Black and White World game

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Abstract

Almost all modern video games use popular but overused gameplay mechanics. There are some original games being developed by independent developers. However not enough of these games focus on original gameplay, they tend to focus on story, music or aesthetically pleasing graphics. This project has focused on a new and unfamiliar gameplay concept. It consists of only black and white worlds with character(s) in each world. The negative space from one world defines positive space from the other, and every action that affects one world will likewise affect the other. The unfamiliarity of this will engage players to think in ways they never have before. This project will explore game play mechanics using this concept.

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Chapter 1

Introduction

1.1 Introduction to the concept

This computer game is based on the concept of two worlds. These worlds/zones are monochrome, one zone is purely black and the other is purely white. The black world is inhabited by a white player, while a black player exists in the white world. The negative space from the black world defines solid matter from the white world and vice versa. It was decided that this game would take on the genre of a 2D co-operative platformer. Figure 1.1 shows this concept in its simplest form.

Using 2D graphics (as opposed to 3D) makes it very clear to the players what the effects their actions have on the world. In 2D you can see every part of the level at any given time, 3D requires the player to navigate themselves around to see every part of the world, thus making it harder to see the effects of their actions. Every action that affects one world will also affect the other, For example, a black block will appear in one world as solid matter that the black player collides with. That same black block appears as empty room for the white player to move in. Moving this block clears obstacles in the black player's world whilst opening additional paths for the white player. This idea of modifying the playable space works best as a co-operative game. If the game was competitive rather than co-operative, then you could get into situations where you had to wait for your opponent to make a move

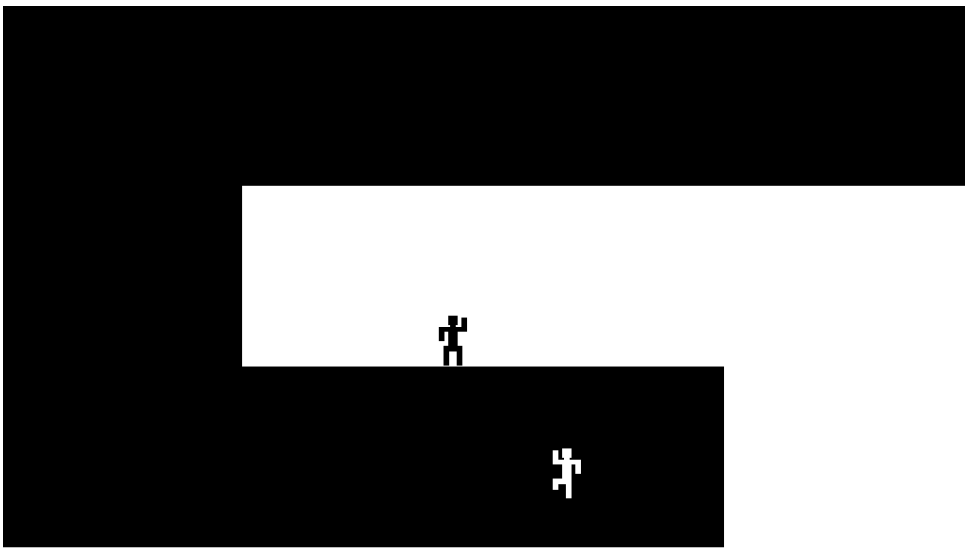

Figure 1.1: Solid matter in one world defines negative space in the other.

and unknowingly open up a path for you. If they are thinking the same thing, then both players would end up waiting for their opponent to make a move, this would obviously make for a very boring game. Instead if the game is co-operative, both player's involve helping each other , so a co-operative gametype was chosen.

Typically when someone plays a platformer, they make mental notes on which parts of the level count as solid geometry and ignore everything else. This game untrains the player to think in this way as negative space is now used as solid geometry. For the sake of this report this game will be referred to as Negative Space, though the final name hasn't been decided yet.

1.2 Motivation

Unlike the film industry, the gaming industry is led in sales by a select few gaming franchises such as Grand Theft Auto, Battlefield and Call of Duty [1]. These Games are referred to as AAA games, these game have high development costs

and are pressured to maximise profits, and to do this they need to appeal to the widest playerbase possible. To appeal to this playerbase, AAA games have little room for experimenting. Changing the game too much can alienate the playerbase resulting in poor sales [2]. So to play it safe, AAA games keep their changes from sequel to sequel minimal and only take ideas that have been proven to work from other successful games [3]. Two somewhat different games will take ideas from each other until they end up being identical. This results in games being too similar to each other [4]. The lack of innovation is boring to long time gamers. It is widely accepted in the vocal gaming community that the first version of the game 'Portal'(2007) was the last innovative AAA game, which was released in 2007, 8 years ago. On the other end of the AAA spectrum are independant games (indie games). Indie games are not pressured by publishers to maximise profits so they have alot more freedom and opportunity for innovation. Unfortunately these indie games usually blend existing concepts togethor, rather than creating brand new ones. For example, the game 'Secret Ponchos' developed by Switchblade Monkeys [5](2014). Secret Ponchos is a competitive twin stick shooter. Competitive games are not new. Twin stick shooters are not new. The combination is fairly unique but the actual gameplay is no different from any other twin stick shooter. Negative Space is about exploring new gameplay and not just combining old ones.

1.3 Approach

The aim of this project has been to explore gameplay mechanics that would work well with this black/white concept. According to Daniel Cook (2006), "Game mechanics are a shape different from rules, they are constructs of rules or methods designed for interaction with the game state, thus providing gameplay" [6]. In the case of Negative Space, the mechanics include but are not limited to the in-game objects and how they can be used to manipulate the worlds. Before implementing mechanics in GameMaker, they have been sketched and had story boards created with traditional pen and paper.

Since this project has been highly experimental, it was seen to be wise to choose software that can quickly create these game mechanics. This is why GameMaker Studio was chosen. Generally GameMaker is excellent for creating basic features very quickly, although other engines such as Unity2D are better for making more advanced features and fully fleshed out games.

Chapter 2

Background

2.1 Related Work

Negative Space is controlled just like any other 2D sidescroller game. In sidescrollers the player views their character from the side, The player has controls to move the Character towards the left ot right side of the screen, they are commonly able to jump. The most obvious example of this is the Super Mario Bros. first developed by Nintendo R&D4 [7] in 1985, This game's first level can be seen in Figure 2.1. In Super Mario, the player takes control of the Mario character and moves to the right of the screen, as Mario approaches the right side of the screen the level scrolls with Mario. Mario can jump over Piranha plants, jump on Turtles and Goombas but may fall into pits. The objective is to reach the Castle to the far right to rescue Princess Peach. In Negative Space the player will control character/s by moving left and right, jumping and interacting with objects such as switches and Movable Blocks. Unlike Mario, Negative Space's levels will not scroll to the left or right, This was decided for reasons that will be discussed in Section 3.

Negative Space is a game in Black and White, there are some other games that share this aesthetic. Limbo, developed by Playdead [7] in 2010. Figure 2.3 shows the games black and white aesthetic. The difference is Negative Space uses only Black and White, while Limbo uses these colours and every shade of grey in-between. Limbo uses these colours purely for aethetic reasons, the silhouettes it

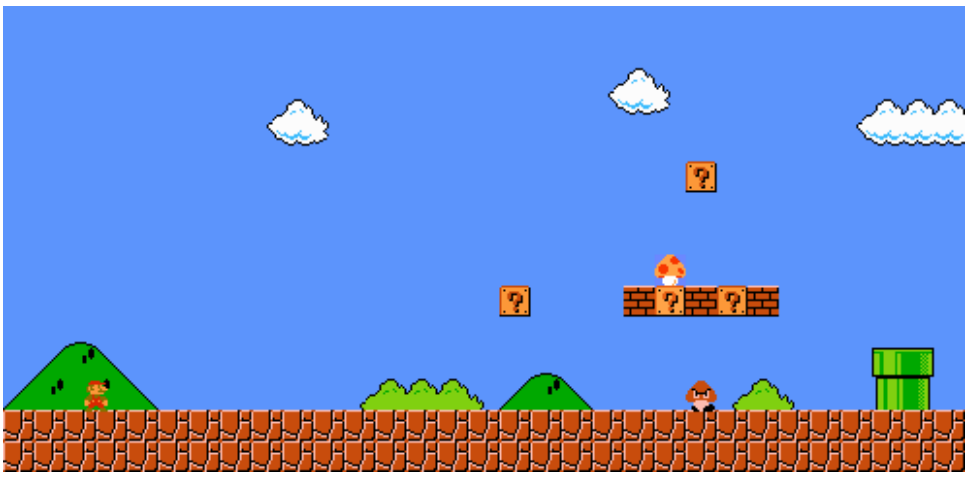

Figure 2.1: A screenshot taken from Super Mario Bros. A traditional 2D sidescroller.

forms create a very pleasant unique art style in games. Negative Space does not just use black and white as as its style, it also uses them for gameplay purposes.

There have been other games that play with the idea of two or more worlds, the most notable one being 'The Legend of Zelda: A Link to the Past', developed by Nintendo EAD [8] in 1991. In this game the player takes on the role of Link in the 'Light World' from a top-down perspective. As the player progresses through the game, they acquire a Magic Mirror that allows them to teleport into the 'Dark World' as seen in Figure **??**. The player must navigate between these worlds to find equipment so they can progress through the game. Some paths can only be taken in one world and not the other. In context to Negatice Space, these worlds usually do not affect each other, cannot be seen simultaneously and the player navigates between both worlds.

Another more recent example of multiple worlds is in the game Guacamelee!, developed by Drinkbox Studios in 2013 [9]. In this game the player gains the ability to transport between the 'land of the living' and the 'land of the dead'. This is required for solving puzzles and fighting enemies that can only be attacked in a certain world. The worlds are handled differently than in A Link to The Past, this

Figure 2.2: A screenshot taken from Limbo. Note the Black and White aesthetics

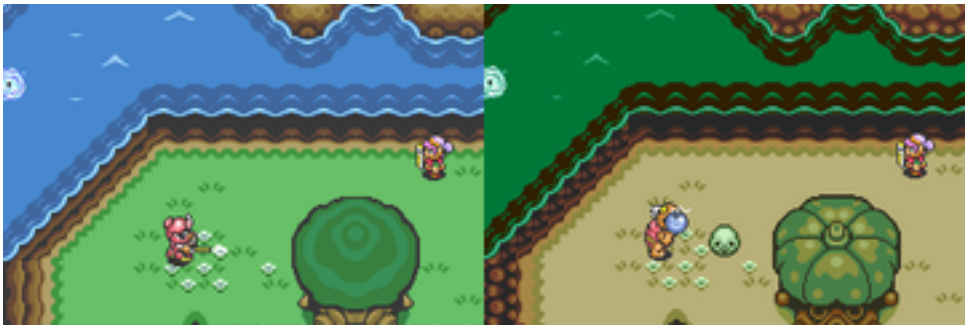

Figure 2.3: Screenshots taken from 'The Legend of Zelda: A Link to the Past'. Both shots are taken in the same location. The left screenshot is in the 'Light World' and the right screenshot is in the 'Dark World'.

time the player can see shiny outlines of geometry from the other world as shown in Figure 2.4. Players can switch between worlds instantly, even mid jump. This typically means the Player needs to switch between worlds as they jump from a platform in one world to different platform in the other. The worlds overlap each other and both can be seen simultaneously. However actions that take place in the land of the living do not affect the land of the dead.

The co-operation aspect of Negative Space is handled similarly in many games including Portal, specifically the two player levels of Portal 2, developed by Valve [10]

Figure 2.4: A screenshot taken from Guacamelee!, the sparkling outline highlights the geometry that changes between both worlds.

in 2011. In the co-op test chambers of Portal 2, each player is equipped with a portal gun. The Portal guns shoot portals/holes on specific surfaces, a player will walk through one portal and appear out of another. The two Players work together and help each other reach the final room. In many games, playing co-operatively makes reaching the goal an easier task, In Portal and Negative Space it is necessary to reach the goal.

Many games have their levels designed in a way so that the player can not get into a state where it is impossible to complete the level, it would be frustrating to the player if they unknowingly get into an unsolvable state and spends time trying to solve an unsolvable puzzle. This idea is more complex in co-op games because the game needs to be designed in a way so that the co-op players can not get too far from each other, they must always be able to re-group. At any point in the puzzle, the players need to be able to undo/retrace their steps one way or another. In Portal 2 there is always a way to retry the test chamber without needing to select retry in the pause menu.

Chapter 3

Design

Negative Space will take the form of a two player game where players will need to work co-operatively to solve puzzles. Each games mechanic has been sketched and story boards were made before they were coded and tested in GameMaker. Only mechanics that modify both worlds were implemented, as these mechanics challenge the player to solve puzzles and encourages co-operation. As a puzzle game it is necessary to keep the player engaged, if the puzzle is too easy the player will go into auto-pilot and it will feel less like a game and more like work. However, if the puzzle is too hard then the player is more likely to give up. Puzzles are meant to be solved so there should be sufficient clues to assist the player. If the puzzle is too difficult then it would feel like the game is trying to beat the player, which increases the chances of it being put down. Unlike the game mechanics, paper prototyping was not necessary for puzzles. Negative Space's objects have been built to allow quick assembly of new puzzles by dragging the desired objects into each room and can be tested without the need for any code, assuming that the mechanics have been implemented correctly. GameMaker can function as a drag and drop level editor. Every mechanic in this game will need to be made twice, once for the black world and once for the white world. This report will cover the black versions.

Figure 3.1: Many designs for the playable character, including different poses.

3.1 Mechanics

Designing game mechanics for Negative Space involves some degree of creativity, ideas for game mechanics come and go so it is important to quickly record ideas. For this step the traditional pen and paper has been used. Thought needs to be put into each mechanic to make sure it does not overpower the effects of other mechanics rendering them useless. As more and more mechanics were implemented it was decided that each game mechanic can benefit both players in some way. The reason for this is that it encourages co-operative play. For example, a situation where the black player can not make any progress because his path is blocked by a pushable black block; while at the same time the white player has hit a dead end. In this situation, when the black player pushes the block, it will fall into the hole. This action clears the path for the black player and opens a new way for the white player, thus this mechanic benefits both players whilst encouraging teamwork.

3.1.1 Player Character

It is important to design the player controlled character first. The movement needs to feel right because the user will be controlling them directly. If controlling the character feels slow and clunky then the whole game will feel slow and clunky.

Levels need to be designed with the character's abilities in mind. Parameters such as jump height need to be taken into consideration in a level which will require jumping. In this game the player will have a jump height of just over one block. This will make it clear to the player that they can comfortably jump up one block with some room for error but not be able to jump up two blocks. This jump height is taken into consideration when designing each level.e.g. A wall needs to be at least 2 blocks high so the player can not jump over it.

After some preliminary testing with the character it was clear that the character had too much control in the air. The player could instantly stop and turn around mid air, this is bad because it allows the character to move in unrealistic ways, which is not immediately clear to the player. It has since been changed so the player's mid air movement has been limited to reflect real life physics.

At first the character had a very curved look, but some feedback from a graphic designer highlighted how the character's curved look clashed with the rest of the boxy look. So the character was changed and the newer design uses only 90 degree angles. Figure 3.1 shows many designs of the playable character. The final design can be seen in Figure 4.2.

