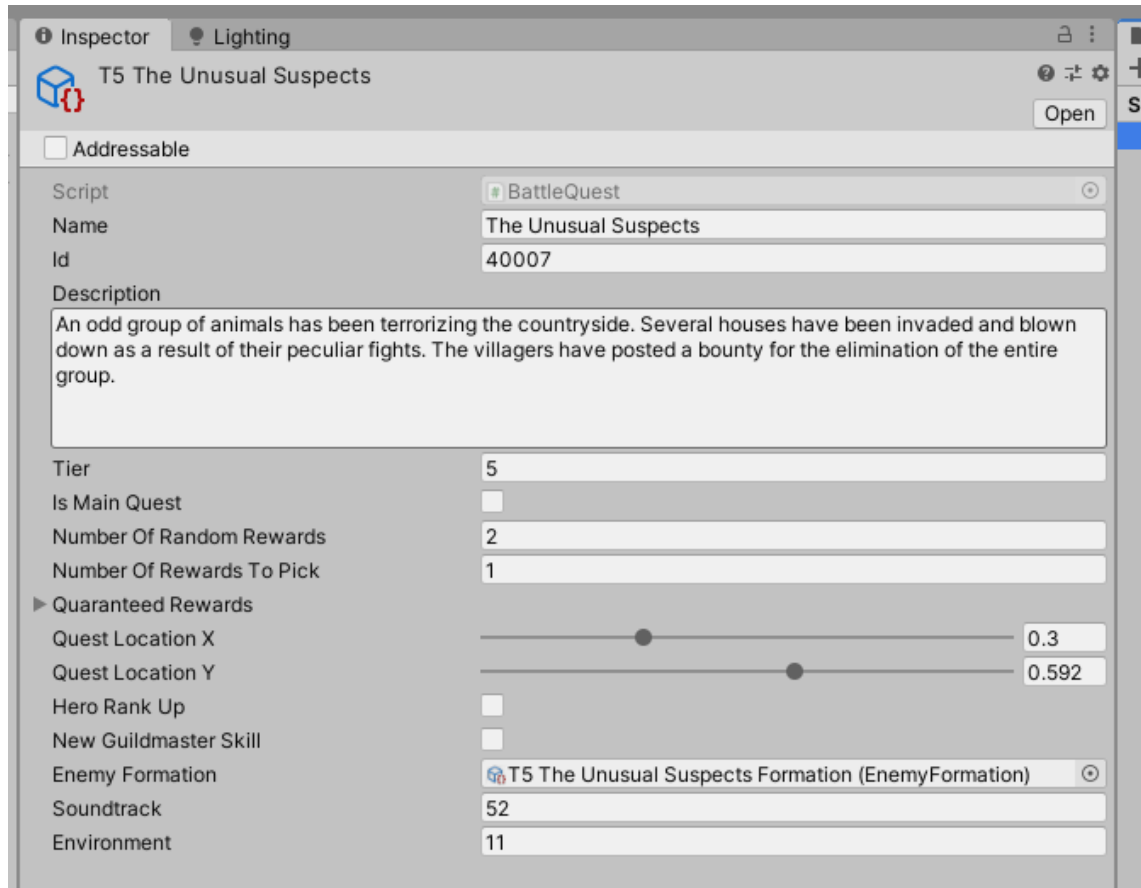


Figure 2. Scriptable game object of a quest with reference to the formation.