3.1.2 Ball

This is the first mechanic that was made into the game as a minimum viable product, ironically it is the only mechanic that made it into the code which was finally left out. The black player can push the black ball by moving into it. Once the ball is pushed over the hole it will fall in and become a black square. The white player, previously trapped can now move through where the black ball landed. Figure 3.2 shows the initial designs for how this would look in the game. This mechanic has been removed from the game for many reasons. Its style does not fit in with the rest of the game. Every other surface has been made of completely straight edges and the ball's round shape clashes with this. The ball object was chosen to be round so

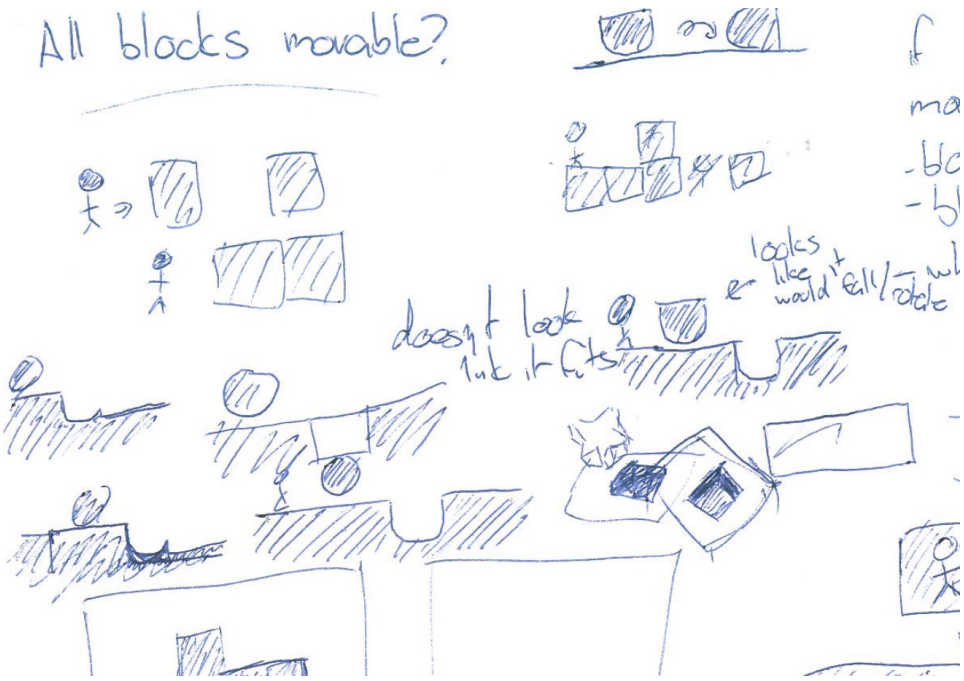

Figure 3.2: Sketches that show what the Ball and Ball pit could look like. Note the different shapes of the ball and ballpit.

that it looks like it can be 'pushed' or 'rolled' by the player. Another reason is that the balls circular shape becomes a square (The square look is necessary because it needs to look like the white player can pass through it), this looks odd because it does not seem like it should. This relates to the classic baby's toy, the toy that involves a baby pushing a star shape through the star hole and the square shape through the square hole, but in this case we are pushing a circle shape through a square hole. It just does not look like it would fit. Another reason is that once the balls becomes a solid square, the process can not be undone. To make the game less frustrating for the players, they need to be able to play around with the objects and know that whatever wrong move they make, that they can always reverse it.

3.1.3 Elevator

This mechanic involves player/s activating a switch/button that will move an otherwise immovable block/s to have access to more areas. The first version of this elevator works by extending a block upward. In the first version the activation switch had not been implemented yet, so it was just assigned to a key for testing

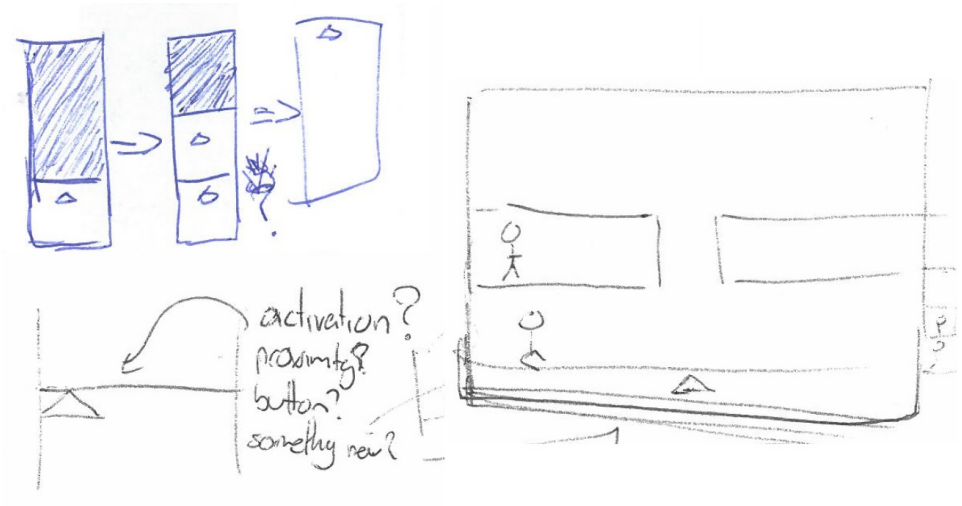

Figure 3.3: Sketches that show what the first version of the elevator could look like. The Triangle was intended to differentiate from other blocks, it was decided as being too obtrusive and changed to a straight line in the current version.

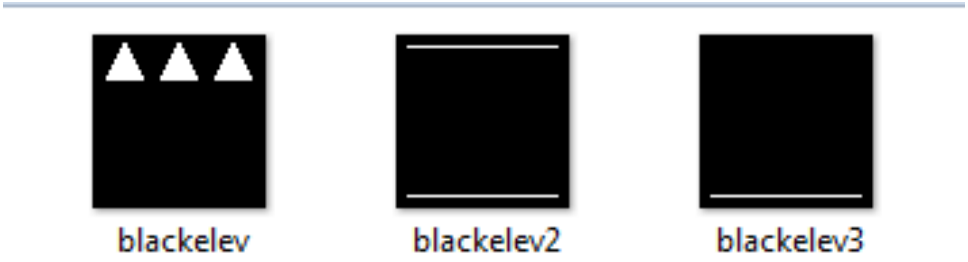

Figure 3.4: The graphics used through out the elevator's development.

purposes. The black player can stand on top of the elevator and ride it up as it elevates, once elevated the white player can now move through the black space created by the elevator. Therefore this mechanic benefits both players. This elevators initial sketches are shown in Figure 3.3. However the elevator has been changed since then. The newer version is simply a block that moves up/down, this time it does not create black area underneath itself. This elevator was chosen beacuse now the black player can go under the raised elevator and the white player can ride up the elevator as it now has a floor. The elevator has gone through a few graphical changes. At first it looked like any other ordinary block. This was changed when movable blocks were added [Section 3.1.4]. With this new block it was possible to block the

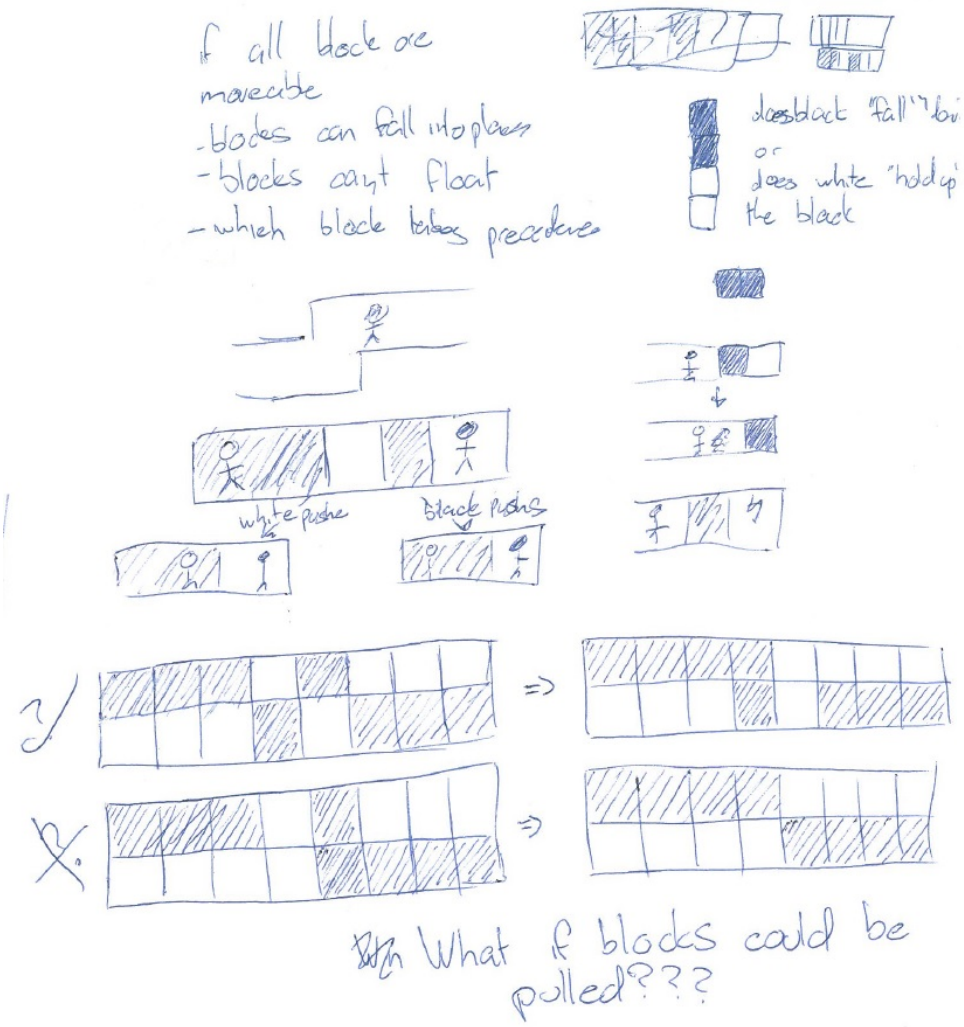

Figure 3.5: Sketch used to contemplate whether or not all blocks being movable made sense.

elevator and prevent it from moving, if this happened then nothing would happen if the player flicked the switch. This could confuse the player as they would have no idea where the elevator was and why it was not moving. The second graphic of the elevator has a wavy roof but this time it looked odd when anything rested on top of it. The third graphic features simple white lines on the inside of the elevator, the lines do not appear as if they would have any effect and are there to simply distinguish the elevator. These sprites can be seen in Figure 3.4.

3.1.4 Movable Block

A lot of thought was put into having movable blocks. One initial idea was to have every block that made up a level pushable. After further evaluation this idea it was apparent that this does not make sense. The blocks need to be susceptible to gravity, but due to the concept of two worlds it is unclear how this could work. For Example, when a black block was positioned above a white block, would the black block fall down into the white block (because white represents empty space in the white world), or would the white block hold up the black block (because black represents empty space in the black world). These ideas are shown in Figure 3.5.

Some blocks are movable, these blocks look just like any other block that makes up the level, but this time players can push and pull it, it is susceptible to gravity so it can be used just like the previous ball mechanic. The block was made square like all other blocks to make it clear that the white player can pass through it and the black player can jump on it to use it as a step to reach higher ground. Handles stick out of its sides to show that it differs from other blocks. At first the handles came out off the block at a 45 degree angle, they were later changed to right angles to match the aesthetic of the rest of the game. The handles have no collision and the idea is that they fold into the block when it is pushed up against a wall, this makes the block flush with the wall so it looks like the white player can move through it. Unlike the ball, the movable block does not change once it hits the ground, it can be moved after and may even be moved back up so the player can try using it somewhere else.

3.1.5 Falling Block

This mechanic consists of the previous Movable Block. As previously mentioned the block is susceptible to gravity and the white player can pass through the block. This mechanic comes into play when the block is falling while the white player is inside it. In this case the white player moves down with the block until it lands.

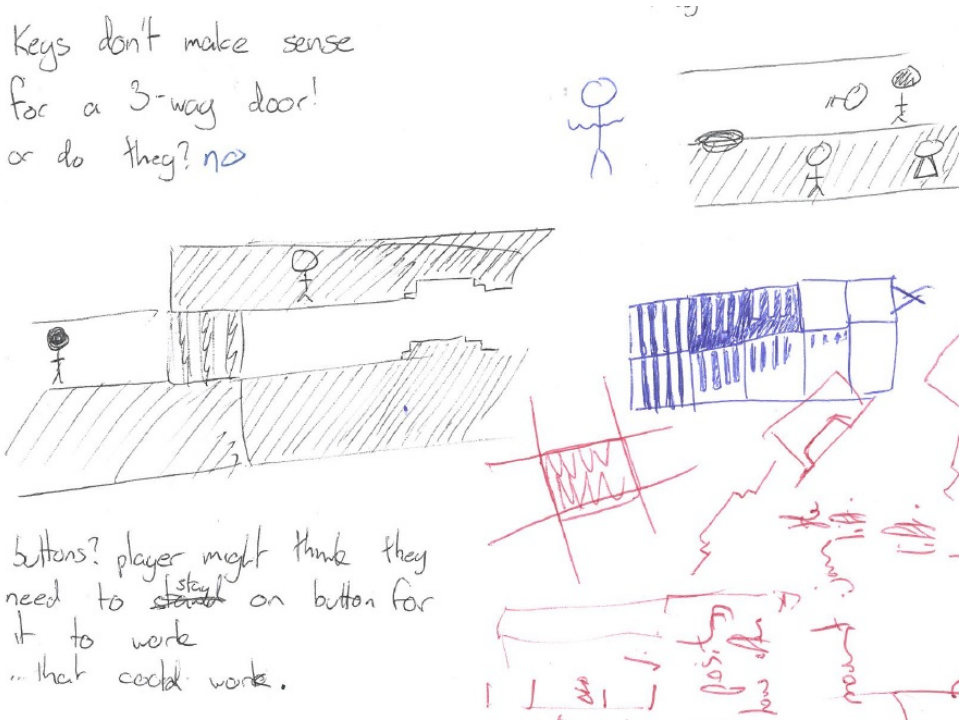

Figure 3.6: Sketches showing what the gate could look like. Note the strip on the right showing the open/closing animation, it needed to look like it was closing in one world but opening in the other.

This can be used to transport the white player from one area to another. The idea for this mechanic came up when implementing the movable block so there were no sketches for it.

3.1.6 Three state gate

The three state gate is a block that can switch between 3 states (closed for black player, closed for white player or closed for both players). Some thought has been put into how to open these gates. The first idea was to find and use a key on the gate, but this only works well with a regular 2 state gate. So the only 2 other options were switches or buttons. Switches are already being used for the elevator so buttons were chosen in a process of elimination. By using buttons, the player needs to stand on the button to control the door. Jumping off the button will close the gate again. Retrospectively this strengthens the decision to use buttons over switches as they require more cooperation. At first, the sprite for the gate was made up of vertical

bars, it could be viewed as black bars with a white background or white bars with a black background, so it fit in nicely in both worlds. The initial sketches can be seen in Figure 3.6. However when it came to developer testing it was apparent that the bars lost their look when the player wants to pass vertically through the gate. To fix this the gate needs to look identical when rotated 90 degrees. The current checker board sprite achieves this. It is now clear that neither player can pass through the closed gate, however it is still open to change because although its purpose is clear, it does not look like a real world object.

3.1.7 Screen looping

If the player walks off the bottom of the screen, instead of landing on the bottom they will pass through and re-appear at the top of the screen. This was decided to benefit the puzzle nature of the game. As mentioned earlier the player needs to be able to retry their actions and not be able to get in an unsolvable state. If a block is pushed off a platform there might not be a way to get it back up, with screen looping the block can be pushed further down and reappear at the top. Sometimes getting it back up will be a puzzle in itself. This screen looping will work on the left and right side of the screen as well to add more depth to puzzles. This idea was very clear so it was never sketched.

3.2 Puzzles

Once the mechanic had been decided, it was then time to design the puzzles. When a player first picks up the game, they will still be unfamiliar with how the mechanics work. Tutorials are very common in modern games, they involve walls of text that the player needs to read to understand how the game works. However many gamers are impatient and will skip these walls of text. They then get frustrated later when they don't understand what to do. To avoid this issue, the game needs to communicate its mechanics in a different way. One way is through level design. The levels can introduce these mechanics one at a time. The first time a mechanic

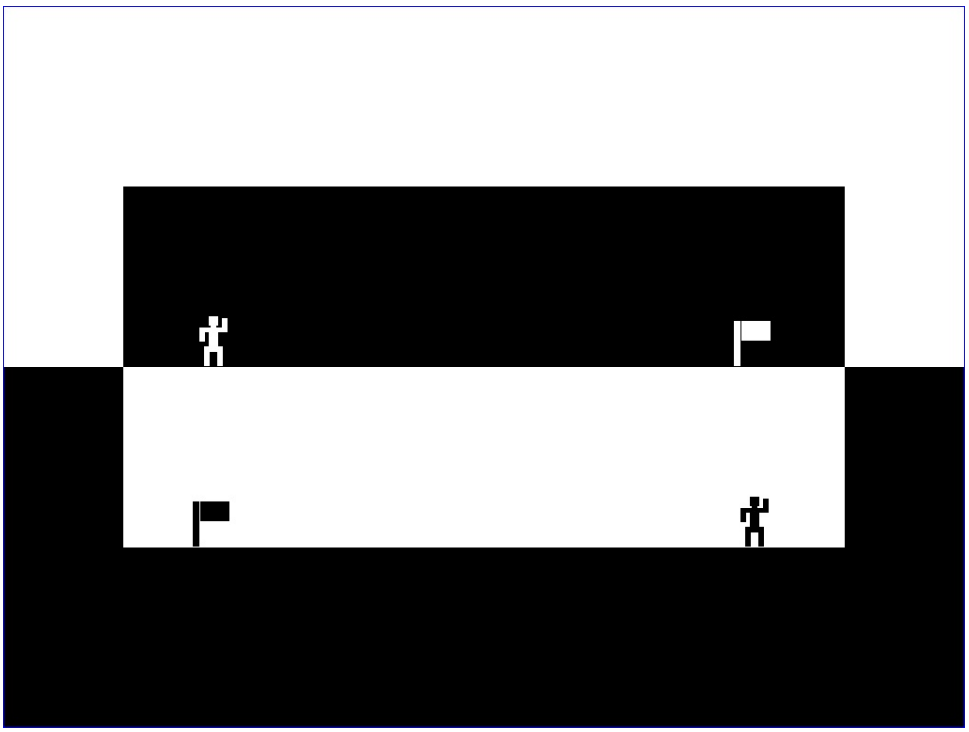

Figure 3.7: The very first level teaches the basics of movement and the goal of each level.

is used, it is best to show it in its simplest form. Following levels use the same mechanic in more difficult ways. This will further drive the mechanics into the players mind as well as allowing them to feel like they have mastered their new skill. In Negative Space the first level (see Figure 3.7) is simply a straight line to the finish for each player. This simple puzzle teaches the player the basics of movement, it shows that reaching both flags will complete the level. The next level will require both players to jump. Generally level will go in this order: Mechanic A easy, Mechanic A moderate, Mechanic B easy, Mechanic B moderate, Mechanic AB moderate, Mechanic AB hard. This pattern allows enough time for players to master one mechanic before learning another one, then reintroduces the older mechanic in combination with a newer one.

Using a whiteboard was the fastest way to design puzzles as it allows for the quick modifications that turn up frequently. Figure 3.8 compares a level's first design along with how it currently looks in-game.

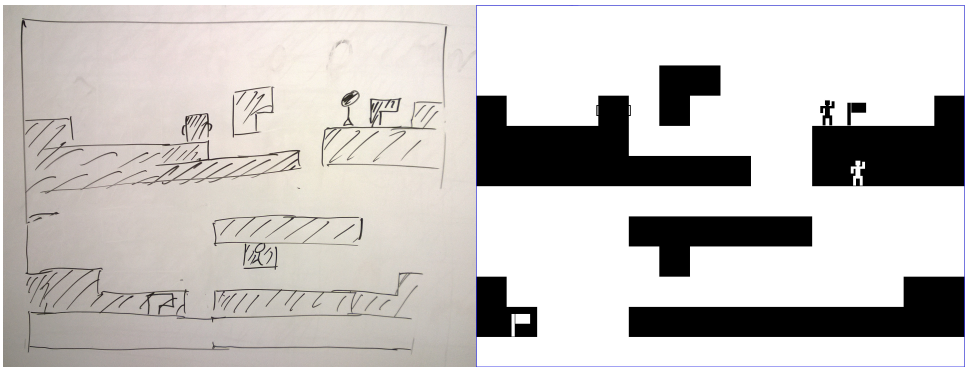

Figure 3.8: Left: A typical puzzle with its first whiteboard drawing. Right: The same puzzle made in the game. There are some adjustments made between the two designs.

Chapter 4

Implementation

4.1 GameMaker Studio

GameMaker Studio makes it easy to make puzzles once the mechanics have been made. In-game objects such as the movable block and the three way gate are coded individually. Objects are initially created by importing sprites. In Negative Space almost all sprites are 64 by 64 pixels. After a sprite is imported it is assigned to an object. The object can execute code based on events. For Negative Space's objects only three different events are used. The creation event is used to initialise variables which will be used in the step event. The step event is activated every frame (Negative Space runs at 60 frames per second); this is where the majority of code is written. It generally computes movement speed, gravity and interactions. This code will be explained in greater detail in section 4.2. And finally the draw event, which is used to draw additional sprites without affecting collision. Figure 4.1 shows the movable block's three events, its sprite, depth and parent. Each event calls a block of code, a portion of the Step event code can be seen in the background. Once the game objects have been carefully created, GameMaker's room editor is a great tool for creating each level. Existing objects can be dragged and dropped into a room to create a level without the need for additional programming. The YouTube channel by Shaun Spalding [11] has been very useful for learning to code in GameMaker. GameMaker has a very useful manual that that can be accessed by pushing F1 at

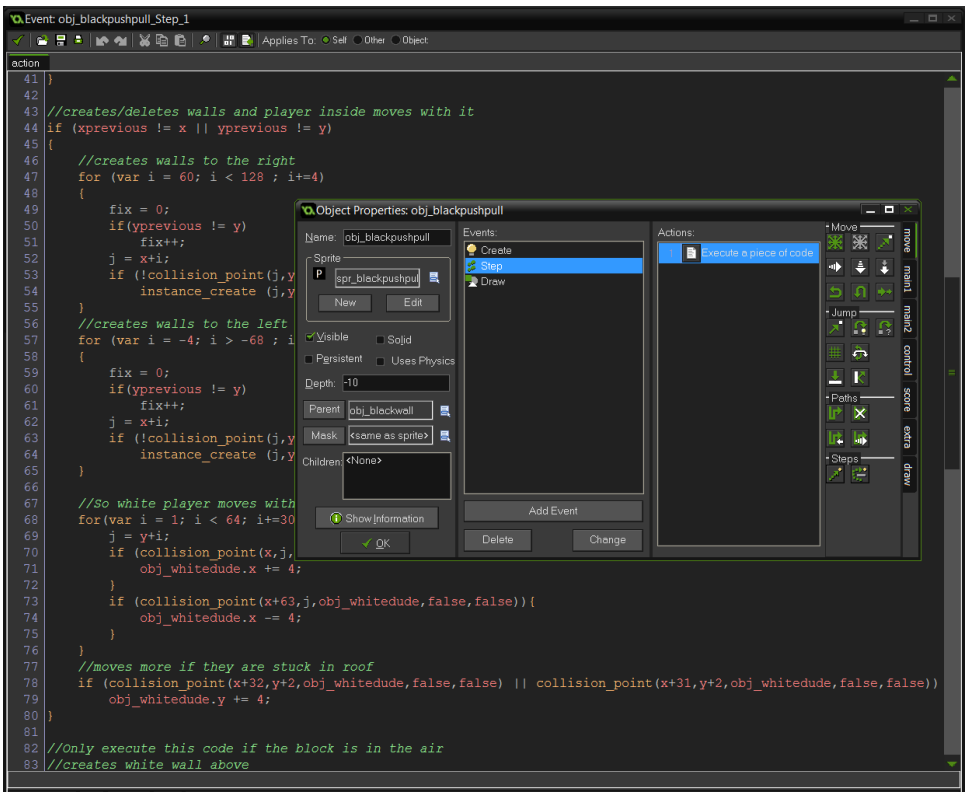

Figure 4.1: The Movable block object. A portion of the step event code can be seen behind the object properties window.

any time, clicking on index and then typing what you are looking for is a very quick way to find details on useable methods.

4.2 Mechanics

4.2.1 Player Character Movement

As mentioned in section 3.1.1, it is important to start development on the Player Character. The Character is represented by a 32 by 55 pixel sprite that animates based on the player's input. Variables are initialized in the create event. the create event calls a script that initialises variables such as jumpspeed, movespeed and states such as snapleft/snapright and grabbing, Both charcters use the same Create script to keep their movement identical. The variables were arbitrarily adjusted until the movement felt right as there really is no way to formally choose these things [12]. The concept of Finite State Machines was used to put the character in

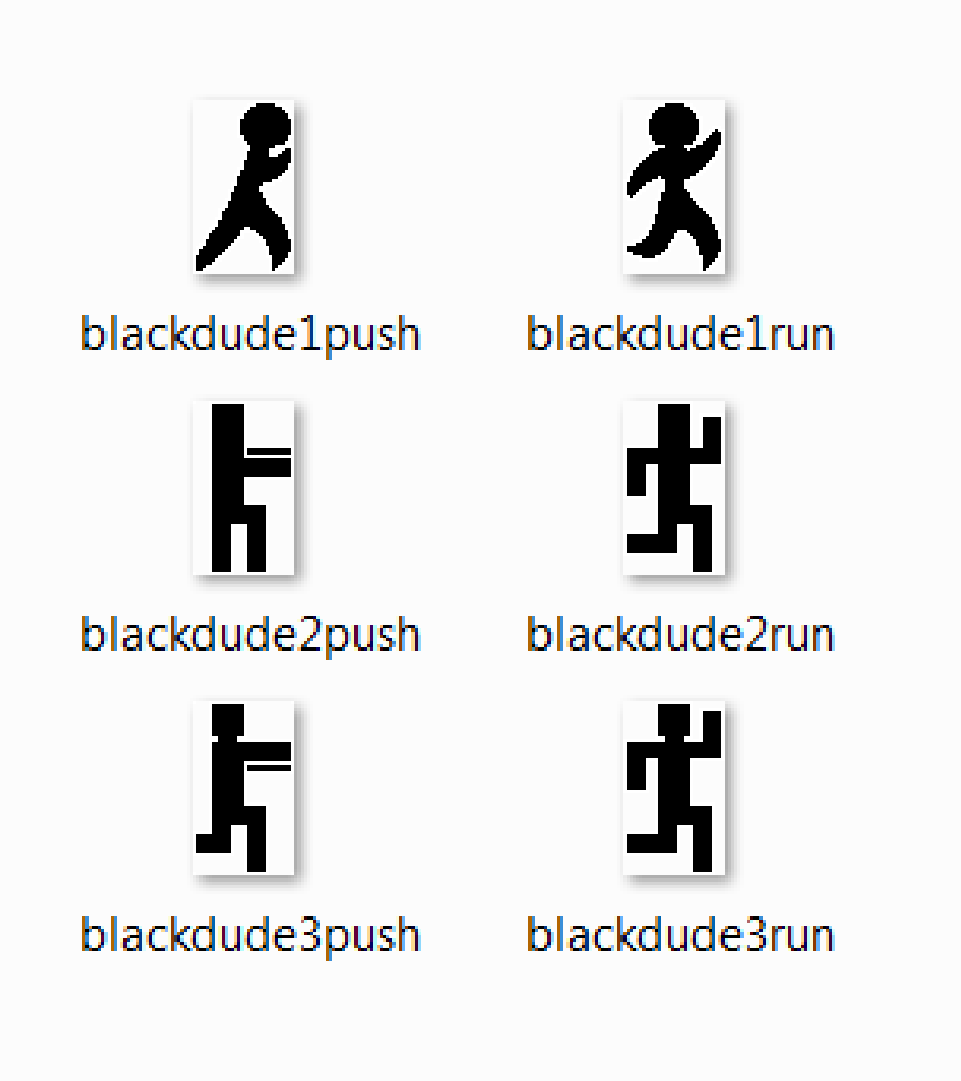

Figure 4.2: The Character has been through some changes based on outside feedback.

different states, specifially when interacting with the movable block, the character object calls a script, this keeps the code more readable and avoids needing to check other comparisions as they are irrelevant in the given state. In the first test version, the character movement was satisfying other than the amount of control mid-air. In the final version it takes the current horizontal speed and locks in this speed once the character is airborne. Pushing left/right only slightly toggles the horizontal speed. This was chosen so the player can still jump up a block even if the had no horizontal speed at the time of the jump. Otherwise the player would not be able to jump onto a block right next to them unless they had a running jump and did not collide with

the block. Currently the amount of mid-air control does not feel right and hasn't had further work on due to time constraints.

Negative space has a very simple collision hierarchy. The Black character collides with black wall objects. Every other black object (such as the movable block and elevator) inherit from the black wall object and therefore collide with the black character. All the main collision code in this game runs from inside the character's step event.

Many sprites were needed to create the character animations. These sprites help to let the player know what the character is doing. When the character is running, the character object uses a strip instead of a sprite. A strip is an image consisting of subimages, the strip cycles through the subimages each step. The result is a walking animation where the character looks like they are taking steps as they move across. If a character walks into a wall, the character's moving animation will continue. This was decided so the player knows that their inputs are still being registered. Figure 4.2 shows two different poses from the three different sprites implemented.

4.2.2 Ball

The ball object was the first mechanic coded in. The black ball has its parent set to be the blackwall. This means the black character collides with the ball without having to wright any additional collision code. The ball can be moved only horizontally or vertically but not both at the same time. This was decided so the ball can only fall and land whilst aligned to the grid. The ball can be pushed horizontally when the player aligns themself one a side of the ball and moves towards it. The Ball will fall once it no longer detects any walls of the same colour underneath it. It then starts falling and with a gravity variable it gains vertical speed. There is a maximum vertical speed put in place, chosen so that it can always be followed by the players eyes.

When the Ball was first made, the player moved horizontally at a linear rate

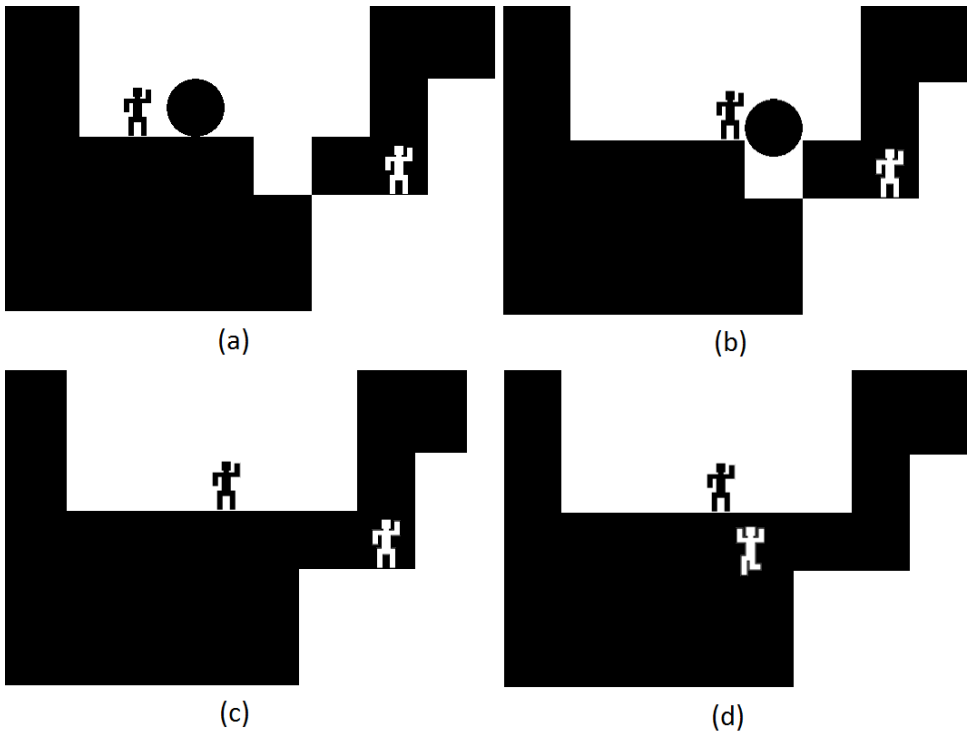

Figure 4.3: (a) The Ball sitting where it spawned. (b) The Ball is pushed into the pit. (c) The Ball hits the ground and squishes into a Black Block (d) The White Player Walks through the newly created Block.

and the ball was pushed at half player's speed, since then the players horizontal movement has been modified to make use of acceleration. Now whenever the player trys pushing this ball, it moves at a much slower rate. As mentioned in Section 4.2.1, this demonstrates how important it is to complete the characters movement first. Fortunately the decision to scrap the ball was made before the player's movement was expanded, so this did not impact development time. Figure 4.3 demonstrates this mechanic in action.