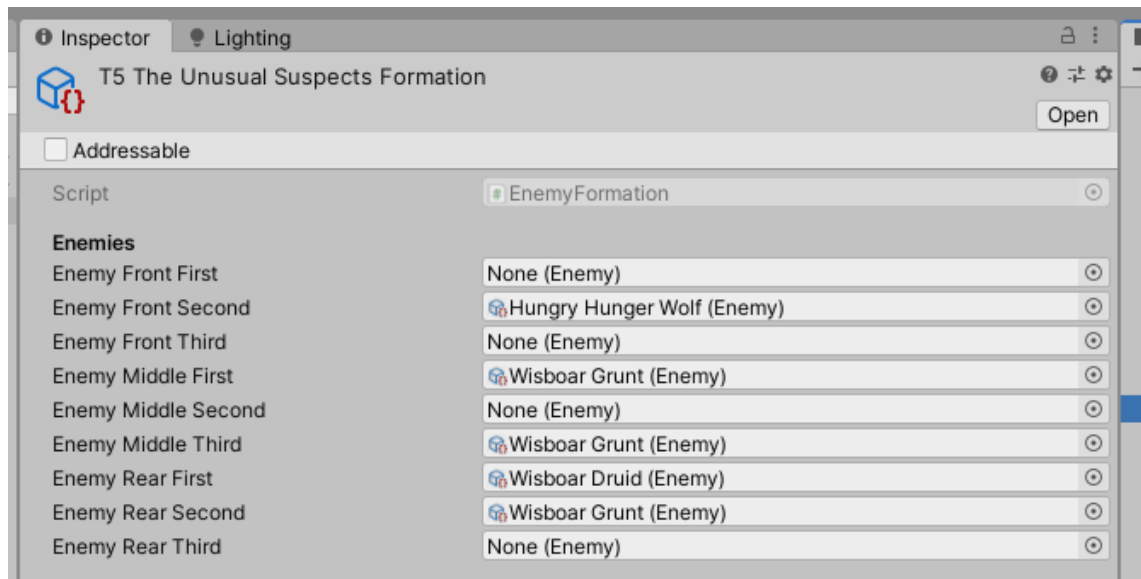


Figure 3. Scriptable game object of an enemy formation used by quest.