4.2.3 Elevator

The black elevator also has it's parent set to be the blackwall. It only moves vertically and uses a boolean to control which way it should move. The switch that controls the elevator works by changing this boolean. By default the elevator is set at its bottom position and will rise two blocks, this can be changed by modifying its creation code. By setting the boolean 'elevate' and the int 'addheight' the elevator's

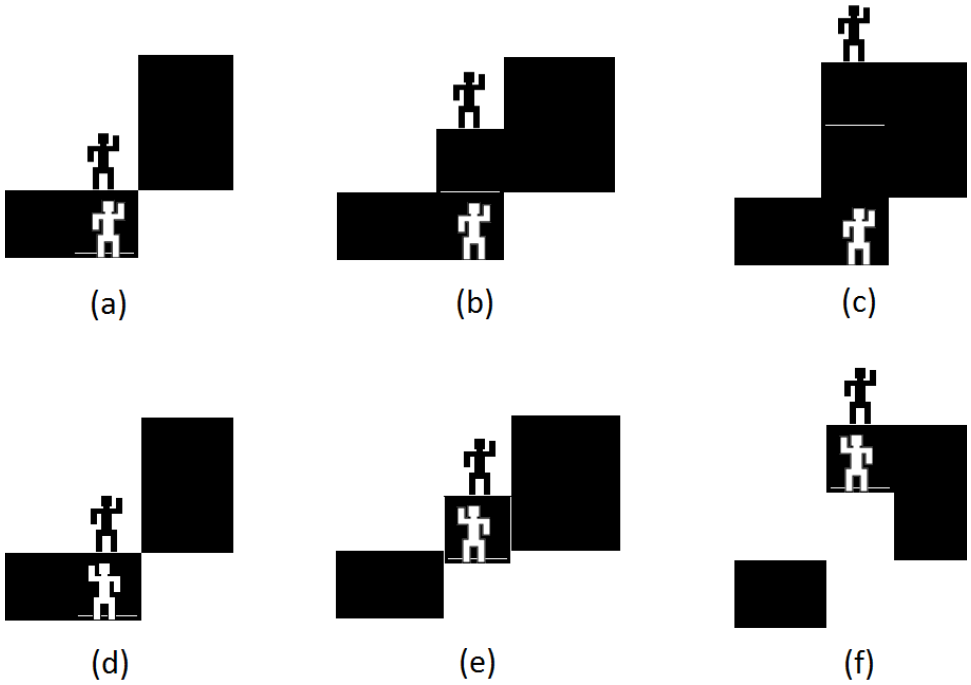

Figure 4.4: (a) The initial position of Elevator1. (b) Elevator1 halfway up. (c) Elevator1 reaches the top. The Black Player can move on providing he rode up with it. The White Player can now jump through, though this only works if they can jump high enough (d) The initial position of Elevator2. (e) Elevator2 halfway up. (f) Elevator2 reaches the top. The Black Player can move on providing he rode up with it, They can also go underneath it this time. The White Player can ride inside it, transferring them to a new area.

starting position and travel distance can be changed.

Due to the 'two worlds' nature of Negative Space, moving the elevator block is not enough to get it to work as intended. As it moves it needs to actively do two things. Firstly, the black elevator needs to delete the white wall objects that it is overlapping, this is necassary to allow the white player to move into the black elevator, otherwise the white player would collide with the underlapped white geometry. As a result, it needs to modify the white space above and below itself, the white blocks used to create the level are 64 by 64 pixels. The white block is deleted as soon as any part of it collides with the elevator, So as the elevator moves it would delete white blocks overlapping it and therefore around itself too as a side effect. To fix this, the elevator needs to create smaller white block instances above and below

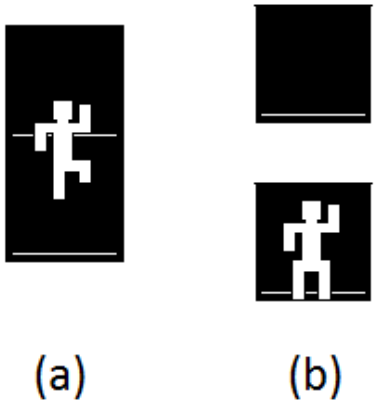

Figure 4.5: (a) The white character is halfway between two elevator blocks. (b) The white character is pushed down when the two black elevators seperate.

itself, these instances need to be small so they can fit between the black elevator and any possible black blocks. Figure 4.4 demonstrates this mechanic in action.

There are some cases that need to be specifically coded. One example is if the white player is in mid air with their bottom half in the black elevator and their top half in a black block as a result of jumping on the spot - see Figure 4.5. If the elevator is activated at this time then it moves back down taking half of the player with it. One way to avoid this issue is disable the elevator from moving in this situation, but that is no fun because it can feel like the elevator is non responsive even when the white player has only 1 pixel inside. Instead the white player will be pushed up or down depending on their current vertical velocity. This pushing happens very quickly, looks natural and does not cause a jerky motion.

4.2.4 Movable Block

The movable block was the most difficult to implement. Its first implementation had a few problems and had to be completely rewritten. The initial implementation worked entirely in the step event of the movable block. It required the player to be next to the block; The player had a variable to determine if they were currently grabbing a block. The block would toggle this variable and shifted itself as well

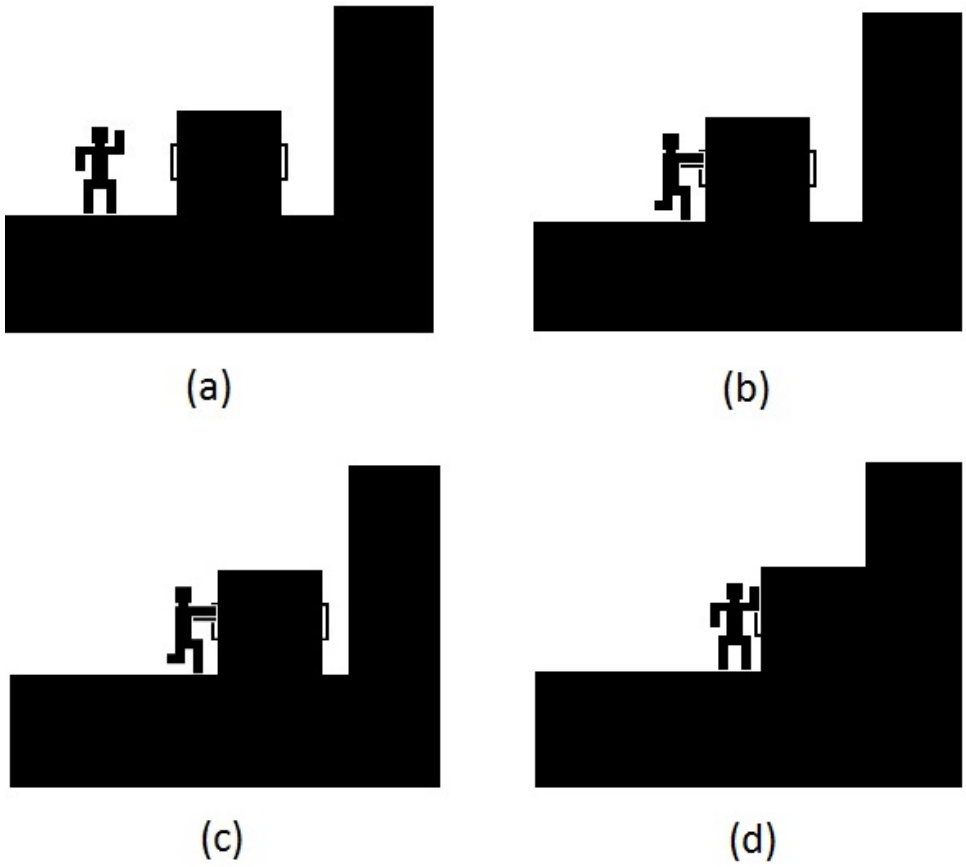

Figure 4.6: (a) The Block with the handles is the movable one. (b) The Player grabs hold of the block, They have not started moving yet. (c) The player pushes the Block towards the wall, The small gap between the Block and the wall is filled with smaller white wall objects created by the Movable Block. (d) The Movable Block is pushed as far as it will go, Its handles do not collide with the wall and it is clear that the White Player could walk through it.

as the character. At the same time it would create small wall instances in a similiar way to the elevator (explained in Section 4.2.3). Some collision checks were needed to be written to ensure the block and the player could not be pushed into a wall. The block is supposed to snap to every half block to make it easier for the player to line up the block necassary to do some of the tricks. However this snap code had some issues, for some unknown reason the player could leave the block mid snap and the block would continue to snap to its next place if the player touched it. This caused some glitches with collision. The worst issue was that sometimes the block moving would freeze the game, this freezing seemed random and was not reproducable.

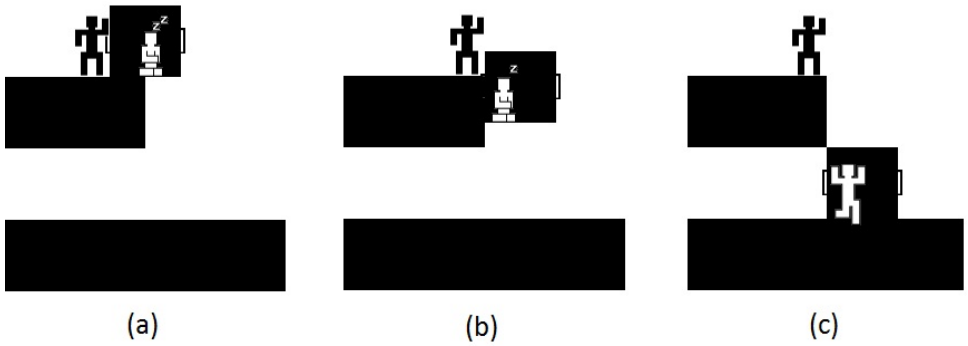

Figure 4.7: (a) The Block sits halfway over a ledge. The White Character sleeps in singleplayer mode when the Player is controlling the Black Character, this lets the Player know which Character they are currently controlling. (b) The Block is pushed off and begins to fall. An issue occurs here where the White walls are underneath the Block, preventing the White Player from moving. Fortunately there is nowhere for them to go anyway (c) The Block lands and the White Player falls through the new opened floor.

The freeze occured more often when a player backed up to a wall with it, but once again reproducing this freeze was inconsistent.

Some time was put into finding the cause of this error but it was ultimately decided that completely rewriting the block code was the best way to do it. This time the code for shifting the block was executed in the player object. The idea of Finite State Machines was used to organise the new code. The Player object calls a specific script when they grabbed a block. These scripts are isolated from the rest of the Player object code, so do not require as many other checks as before and it is now much cleaner code. The different states also change the character's sprite. When a player stands next to a block and pushes the use key, then the player object calles a script which put the instance in 'grab mode'. Now the movable block's step event code still modifies the underlapped and adjacent walls objects. This is further explained in Figure 4.6.

4.2.5 Falling Block

The falling block is the movable block but counts as a seperate mechanic. As the block falls, it would ideally delete any wall objects it collides with. However it is apparent that GameMaker does not let this work. As the block falls, not every wall it touches is deleted. By drawing the movable block as an outline it is clear what is going wrong. It seems to move the block correctly at every step, however there is an odd phenomenom occuring with the collided walls. They take time to be deleted and sometimes the block will have moved on without deleting the wall instance. This means that whenever the black block is falling with the white player inside it, the white player collides with the underlapped walls, then gets stuck in the wall. It is not clear why this is happening, but a work around has been made to fix this issue. The block only deletes underlapped walls when it is has not moved since the last Step. Otherwise, if the block has moved since the last step then it moves any inside players with it. Figure 4.7 shows this mechanic in action.

4.2.6 Three State Gate

The three state gate is activated by two booleans. These booleans are toggeled on when their associated button is being pressed. It works like an XOR switch, if both or neither buttons are pressed then the gate is closed. The gate only opens if one button is pushed. Figure 4.8 demonstrates this The gate itself has no collision on it and works by creating and deleting instances behind itself. A strip was used to create the opening/closing animation (Figure 4.9). A strip is an image consisting of many subimages, the subimage changed each frame resulting in an animation.

4.2.7 Screen Looping

When the player drops off the bottom of the screen they will loop around to the top. This works by modifying the player y coordinate, effectively teleporting them to just above the screen. This means that players will not be able to jump at the top to appear at the bottom, it was decided that this would not be a good idea as the

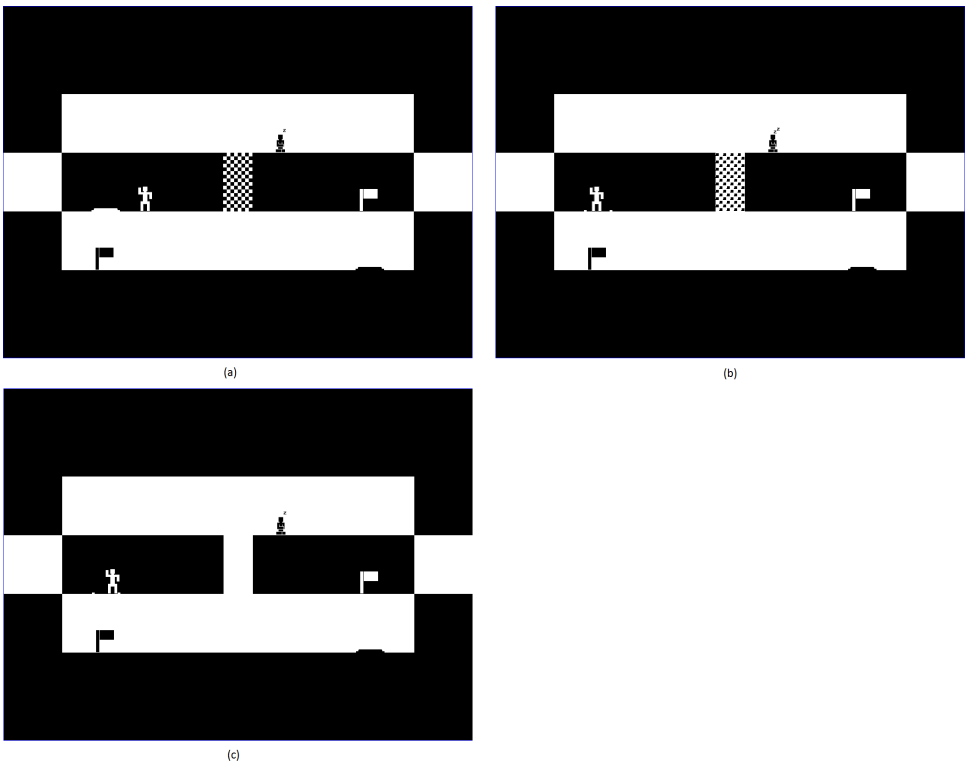

Figure 4.8: The level that introduces the 3 state gate (a) The gate is closed. (b) The White character steps on the button and the gate is opening. (c) The gate is now open for the Black character. If the black character steps on the black button, then the three state gate will turn black, allowing the white character the pass through.

character cannot jump that high anyway and the transition would not look clean. Looping around the left or right side of the screen works entirely differently. When a character walks over the edge of the right side, They create another instance of themself on the left side of the screen. This new instance is given the same horizontal and vertical acceleration so they move exactly in the same way. When the character walks fully out of the screen then it deletes itself. Figure 4.10 shows this duplication trick.

4.3 Puzzles

Once the mechanics have been implemented, it is easy to create the levels. GameMaker allows room creation, these rooms make up each screen in your game. In Negative Space this makes each level and the main menu. As mentioned earlier in Sec-

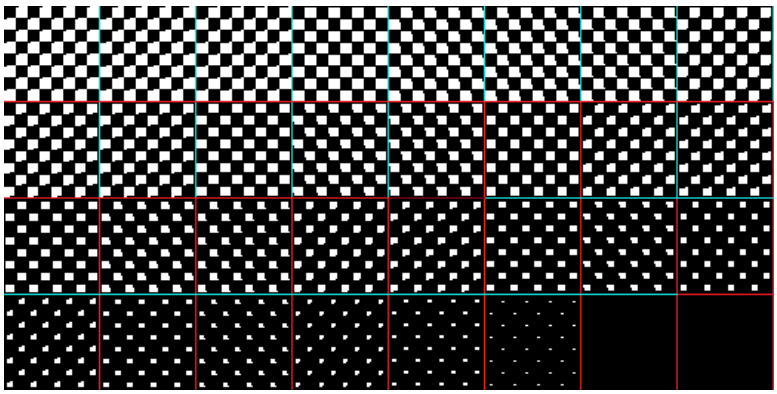

Figure 4.9: The strip used for the gates opening/closing animation.