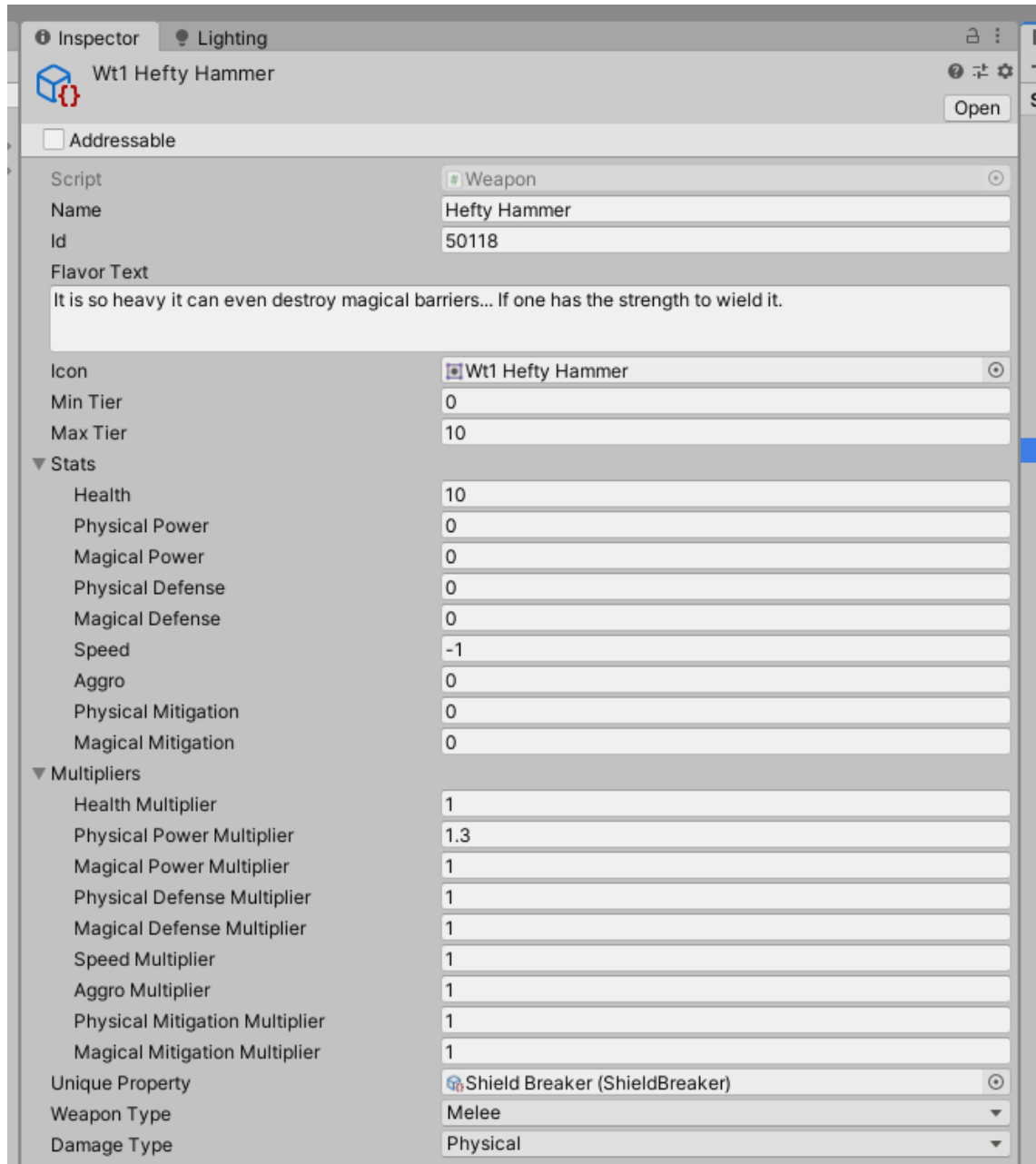


Figure 4. Scriptable game object of a weapon item.

Tables 2 and 3 contain explanations of important terms and concepts in Kilta which need to be understood. Table 2 explains technical terms and classes while Table 3 describes general concepts of the game's structure and design.

Table 2. Technical terms in Kilta.

<b>Term</b>	<b>Explanation</b>
Hero	A fighting character the player has in their party. Player chooses up to five heroes to bring to a battle and what weapons and equipment a hero uses.
Enemy	Enemy characters that the player fights in battle mode. Can also refer to the enemy side in a battle as whole.
Unit	A single hero or enemy in the battle mode. Units are mechanically identical regardless of which side they are on.
Ability	Heroes and enemies have a powerful ability that they will use automatically after a specified number of normal attacks.
Quest	A battle with randomly picked item rewards. Most of the time the player can select from several possible quests which all have an associated enemy formation. Some quests are boss battles with a special boss enemy that the player must win or the campaign playthrough ends.
Formation	Arrangement of units on a battle grid. Enemy formations are pre-made and attached to a specific quest while player formation is deployed by the player before battle is started.
Weapon	Every unit has one weapon equipped that determines the damage type and targeting of the unit's non-ability attacks.
Equipment	Second item alongside the weapon. Both heroes and enemies can have one piece of equipment.
Item	Includes both weapons and equipment. Any item can have stats and a unique item property with an effect like stunning an opponent on hit or healing the hero when dealing damage to the enemy.

Table 3. Terms regarding Kilta's overall structure.

<b>Term</b>	<b>Explanation</b>
Battle mode	Part of the game where the player deploys their heroes on the grid and starts the battle between the heroes and enemies. Player heroes and enemy units are placed on their respective 3x3 square grids.
Management mode	Part of the game where the player selects and equips heroes for the quest. The player also chooses the quest from provided options.
Campaign	Acts 1, 2 and 3 of the game with 10 chapters each, every act ending in a boss battle quest. In each chapter the player chooses one quest to play. During a campaign the player hires new heroes and receives new items as reward for winning quests.
Playthrough	A single playthrough of the campaign. Hero level (also called rank) and encountered heroes are saved across multiple playthroughs while items and hired heroes are reset each playthrough.

The basic game loop of Kilta is that the player starts a new campaign playthrough with two heroes, they start in management mode where they select a quest from the available options each quest with its corresponding combat encounter or formation, some of which are boss battles. The player then equips their heroes with items and starts the quest, which takes the player in combat mode, where they position their heroes on the 3 by 3 grid facing the enemy's similar 3 by 3 grid. After that the player starts combat where the units act automatically until one side loses their last hero. If the player wins, they are rewarded with a selection of new items immediately and possibly a new hero when they return to management mode. The cycle is repeated until the player reaches the end of the campaign or loses a boss battle. The player can then start a new playthrough with some saved progression the nature of which had not yet been decided on.

### 3.3 Balancing during early development

#### 3.3.1 Heroes

After implementing the technical structure of units and items the next step was deciding how large the numbers in the game would be. Many players find growing numbers rewarding and especially in Massively multiplayer online role-playing games, also known as MMORPGs, the values of stats and damage are often raised several orders of magnitude over the course of the game. However, smaller numbers are easier to read at glance and would also work better with the planned screen reader accessibility features of Kilta. Integers were to be used for both visual clarity and technical simplicity. Another major factor in deciding the size of values was ensuring that the integers would not be too low for small adjustments. A starting integer value of 10 can be raised or lowered by 10 % to 11 or 9 respectively but for a starting value of 2 the smallest possible increase and decrease would be 50 %. With all this considered it was decided that most stats and final values in the game would be in 2 digits while health value would often go into 3 digits. This range of desired values was then used as a guiding principle in all the following decisions.

Before the content creation and detailed balancing work could start the combat system of the game had to be designed and implemented. Real time combat with moving units was considered but a simple turn-based combat system with fixed positions for units was chosen for the easier technical implementation and balancing. Player and enemy units would both have their own 3 by 3 grids of unit positions where being closer to the enemy would increase the chance of a unit being targeted, and a unit behind another unit would be protected from melee attacks but not ranged attacks. It was thought that this grid size with 5 player units and 1 to 9 enemy units would enable enough

One of the most important goals in design was that the players could easily change their party of heroes during a playthrough in response to the different enemy formations they would face. In practice this means that all the player's

heroes must maintain a similar level of power regardless of how often the player uses them.

One common design decision that effectively prevents or at least strongly discourages the player from playing like this is forcing the player to permanently invest limited resources into specific characters. In practice that could mean receiving experience only for characters that participate in battle and/or permanently attaching items or upgrades to the characters. This causes a situation, where spreading the limited resources across more heroes than can participate in any one battle, results in the average power of the participating heroes being lower. This kind of design can quickly render unused units useless as they can no longer match the more powerful enemies, or it can lead to the entire player force becoming underpowered if the resources are spread too evenly.

If permanent limited resource allocation is combined with heroes that can be permanently lost, it can easily lead to strong feedback loops. In a positive feedback loop the player party with all the concentrated resources becomes too powerful compared to the enemies so each victory and the resulting rewards are achieved at low cost to the player which makes subsequent victories even easier.

In a negative feedback loop the player might lose a single high-power unit and the attached resources which will have to be replaced with a less powerful unit. This makes subsequent losses of heroes and the attached resources more likely and ultimately the player force can become too weak to progress in the game.

To keep switching the heroes in and out of the party during a single playthrough viable option, all the heroes must remain powerful enough through the entire length of playthrough, regardless of how much they have seen action.

One way to achieve this would be to share experience between all player heroes regardless of if they participate in battles but instead, it was decided that there would be a very limited experience-based hero level system and most of

the player heroes' power increase would be tied to the equipment that can be freely swapped between party members.

### 3.3.2 Quests and items

The core loop of the game is that the player selects and equips heroes for a quest which, upon successful completion, rewards the player with more items and sometimes new heroes. Every tenth quest would be a mandatory boss battle quest that the player must win to proceed with the campaign while the others could be selected from several alternatives with different enemies and rewards.

In terms of balancing this means that the player will get progressively stronger with the additional heroes and items. Quests would have to get progressively harder and reward items stronger for the gameplay to be consistently challenging and rewarding.