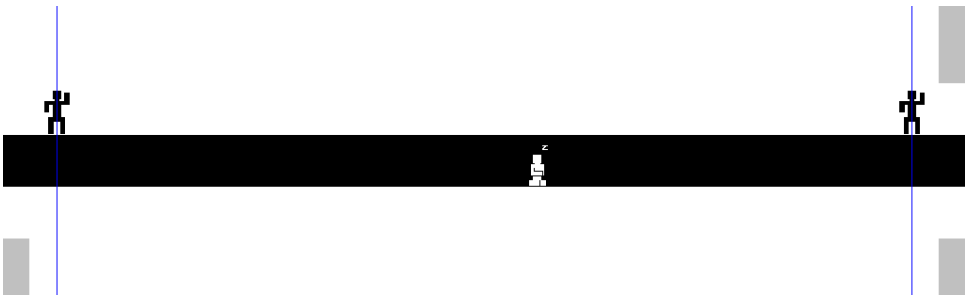

Figure 4.10: This is one of the developer test rooms. This room is zoomed out for demonstration purposes, the blue line represents where the edge of the screen would normally be. In this case the Black Character is on the left edge of the screen and copied to the right side.

tion 3.2, designing puzzles was done on a whiteboard, then the puzzle was created in GameMaker. As seen in Figure 4.11 game objects can be dragged into the level from from a list on the left. Objects can be snapped in place to a specified grid, Negative Space uses the default size of 32. The Movable block appears as a block with labeled ”P” (for push/pull). It’s draw event replaces this graphic with a black square and adds handles on its sides, the P makes it easier to differentiate from other blocks during level design.

When placing objects in the room editor, it is possible to give each instance some creation code. An invisible object called levelControl makes use of shortcut keys to change level in-game, It also makes use of creation code to control which level to go to after the current level is complete as shown in Figure 4.12. The eleva-

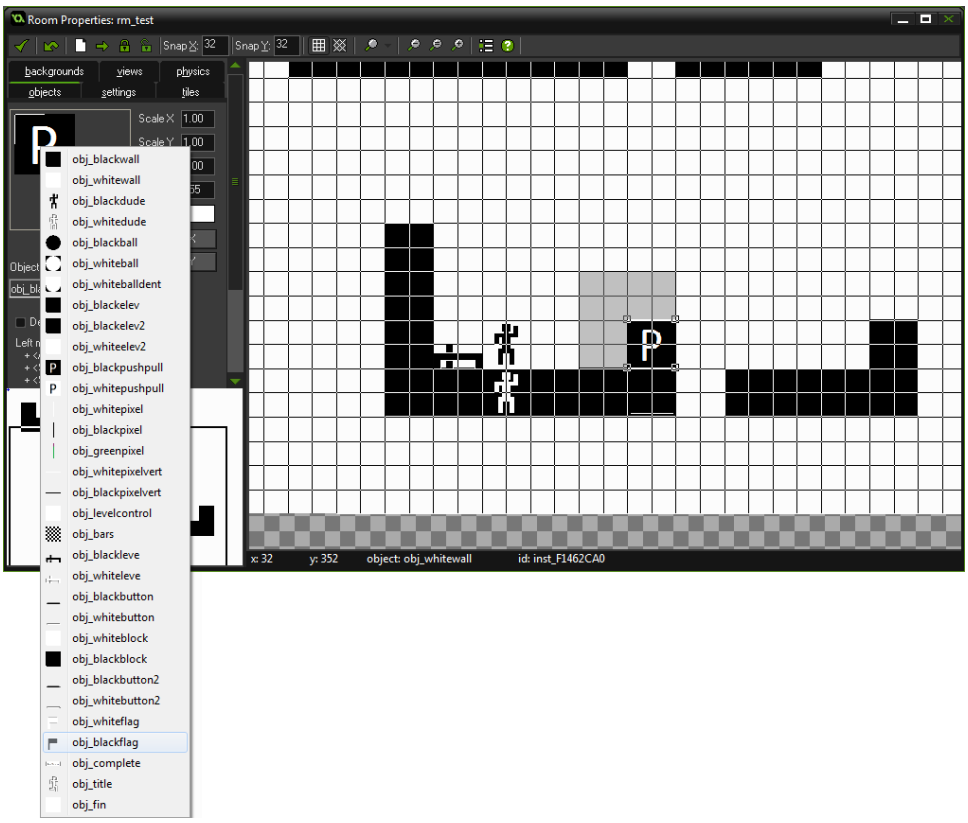

Figure 4.11: GameMaker's Room Creation GUI makes it easy to create levels.

tor object can be given creation code to determine its starting position and how far it travels.

One of the levels requires precise timing. It involves the white player jumping up some elevators. The black player uses the elevator switch at the wrong time then the white player is temporarily set back. The manoeuvre is too difficult to do in single-player because the player needs to quickly switch between characters, so the level has been left out of the single-player level rotation.

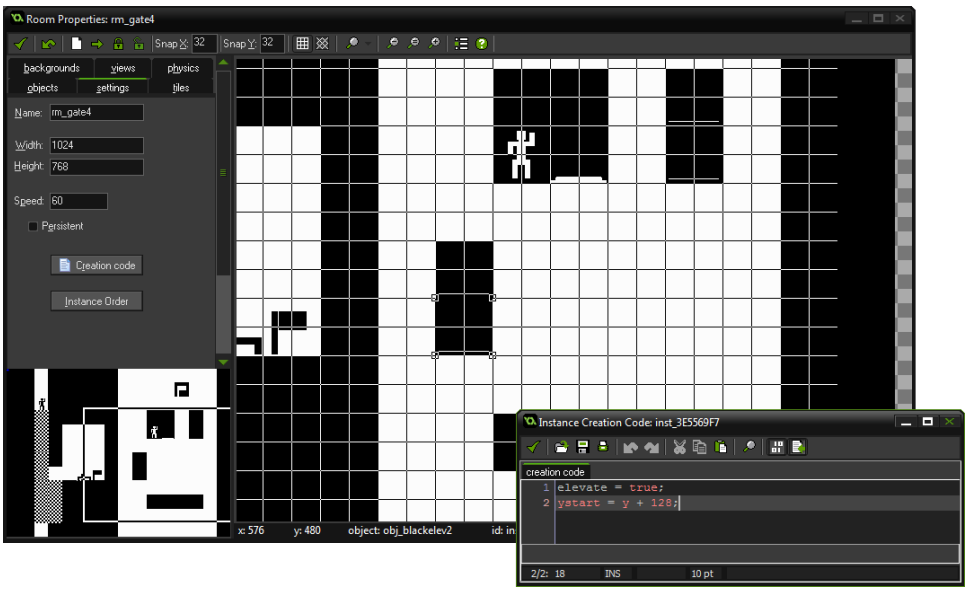

Figure 4.12: Giving object instances Creation Code.

Chapter 5

Evaluation

Unlike other software, the only way to evaluate a game is to play it. Negative Space needs to be fun and challenging. This is the only way that Negative Space can be considered a success. Each mechanic needs to be tested to make sure it works as intended. If these mechanics are going to be used together then they need to be tested together. An example of this is getting the black elevator to lift a black block. Code has specifically been written to accomplish this. Another example is what should happen when a white block is pushed inside a black elevator. For now puzzles have been designed in a way to make this impossible. It is very important to get the puzzles right, creating successful mechanics does not gaurantee successful puzzles.

5.1 Preliminary testing

A test room has been made for each mechanic implemented. This makes testing them quick. Figure 5.1 shows the level used to test that the falling block mechanic works as intended. In this example the white character can jump into the movable block and the black character can push the block left or right off the ledge, this room also tests that the looping mechanic works with the falling block. When this was first tested, The character appeared halfway in the movable block after looping. This was because the character's y position was being set too high when looping back to the top. Each test level was bound to a keyboard shortcut to allow instant access

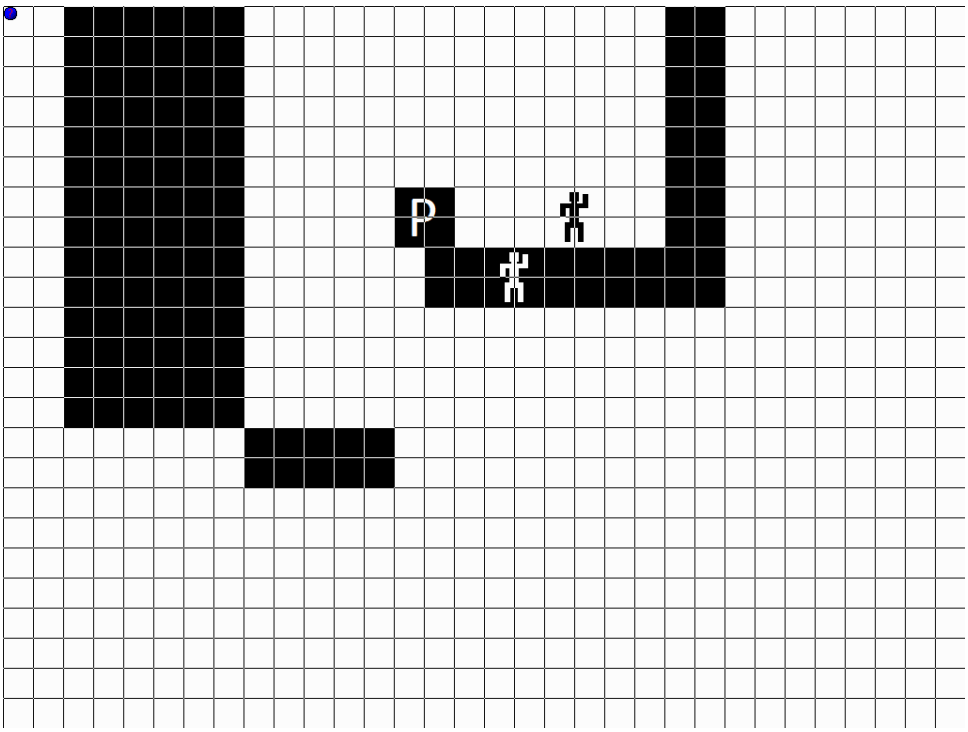

Figure 5.1: A level made specifically for testing the Falling Block Mechanic.

to it. Figure 4.10 mentioned earlier in Section 4.2.7 is one of the levels used for testing the horizontal looping mechanic. After mechanics were proven successful in the test rooms, it was time to design, create and test the Puzzles. Some more errors showed up that were not produced in the test rooms. Fortunately these were just errors in object's code and were quickly fixed.

5.2 User testing

User testing was carried out at The University of Waikato, R block during Week 12 of Semester A, 2015. An Ethical Consent Application was submitted and accepted prior to user testing, a copy of this application can be found in the Appendix. Advertising for testing sessions was put up around R block via posters and whiteboard drawings. Participants were free to turn up anytime during the testing timeframe. Chocolate and fruit were used as incentives for possible participants to turn up. 42 participants turned up over the 2 days. On arrival they were given a Participant Information Sheet and Consent Form to sign before they were allowed to start play-

ing. The Participant Information Sheet explained to them that their survey results would be anonymously used in this report, they were also told they could choose their chocolate insentive before or after the testing and leave the session at any time. This was said because one of the things being testing was how long they would willingly stay. Participants were then directed into the testing room and given a choice of using a Playstation 3, Xbox 360 or Xbox One controller when available. The controls were printed out on a sheet of paper in front of them. They were left alone to play to ensure they did not feel like they were being judged. There were some statistics being recorded in the background, these stats recorded were whether or not it was two player mode, the level name and how long it took them to complete it. These stats are used to figure out how many levels they completed and which levels were considered too hard. Once Participants had finished playing, they were given a short survey. Before Participants were handed the Survey, they were told to place their sheet randomly in the pile. They were left alone while filling the sheet in. Some Participants left additional notes on the Survey: “Prettygood, would play on Newgrounds”, “Some harder levels would be sweet”, “Use Thumbstick for number of players selection” and “Best Game ever. 10/10”. One Participant ticked the I’d preorder box but crossed out preorder and wrote “I’d buy release, probably full price”. Generally people seemed to really enjoy the game and the following survey results support this.

5.2.1 Statistics

Survey results are not the most reliable form of feedback, Sometimes participants may incorrectly answer the questions or even misunderstand them. Log files have been generated in the background as Participants play. These Log files record three things: if the game was played in single player or multiplayer, the time taken to complete each level and the level’s name. With this information it will be possible to see how many levels they played, which levels are too difficult and the completion time difference between singleplayer and multiplayer.

Figure 5.7 compares the average time it took to complete each level in single-player with two-player. These values were expected based on the level design. Every level was completed at a faster rate in two-player. The dips show where new mechanics are introduced. The rising slope is caused by harder puzzles for the newly introduced mechanic. The line dips down again when a new mechanic is introduced and so on. Retrospectivly the written survey should also have asked which mode was being played in (single-player mode or two-player mode), as the modes have gotten different results.

The game was completed by 94% of the two-player groups but only 67% of those who played single-player, This is not suprising because the game has been developed from the start as a two-player game. Single-player was only implemented one week prior to user testing. There seems to be no correleation between level design and participants leaving early. There were five tests that were left unfinished, Some left during the introduction of a new mechanic, Others left on the harder levels. Of the five that did leave, two of them stated taht their reason for leaving was because they didn't have enough time, (They were witnessed walking into a COMP125 test opposite the user testing room). One Participant recommended uploading Negative Space onto Newgrounds, a website that hosts many flash games. Another participant recommended submitting a polished and expanded Negative Space to Steam's Greenlight Program, a voting program where the Steam community vote on which Indy games should be available to purchase through the Steam platform. About half of the participants commented on how much they enjoyed Negative Space.

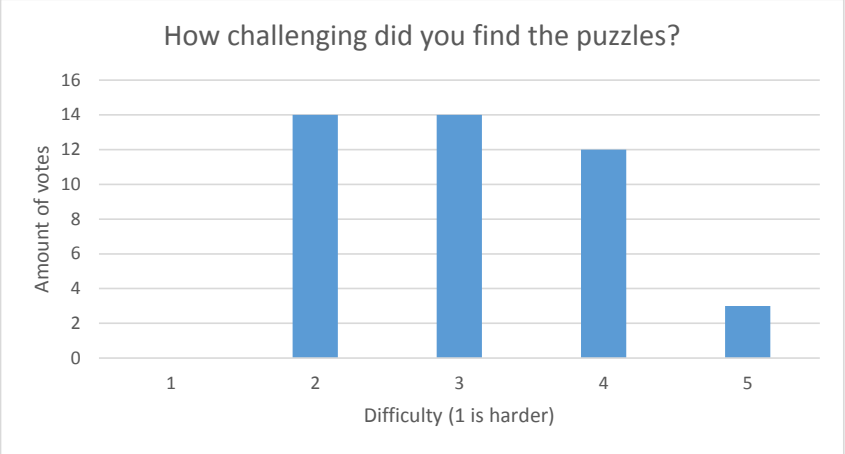

Figure 5.2: These results indicate that the puzzles had a fair level of difficulty, If this graph was left skewed then it would mean the tutorial stages did not do a good job of teaching the mechanics, If this graph was right skewed then it would mean the puzzles were too easy and not engaging enough. Almost every level tested was still teaching the mechanics and only 6 of the 21 puzzles were intended to be challenging so it was expected to see some Participants choose the easiest option. Some Participants could have chosen the easiest option to reassure themselves that they were too smart for the puzzles.