A decision was made that the possible quests offered on any phase of the campaign would be randomly selected from a carefully curated small set of premade quests, while the rewards for each quest would be randomly selected from a larger set of items that can appear on a wider range of tiers. This would allow good control over the difficulty of the quests a player faces while offering meaningful decisions and replay value through the items that would be more variable over multiple playthroughs.

### 3.3.3 Enemies

The different enemies would have different levels of power with weaker enemies appearing predominantly earlier in the game campaign while stronger ones would appear later. Especially powerful boss enemies would only appear in the specific main quests that divide the game's campaign into chapters. Enemies would not have items with stat values so all their stats would be contained in each enemy's scriptable game object. This approach was chosen

to keep all the relevant variables of each enemy type in one place, which would make managing and adjusting them easier.

### 3.4 Middle development and closed testing

As the game's development progressed and the various systems were coded and added to the game, the nature of balancing work shifted from establishing principles and creating systems to determining and applying values to game content.

The structure of Kilta's battles can be roughly reduced to two sides each dealing damage to the other and negating damage to themselves over time. Damage can be dealt directly by attacks against single or multiple opponents. Damage can also be dealt indirectly by buffing friendly units so they can deal more damage or by de-buffing the enemies so that they take more damage from attacks. Damage can be negated directly through defence and mitigation of the unit that is being targeted. Damage can also be negated indirectly by healing or applying statuses that either increase the defence and mitigation values or otherwise absorb received damage.

The damage is applied to the health of each side's units which collectively makes the teams health pool and when one team's health pool runs out it loses and the other team wins. Furthermore, when an individual unit runs out of health its ability to deal and negate damage is removed from the team's total capacity which gives the opponent an advantage.

The heroes are in internal balance and offer meaningful choices without obvious best decisions when their potential for dealing and/or negating damage is similar across the whole group. The same applies between weapons and equipment of the same tier. The player's task is to unleash that potential by making synergizing choices when selecting the heroes and optimising their items and formation.



The enemy units are not balanced internally. They have different capabilities and are mixed and matched in quest formations to produce a challenge that is a fitting match for what the player is expected to have at that point in the game.

At this stage of development features were being constantly added and adjusted so while a systematic and calculated approach to balancing the variables of heroes, items, enemies, and quests would be possible, it is not sensible use of resources as the balancing formulas, values and documentation would have to be updated after every gameplay affecting change.

At this stage of development, the first playable alpha build of the game was prepared and play-tested by a group of people who had no prior experience of the game. After playing the alpha test build at their own time the testers were interviewed by team members on various subjects including how they felt about the difficulty and balance of the game.

Majority of the testers found the test build to have been very easy. This was recognized to have been due to the new players unfamiliar with the game having been underestimated when the game's balance was adjusted for testing. To address the issue, modest increases were made mainly to the Maximum Health of the enemy units, which linearly increases the time the enemy can deal damage, and Defense values of the enemy units which would negate more of the incoming damage and further prolonging the fight to give the enemy more time to deal damage. Additional enemies were also added to some formations which increases health pool, damage dealing capacity and damage negation capacity of the enemy formation.

Another balance issue noted by the testers was that there was little need to change their formation between battles. This issue was determined to be a result of both the generally too low difficulty and the lack of enemy Abilities and other effects that would discourage the player from always relying on the same formation. The too low level of challenge led to diminished number of meaningful choices as it made small adjustments unnecessary, and the player would win even with suboptimal items assignment and formation. Adding

features that would add more incentive for the player to change their formation was made one of the priorities for future development.

### 3.5 Early access feedback and development

The closed testing was followed by further development addressing issues and adding features based on the collected feedback. One of the additions was a system that allowed players to use skills during the otherwise automatic battle to influence the outcome. This system was added in response to the noticed tendency of the testers to fast forward the battles as much as possible rather than follow the events. It was a break from the game's auto-battler concept but deemed necessary for improved player commitment during battles. The focus of ongoing battles was shifted from being purely chance based to requiring player skill to make the length and timing of battles more enjoyable. An alternative approach would have been simply speeding up the battles, but this was not considered desirable as it would have both reduced the overall length of the game and made it less likely that players would have had time to learn the intricacies of the battle system.