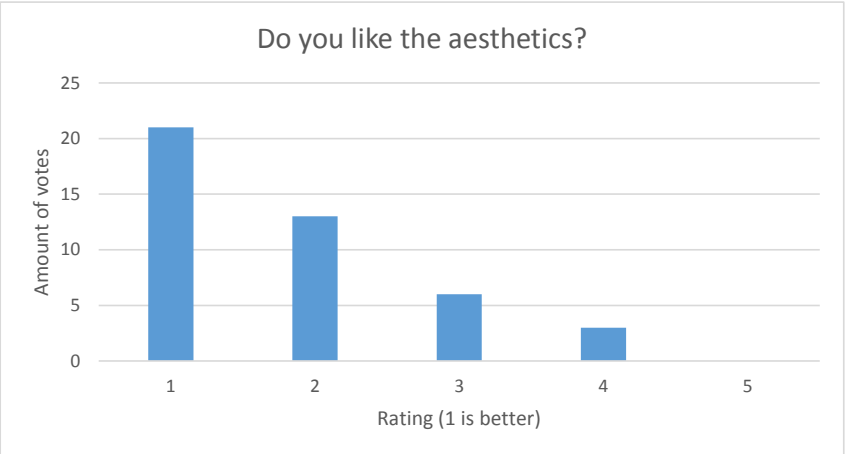

Figure 5.3: This shows the vast majority of Participants liked the Black and White style of the game. If work is continued on this game, then its general style can remain unchanged.

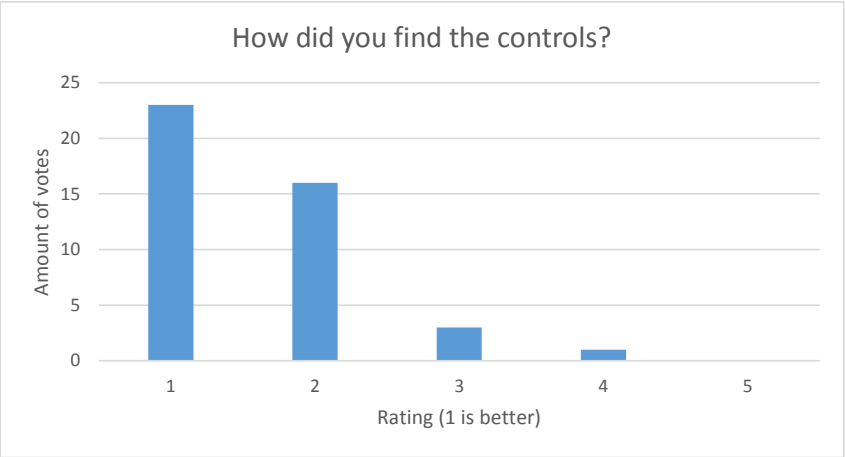

Figure 5.4: This has been the most suprising of the results. Participants seemed to find the controls reletivley smooth.

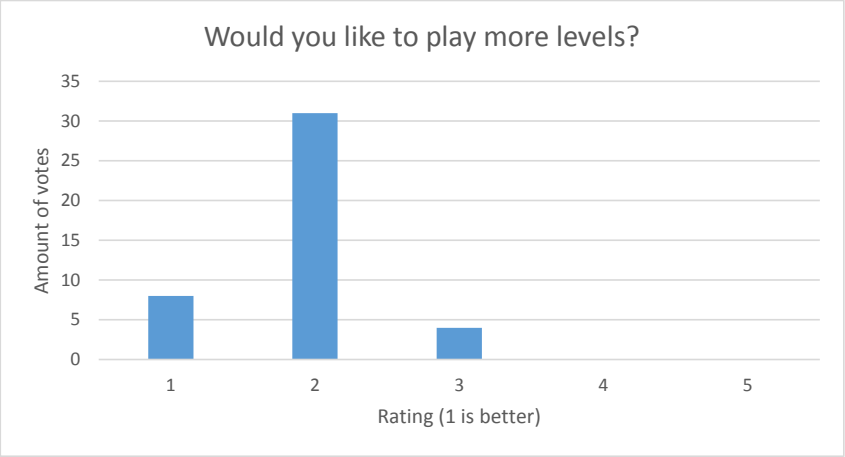

Figure 5.5: Almost everyone said they would like to play more levels. Some people even ticked the far left box saying they would pre-order, this option had been intended as joke option to lighten up the survey.

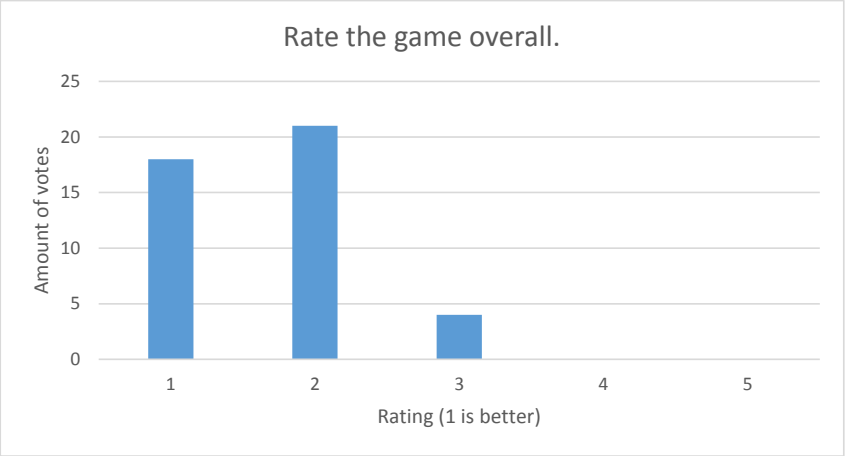

Figure 5.6: Based on these answers it seemed almost everyone enjoyed the game and no-one said it was less than OK.

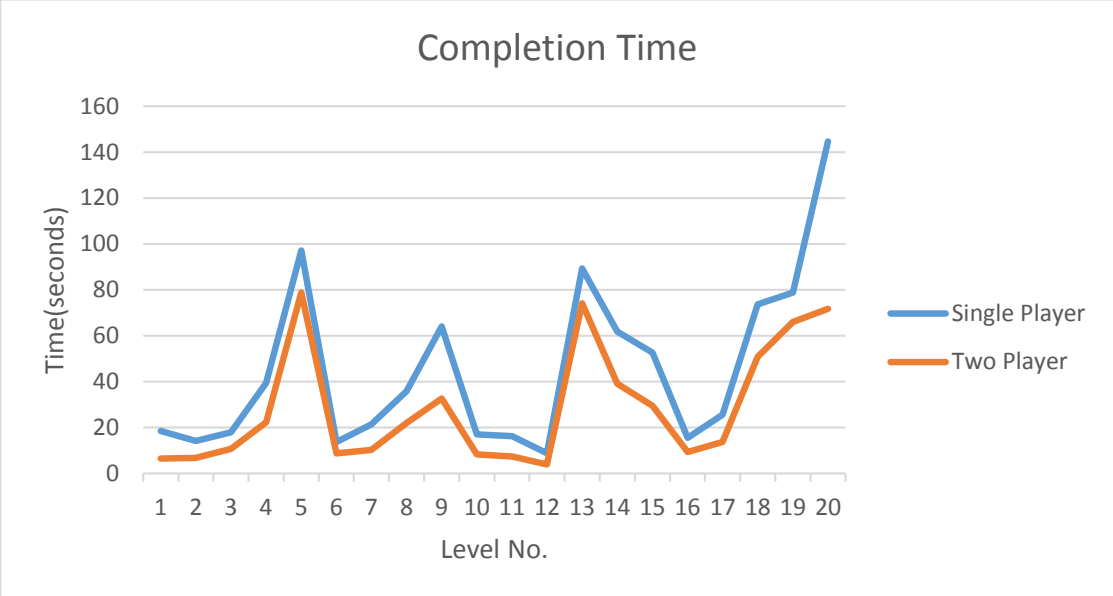

Figure 5.7: Comparing the completion time between single-player and two-player. The two-player only level is not included in this chart.

Chapter 6

Conclusion

6.1 Future Directions

There are still some ideas for new mechanics. Currently the winning condition is having both players stand by their flag. One idea was to have a key in one world and the key hole in the other, when the key reaches the key hole the level would be complete. This idea would further encourage cooperation from both players. The only problem with this is getting the key object from one world to the other. Once this problem is figured out the key idea can be further worked on.

Currently the game crashes when a block is pushed off the left or right side of the screen, further work could be done to make sure this works. Currently levels have been designed in a way to make this impossible, but fixing this would add a new layer of depth to puzzles.

When designing with the three state gate, another alternative came to mind. The three state gate is closed by default and opens when activated. One idea is to have the opposite, a gate that is open by default and closes when activated, so it can be used as a step or something. This gate would need to look visually different to the current gate so they are not confused with each other. Since this new gate is open by default, it would need some visual indicator to separate it from normal blocks.

Another idea is having multiple black/white characters, this idea came up when the left/right looping wasn't working properly and would spawn more characters. The characters could be in separate isolated sections of the level or they could be in the same section and collide and jump off each other.

Something that has not had much work done on is how should movable blocks interact with other movable blocks. Having blocks stack on top of each other could be used to create more puzzles. What should happen when the bottom of the stack is pushed? Should the stack be too heavy for the character to move? Should only the bottom block be pushed so the stack can be used as stairs? Or should the whole stack be movable? Another question is what would happen when a black movable block is pushed inside a white movable block? Currently this would delete the underlying block, but even if it did not do this, the Block would be completely overlapped and there would be no visual indicator showing that it was indeed there.

Single-player mode was introduced late into development and the current idea is to switch between characters with a button press. But a player could be able to control both characters simultaneously with a controller. Each stick can control each character and their interact button could be remapped to the shoulder buttons. These controls would allow for time based events such as the one included in the Two-player only level to be executed more easily in single-player than it currently is.

Negative Space has been developed to be very grid-based, almost all object are 64 by 64 pixels and snap to 32 by 32 grid. This grid-like nature does not seem necassary for the black and white concept but maybe more issues could crop up if Negative Space was not grid-based.

6.2 Summary

This project been about exploring ideas to introduce new gameplay into the stale video game industry. New mechanics have been designed and implemented over the course of this project. These mechanics were introduced into this game currently referred to as Negative Space. Being a video game, the only way to test its success is by having players enjoy playing it. Negative Space has had user testing sessions which determined that these fresh gameplay elements are enjoyable, therefore successful. Based on the good reception from the testers, theoretically Negative Space will be successful if further work is done for it to be released as a commercial game.

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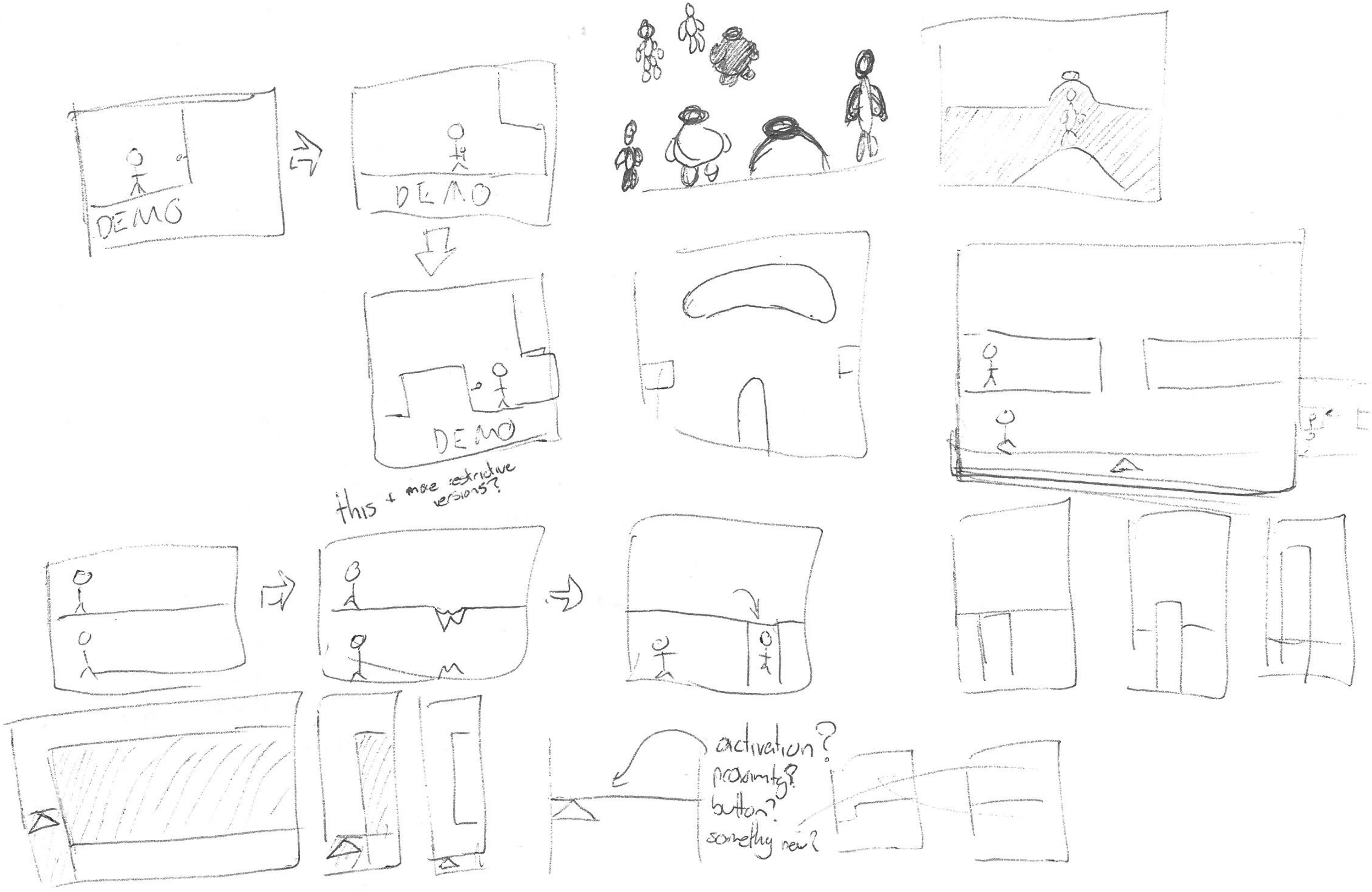
Appendices