The game was then released to the public as a paid product on Valve's Steam platform through the Early Access program which allows developers to publish games unfinished and still under active development to gather feedback from the players before the game is ready for normal release.

The Early Access release version was considered too easy based on feedback received from Steam reviews, the game's Discord server and other channels. The main reason was determined to be that in a rush to prepare the release version there hadn't been enough resources to adequately test and adjust the game's difficulty following the addition of new game mechanics and features which had made the player side relatively more powerful. There was also an issue with the internal balance of the player heroes as one of them was far more powerful than the others due to poorly tested late change to the hero's ability.

Maintaining a good balance is one of the major challenges when the development is ongoing with constant changes that affect the balance in different ways. The issue is especially prevalent and important to address when the game has been released to the public through Early Access where the game must always be in playable state.

As a result of the feedback the difficulty was increased by increasing the power of enemies to better match the player side. To address the internal balance issues of the heroes the one standout hero was weakened to match the other heroes which was determined to be the more desirable level of power considering the recent issues with too low difficulty.

At this point in development, it was also decided that it would be good to have various difficulty modifiers that would allow the player to make the game harder or easier by turning on various benefits or penalties to the player or enemy side. The most important modifiers were easy and hard mode which respectively lowered and increased the stats of the enemies by a percentage. This would give the player the ability to adjust the game's difficulty to fit their personal preferences and skill level.

### 3.6 Balancing during late development

After the Early Access release, the team was joined by a dedicated content maker who could fully focus on designing quests, enemies and other content as well as properly balance it all through a more methodical process. Formulas were created for calculating the relative power of the heroes and items, as well as the relative power of enemies and enemy formations.

The balancing maths and formulas are different in every game and must be created with a good understanding of how the game functions. In the case of Kilta it was necessary to create measures for how powerful the heroes were in comparison to each other so they could be internally balanced. There was a need for a measure of how powerful an item was so their stats could be adjusted for consistent progression through the campaign. Enemies would

similarly need formulas to estimate how powerful individual enemies and groups of those enemies would be.

The formulas were made by weighing different stats and other factors to produce an abstract power value that could be used to estimate the relative difference between units, items, enemies, or enemy formations. The overall formula and weighing values were tested in game to verify their validity and there was also room in the formula for manually making estimated corrections to account for synergies or complex factors that couldn't be realistically included in the calculations. With the balance formulas utilised in a spreadsheet, new content could be more easily adjusted to fit the overall balance and outliers of the existing content could be more easily noticed even without extensive in-game testing. Using the more methodical balancing approach, the overall difficulty of the game was adjusted to be significantly more challenging.

At this point some of the main complaints from the players included the game being too short, an issue of penalties that the player would get from some mechanics being unenjoyable and changing the positions of player units still not being important enough.

To address the issue of length, it was determined that the contents of the game would offer sufficient replayability for about 4 or 5 playthroughs of the campaign with each playthrough taking estimated 90 to 120 minutes for a total length of 7 to 8 hours. The game would be structured to promote this length by the old difficulty modifiers being replaced by a single hard mode that the player would first have to unlock by winning the campaign in normal mode and then win the hard mode to reach the real ending of the game. The limited hero level system was changed so that its impact on hero stats was stronger and the level increases, awarded for winning boss battles, would persist from one playthrough to the next with the idea being that player would have to progress at least partially through the campaign on normal or hard mode a few times before they would be powerful enough to win the game at hard mode. The length of the game was set based on its depth provided in part by its complexity

and implemented by utilising difficulty, demonstrating the interconnections of the different types of balance.

Some mechanics, like the system that awarded player heroes special effects when they were deployed in certain patterns, gave the player both benefits and penalties, and a persistent maximum hero health reduction applied as they take damage, and which is healed by not being used in a quest. The pattern penalties were originally introduced to limit the overall increase in player power from the position pattern effects and to ensure that they wouldn't become the only viable way of deploying the heroes. However, due to the player feedback the penalties in game were mostly removed or toned down which increased the player side's power in the game.