Appendix A

Sketches


DEMO
DEMO
DEMO
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activation?
proximity?
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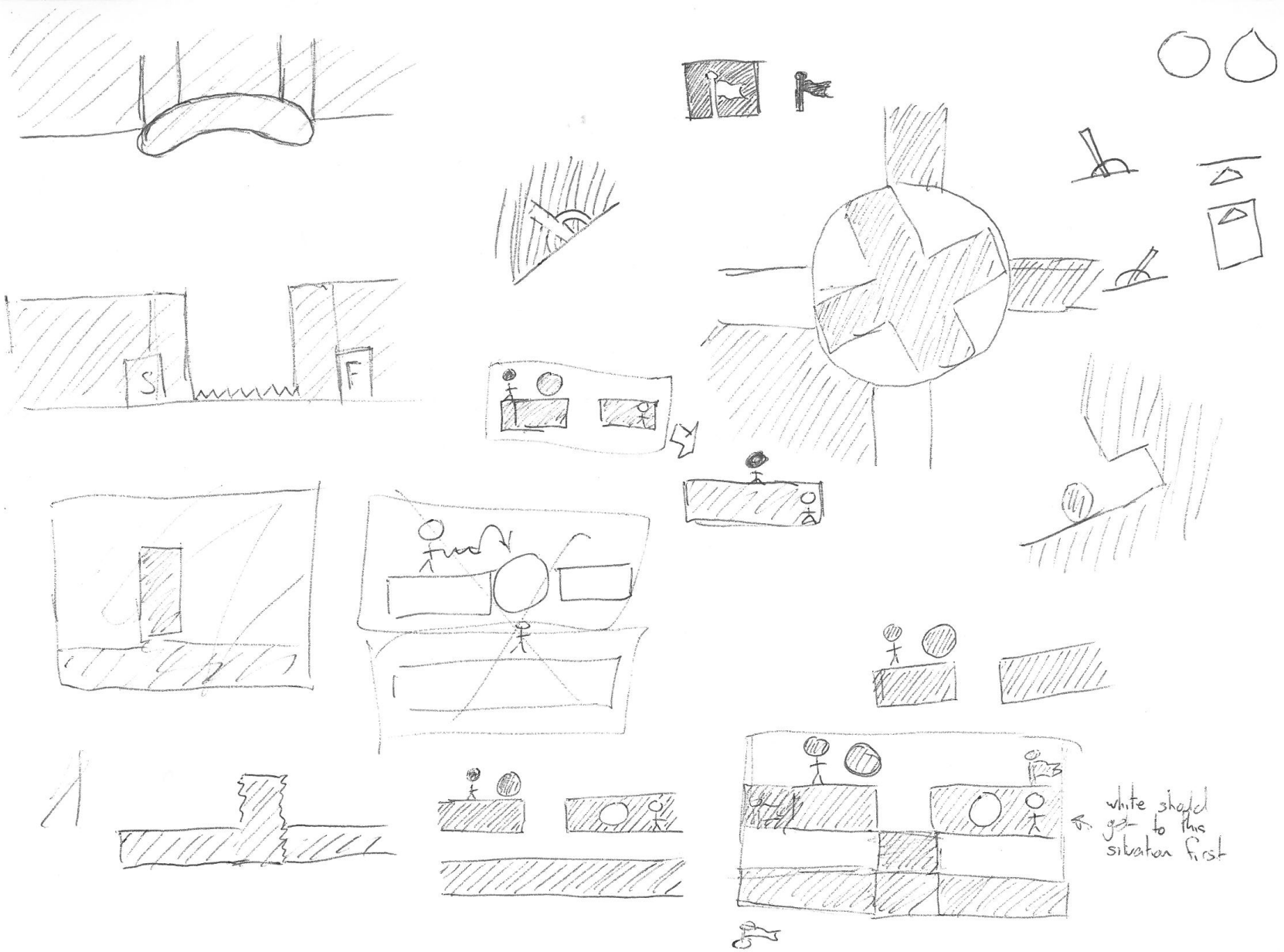
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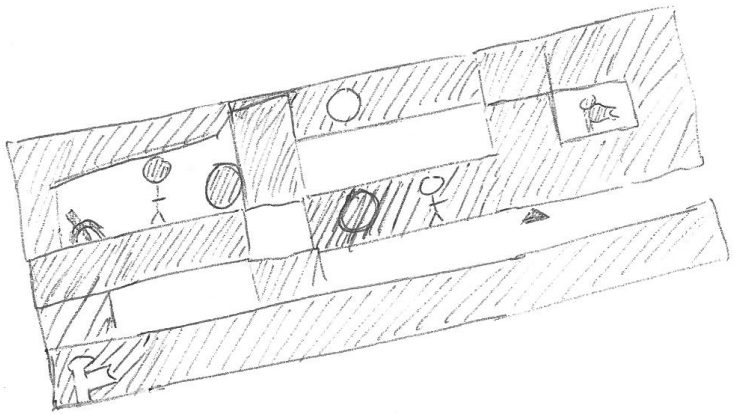
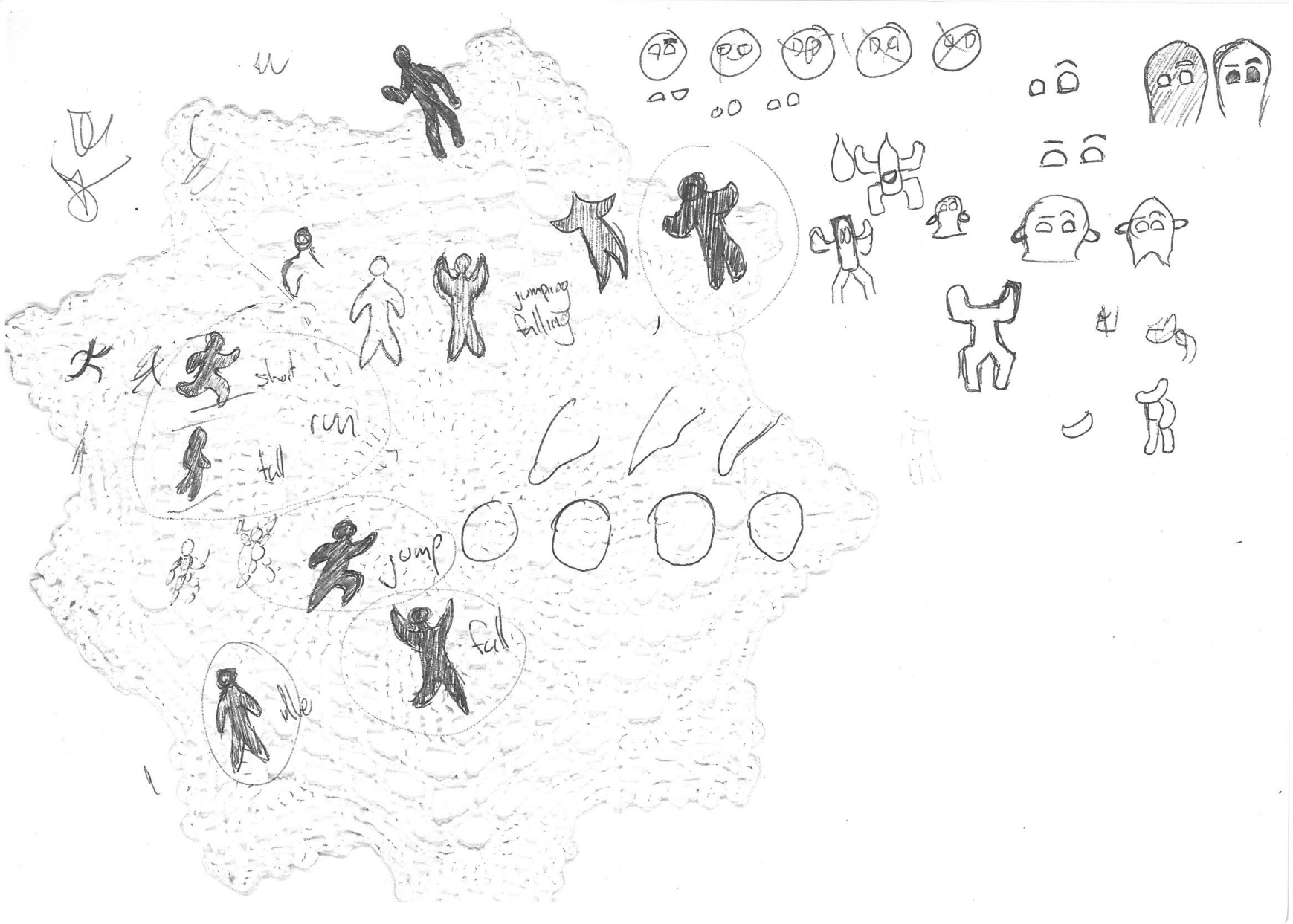
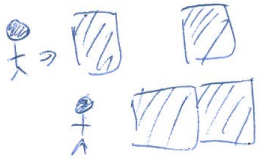
F
white should get to this situation first

grid base necessary?




jumping
falling
short
run
tall
jump
fall
idle

All blocks movable?



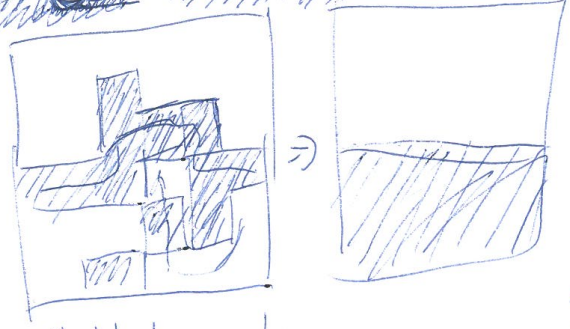
if all block are movable
- blocks can fall in place
- blocks can't float

does black "fall" bc
or
does white "hold up"
the black

looks like would fall/rotate

which block takes precedence

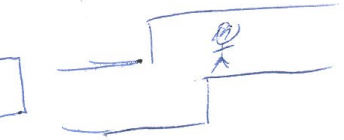
doesn't look but it fits

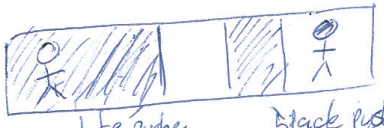


All blocks movable
not possible as sidescrolle
could it work top down?

no? - pos possible to rearrang too much?

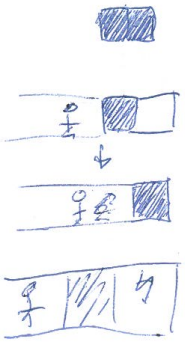
nt on styled paper looks?

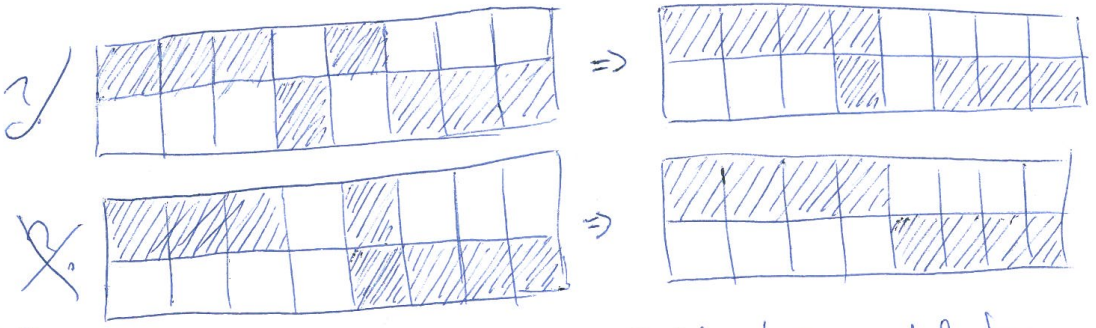




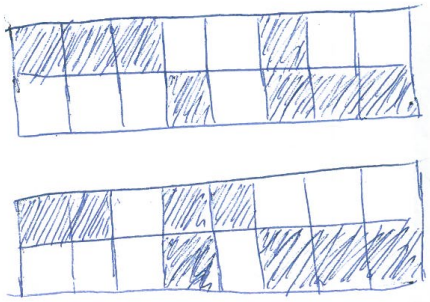
white pushes

black pushes



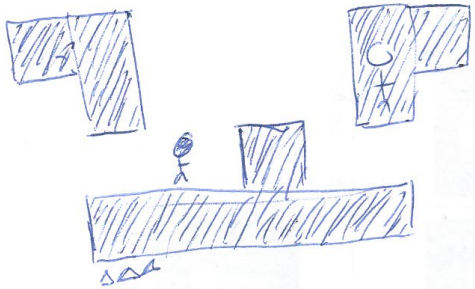


What if blocks could be pulled???

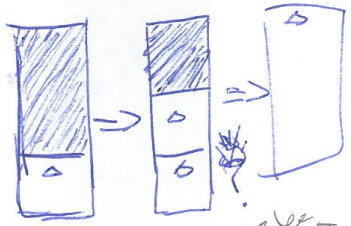


Conc nonmovable block
but kathave lots of movable ones?

move



interactable
toggle
block elev controled by white player?



what intro – black white
background – related goes platformer engine?
puzzler – design – method
experiment
eval – test
concl – anticipated conc

128 originally

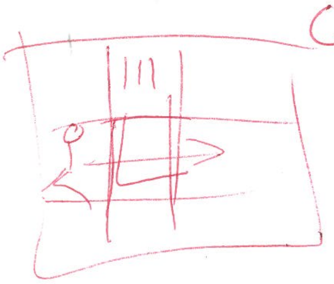
24

can jump ? (power up/down)

Usully sort out a hole — mover/static

push/pull.

conveyor belt/elevator



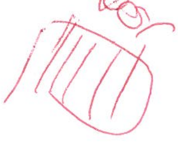
~~move toward~~

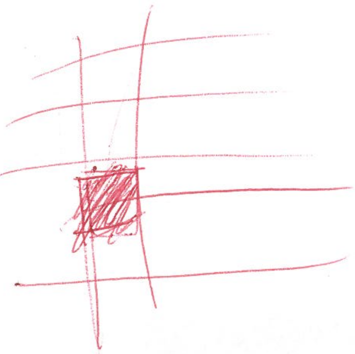
Snap

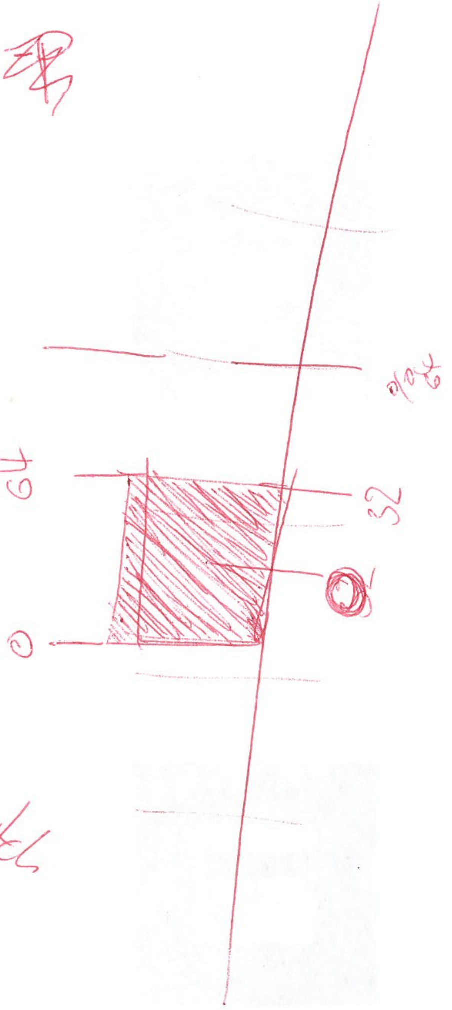
reverse

key?

door



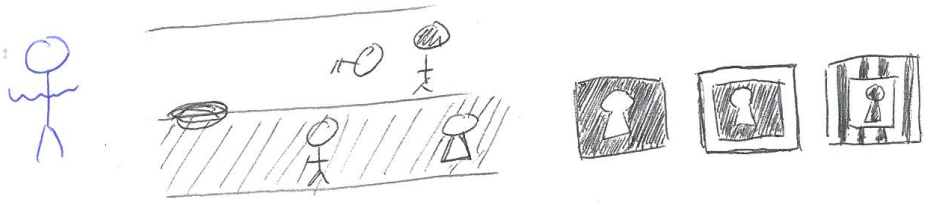


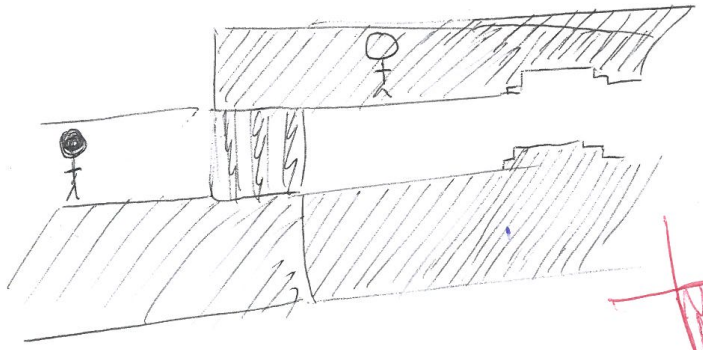


gravity switch

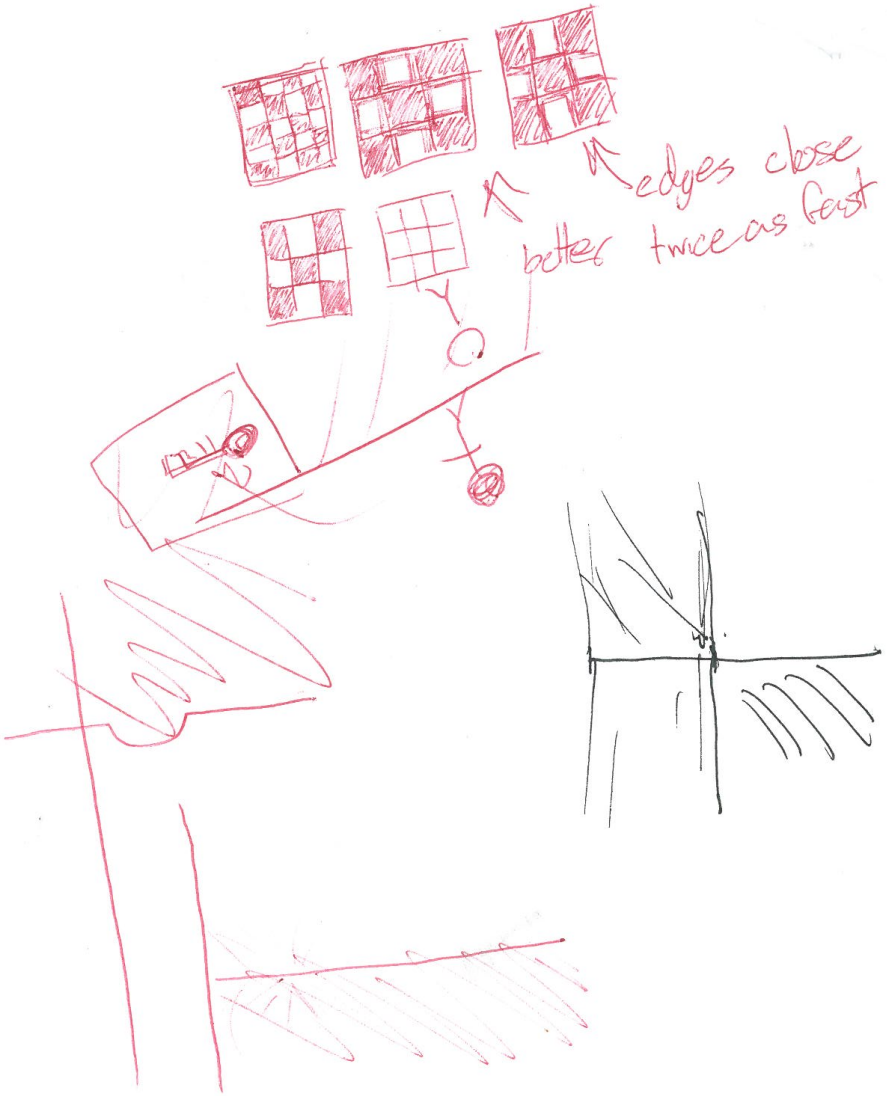
spring?