To make changing the player formation more important a new mechanic was added where one random deployment position in each battle would have a strong random benefit for a hero deployed into that square. More items with effects that benefit from specific positions were also added to provide more meaningful options when arranging the heroes.

With the removal of penalties, the new random deployment position bonus and other changes and additions that made the player side more powerful lowered the overall challenge of the game, but this was expected to be offset by the new hard mode that would make the enemies more powerful while the normal mode becoming easier was deemed desirable.

### 3.7 Full release

The game was then released from Early Access. Figure 5 shows the management mode view of the released game with inventory open in the middle, selected party heroes at the left edge of the screen with their assigned weapon and equipment, and the reserve heroes not in the active party are at the bottom of the screen.



Figure 5. Kilta management mode view.[21]

In Figure 6 the deployment view of the combat mode is displayed. The player party grid is on the left side and mirrored enemy grid, which in this example has one enemy in the middle, is on the right side. Player positions his or her party here before starting the battle with the Begin Battle button.



Figure 6. Deployment view of the Kilta's combat mode.[21]

The full release version of the game received more positive Steam reviews, where the reviewer recommended the game, and general feedback than the Early Access versions did. During Early Access the game received 31 reviews of which 20 were positive while the release version received 15 reviews with 12 being positive. Reviews and other feedback mostly did not comment on the difficulty of the game and the ones that did included cases of both the game being perceived as difficult and easy. This was interpreted as an indication of the challenge level being appropriate for the average player which was the goal. The player adjustable difficulty modifiers had been removed in the full release version in order to implement the progression to the structure of the game. However, the new system still allowed weaker players to progress in normal mode by improving their heroes with several full or partial playthroughs of the normal mode while stronger players could experience higher challenge level by defeating the hard mode earlier with less levelled heroes.

The balancing of difficulty or challenge for the release version was generally considered a success although the last third of the campaign would be made more difficult in post-release updates and one hero was more powerful than the average and would need to be adjusted.

In feedback of the release version the unimportance of positioning of the player's heroes was not prominent like it had been in earlier feedback. Because of this it was assessed that the latest additions and changes had addressed the longstanding issues and offered a satisfying amount of meaningful choices. Feedback from closed testing and Early Access had been invaluable in the development of this area.

Insufficient length of the game or lack of replayability wasn't as common a complaint as it had been during early access. There were also no mentions of the game lasting too long, so the length of the game was determined to be appropriate. There were also no mentions of timing issues between the different parts of the game.

## 4 Conclusion

The thesis work documented the process of balancing a video game from decisions made during pre-production to adjustments made after full release. The work highlights the importance of planning the technical foundation for balancing early in the production and considering the balance implications of all changes and additions at every stage of the development. The thesis demonstrates the wide scope of different balance considerations and describes the problem solving and decision-making needed to balance a game.

The assessment of the success of the balancing work is limited by the informal nature of the collected feedback. Due to lack of resources, most of the feedback was gathered from a variety of sources including steam reviews, gameplay footage, forum posts and Discord discussions. Balance changes were also not the only variable between different game versions as the game was under constant development throughout the thesis work and it was not possible to have parallel productions for comparison where the balancing approach used in this thesis work would not have been applied.

During the development it became clear that it would be very beneficial to have a dedicated team member working full time on game content and balancing through the entire development. This would have allowed more consistent balance especially during Early Access and it would have made it easier to recognize balance issues with new content such as abilities and items even before that content had already been fully produced and added to the game.

The post-release development of the game would include updates to remaining balance issues that had so far been missed like individual items, heroes or quests that were outliers in terms of challenge or meaningfulness of choice. Development of possible future content would be greatly assisted by the established balancing principles and formulas.

Balancing methods and best practices are areas that would benefit from more research in non-commercial projects where comparisons between different



approaches to the balancing process would be more meaningful and results could be collected in a more controlled manner.

With knowledge of the balancing process and the different types of balance, a game developer can recognize the balancing challenges and approach them with a better understanding of what they are trying to achieve. By taking the balancing into account from the start of production and considering it at every stage, the developer can recognize and solve possible balance problems early.

By efficiently shifting the focus of balancing work from making a technical foundation and deciding principles in early production towards more practical and formulaic content balancing in late production, the developer can avoid wasting time and resources by mistakes such as fine tuning a constantly changing system in middle of the development, or leaving establishing of the balancing goals and principles to very late in development when the produced system may turn out to have fundamental balance problems that cannot be solved by simple adjustments.

## References

[1] Jesse Schell. *The Art of Game Design: A Book of Lenses*. Burlington, Massachusetts: Morgan Kaufmann Publishers; 2008. 171-205 p.

[2] Chessgames.com. Chess Statistics [Internet]. Chessgames Services LLC; [unknown date] [cited 18 September 2022]. Available from: <http://www.chessgames.com/chessstats.html>

[3] Edward Winter. The Value of the Chess Pieces [Internet]. Edward Winter [updated 14 May 2022; cited 18 September 2022]. Available from: <https://www.chesshistory.com/winter/extra/value.html>

[4] Patrick Honner. Why Winning in Rock-Paper-Scissors (and in Life) Isn't Everything [Internet]. Quanta Magazine, 2 April 2018 [updated 3 April 2018; cited 18 September 2022]. Available from: <https://www.quantamagazine.org/the-game-theory-math-behind-rock-paper-scissors-20180402/>

[5] Ensemble Studios. *Age of Empires* [Video game]. Redmond, Washington: Microsoft; 1997.

[6] Firaxis Games. *XCOM: Enemy Unknown* [Video game]. Novato, California: 2K Games; 2012.

[7] Red Hook Studios. *Darkest Dungeon* [Video game]. Vancouver: Red Hook Studios; 2016.

[8] Zynga. *FarmVille* [Video game]. San Mateo, California: Zynga Inc.; 2009.

[9] Silver Dollar Games. *One Finger Death Punch 2* [Video game]. Silver Dollar Games; 2019.

[10] Flashback Games. *Panzer Corps* [Video game]. Epsom: Slitherine Software; 2011.

[11] Capcom. *Street Fighter II* [Arcade game]. Osaka: Capcom Co., Ltd.; 1991.

[12] Namco. *Tekken* [Arcade game]. Tokyo: Namco Limited; 1994.

[13] Namco. *Time Crisis II* [Arcade game]. Tokyo: Namco Limited; 1997.

- [14] Mojang. Minecraft [Video game]. Stockholm: Mojang AB; 2011.
- [15] Nintendo EPD. The Legend of Zelda: Breath of the Wild [Video game]. Kyoto: Nintendo Co., Ltd.; 2017.
- [16] Andreas Krassnigg. Why All Roulette Combination Bets Are the Same (Explained) [Internet]. Graz: Mag. Dr. Andreas Krassnigg; [date unknown] [cited 18 September 2022]. Available from: <https://computingskillset.com/game-analysis/why-all-roulette-combination-bets-are-the-same-explained/>
- [17] Greg Walker. Poker Mathematics [Internet]. Sheffield: ThePokerBank.com; [date unknown] [cited 18 September 2022]. Available from: <https://www.thepokerbank.com/strategy/mathematics/>
- [18] Curt Johnson, Robert Donner. Microsoft Minesweeper [Video game]. Redmond, Washington: Microsoft; 1990.
- [19] Infinity Ward. Call of Duty: Modern Warfare 2 [Video game]. Santa Monica, California: Activision Publishing, Inc.; 2009.
- [20] Adam Kwapiński. Nemesis [Board game]. Nottingham: Awaken Realms; 2018.
- [21] myTrueSound. Kilta [Video game]. Turku: myTrueSound Oy; 2022.