Keys don't make sense for a 3-way door! or do they? no

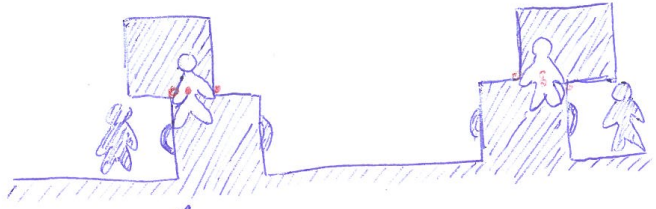




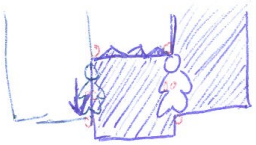
buttons? player might think they need to ~~stand~~ [stay] on button for it to work
... that could work.

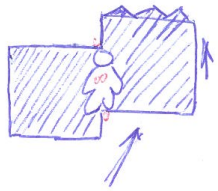

edges close
better twice as fast

rise

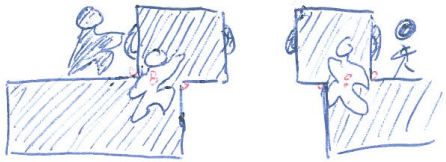


this block cant move right because the white player is blocking it

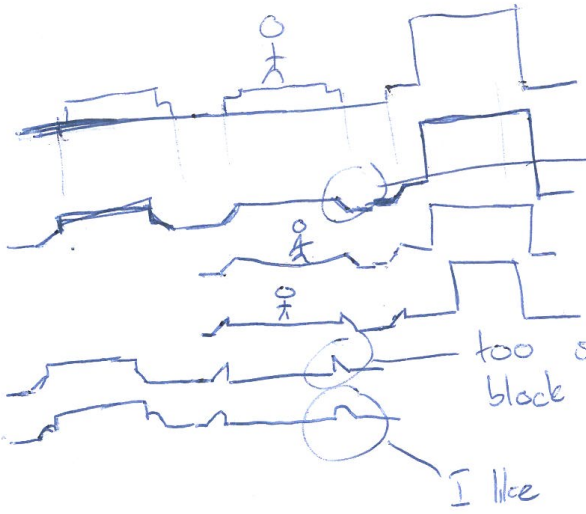




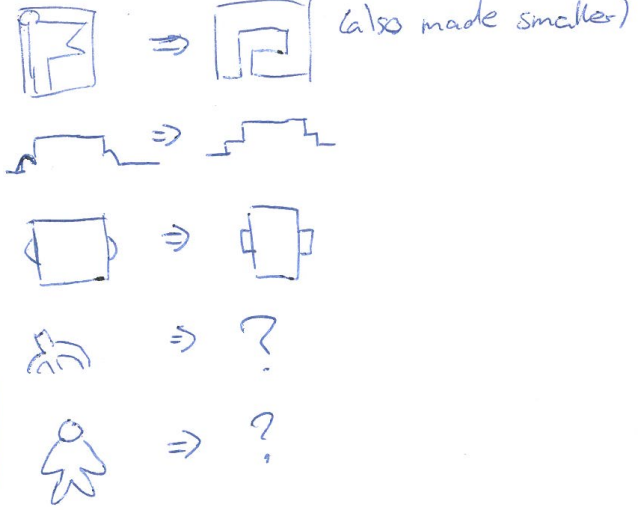
this gets stuck going up resume raising after whitedude moves out

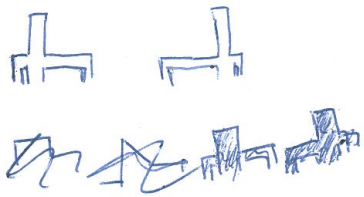


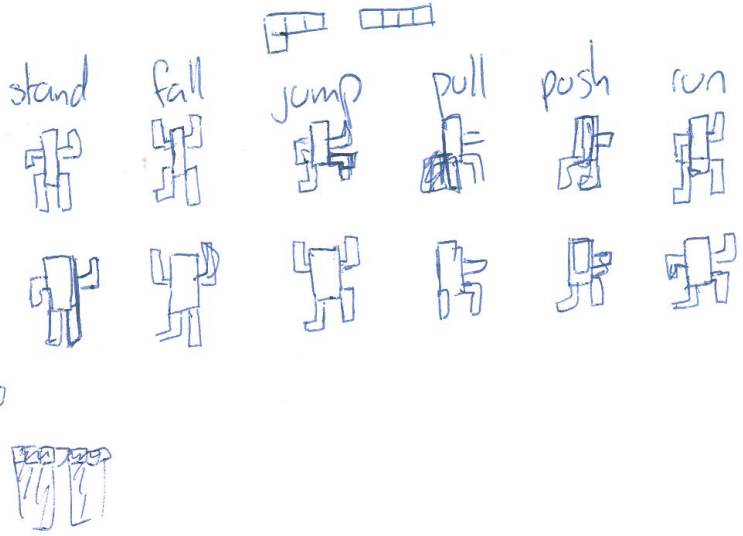
similar situation for left



make things look more boxy/square to be consistent






stand
fall
jump
pull
push
run

Appendix B

Application for Approval

Application for Approval
Outline of Research or Related Activity

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Ethics Committee, Faculty of Computing and Mathematical Sciences

Note: add your project details to this document – do not delete any of the existing content

Details of Proposed Activity

1. Identify the project

1.1 Title of Project

Black and White World Game

1.2 Researcher(s) name and contact information

Janik Singh - Janik333@hotmail.com

1.3 Supervisor's name and contact information

Bill Rogers - Coms0108@waikato.ac.nz

1.4 Anticipated date to begin data collection

1/6/15

1.5 Does your application involve issues of health or disability with human participants? If so, please refer to the guidelines as to whether your application needs to be submitted to the Northern Y Regional Ethics Committee.

No

2. Describe the research or related activity

2.1 Briefly outline what the project is about including your goals and anticipated benefits. Include links with a research programme, if relevant.

The Game consists of 2 areas, a black area and a white area. Each area has a stick figure character and they must work together to reach the goal. Solid matter from one area defines the negative space in the other and vice versa. They will modify the areas to help each other reach their exit. There are only 4 controls, run left, run right, jump and use/interact. The participants will be assigned a PlayStation 3 or Xbox 360 controller based on their preference and availability. The intention of this study is to determine a number of factors that improve the games features, level design and aesthetics developed by the researcher, as well as gather information about the current state of the game. The primary factors that will be investigated is how well the game holds the players attention, this will be measured by how many levels they complete before leaving the session. It is also important to know which level the players leave on to determine which game features were not communicated effectively to the player.

2.2 Briefly outline your methods.

Participants will pick up the controller and start playing with no prior knowledge of the game. The game will be played on a Windows Machine connected to a monitor. There will be less than 10 separate machines for use. There will be a piece of paper next to the screen showing only the controls of the game. The game will automatically record the time spent on each level, this data will only be used later by the researcher to identify weak spots in the games level design. A survey will be

given to the participants after they leave the game (even if they leave early). Following the completion of all levels, the participant will be asked to fill in a brief questionnaire that will record their opinion on 5 5-point scale questions (attached).

2.3 Describe plans to give participants information about the goals of the research or related activity.

Participants will be provided with information about the goal of the research via the participant information sheet, where the goals of the research are stated in the "What is this research project about?" Section. They will also have the opportunity to ask further questions during the study.

2.4 Identify the expected outputs of this research or related activity (e.g., reports, publications, presentations).

Following the completion of this study, a number of values will be gained that will allow the researcher to make decisions on further development options for the testing environment. This will include the level the participants reached as well as how long they spent on each level, as well as any other points identified through insights provided by the participants. This information will be used in the generation of the researcher's report, and will possibly be used in journal publications, and/or conference presentations.

2.5 Identify who is likely to see or hear reports or presentations arising from this research or related activity.

Resulting publications and presentations will be open, and accessible to academics and industry members.

2.6 Identify the physical location(s) for the research or related activity, the group or community to which your potential participants belong, and any private data or documents you will seek to access. Describe how you have access to the site, participants and data/documents. Identify how you obtain(ed) permission from relevant authorities/gatekeepers if appropriate and any conditions associated with access.

A room in the ground floor of R Block (University of Waikato), will be allocated. The researcher can book a room by filling in a timetable on the door. It will have a few stations set up for testing, these stations will be provided by the department. The available room will be booked at least 1 week in advance. Participants can leave testing as soon as they want, if there are people waiting for a turn then testers will be given 30 minutes. Each testing session will be 1 hour, with a maximum of 10 testing sessions. Access is regulated through the department-issued CARDAX system. Participants will be primarily sourced from with the Computer Science student body of the Waikato of University. Additional participants will be sourced from the greater university populace. Potential participants will be notified via a poster hanging in R Block. Additional potential participants will notified via Moodle forums the researcher has access to (COMP520/477 and COMP316). Participation in the study will be voluntary. No private data or documents will be sought.

3. Obtain participants' informed consent without coercion

3.1 Describe how you will select participants (e.g., special criteria or characteristics) and how many will be involved.

Participants will be required to have some video game experience. Participants with extremely limited video game experience will not be selected for participation because they are not the projects target demographic and may take even longer to complete the levels. Participants will be sourced primarily from the pool of students in the Department of Computer Sciences, with a number of non-department participants sourced from the greater campus student population. In order to obtain statistically

significant results, a minimum of 8 participants will be sourced, with additional participants obtained as necessary up to a maximum of 36.

3.2 State clearly whether this is an application under section 10 of the Ethical Conduct in Human Research and Related Activities Regulations: Large Random Sample Surveys.

This is not an application that falls under section 10 of the Ethical Conduct in Human Research and Related Activities Regulations.

3.3 Describe how you will invite them to participate.

Potential participants will be notified via a poster hanging in R Block. They will be free to turn up when/where the poster says without having to arrange a time. If the person is interested in participating, they will be provided with a Participant Information Sheet and Consent Form to read before testing. They will have the opportunity to ask the researcher about any concerns they may have regarding the study before choosing to sign the consent form or not. Additional potential participants will be notified via Moodle forums the researcher has access to (COMP520/477 and COMP316), The Participants will receive the Participant Information Sheet and Consent Form at the beginning of their session.

3.4 Show how you provide prospective participants with all information relevant to their decision to participate. Attach your participant information sheet, cover letter, or introduction script. See document on informed consent for recommended content. Information should include, but is not limited to:

- **what you will ask them to do;**
- **the context in which information sheets and consent sheets will be used. When (e.g. just before the study, a week before etc), where (e.g. in a laboratory environment, in a field setting etc) and in what form (e.g. paper, email etc) information will be provided to prospective participants.**
- **how to refuse to answer any particular question, or withdraw any information they have provided at any time before completion of data collection;**
- **how and when to ask any further questions about the study or get more information.**
- **the form in which the findings will be disseminated and how participants can access a summary of the findings from the study when it is concluded.**

Participants can bring along someone else to test the game with them, In this case both of them will be handed a Participant Information sheet and Consent form and need to sign the consent form before testing. Participants will pick up the controller and start playing with no prior knowledge of the game. The game will be played on a Windows Machine connected to a monitor. There will be less than 10 separate machines for use. There will be a piece of paper next to the screen showing only the controls of the game. A survey will be given to the participants after they leave the game (even if they leave early). Following the completion of all levels, the participant will be asked to fill in a brief questionnaire that will record their opinion on 5 5-point scale questions.

Potential participants will be notified via a poster hanging in R Block. Additional potential participants will notified via Moodle forums the researcher has access to (COMP520/477 and COMP316). Participants will voluntarily show up. The poster/moodle post will provide information on when and where the test is. Upon arrival at the study location, the participant will be presented a hard-copy of the participant information sheet (attached) and the research consent from (attached). The participant will be asked to read through the participant information sheet, and will have the information contained therein explained verbally by the researcher. At this point, the participant will be asked if they have any questions surrounding the details of the study, such as what will be required of them, how they can obtain findings or publications that will result from the study. The researcher will answer any questions asked by the participant, and will inform them that they may ask any further questions throughout the course of study. The participant's attention will then be directed to the research consent form, where they will have the opportunity to consent to participating in the study or not.

3.5 Describe how you get their consent. (Attach a consent form if you use one).

Participants will be approached by the researcher and an overview of the intended study will be given. If the person is interested in participating, they will be provided with a Participant Information Sheet and Consent Form to read (at the session). They will have the opportunity to ask the researcher about any concerns they may have regarding the study before choosing to sign the consent form or not.

3.6 Explain incentives and/or compulsion for participants to be involved in this study, including monetary payment, prizes, goods, services, or favours, either directly or indirectly.

Small chocolate bars and fruit (for healthier alternatives) will be given to every participant as an incentive to participate. The exact incentives will be chosen depending on the specials at the time. The chocolate bars may contain traces of nuts which is why another alternative such an apple can be chosen. They will receive these as soon as they start playing. This was decided over giving them a prize after the session because that might influence them to stay, causing them to stay longer, which would influence results.

4. Minimise deception

If your research or related activity involves deception – this includes incomplete information to participants -- explain the rationale. Describe how and when you will provide full information or reveal the complete truth about the research or related activity including reasons for the deception.

The Objective is to see how long they play voluntarily. Telling them this objective would influence results as they may stay longer than they normally would to be nice. The full truth will not be revealed to them until the final report is available. They can then be told about the deception if they specifically asked for it, or they can read it in that report which will be available to them.

5. Respect privacy and confidentiality

5.1 **Explain how any publications and/or reports will have the participants' consent.**

In accordance with the Participant Information Sheet (attached), and by signing the consent form (attached), participants acknowledge that the collected data will be used in the creation of a report for the described project, and that the data may also be used in publications.

5.2 **Explain how you will protect participants' identities (or why you will not).**

Participants will not be uniquely identified in any way in publications or presentations. Resulting data will be presented as opinion data presented on a numeric scale. No notes will be made available to anyone outside of the researcher and supervisors. Any notes made will be destroyed once relevant data has been extracted from them. Participants will be referred to by randomly assigned participant IDs that will not be linked to their real names.

5.3 **Describe who will have access to the information/data collected from participants. Explain how you will protect or secure confidential information.**

Personal Information that could be used to identify participants will not be shared outside of the researcher and supervisors. Any notes created during the duration of the study will only be made available to the researcher and supervisors. Any notes made will be destroyed once relevant data has been extracted from them. Data that has been collated in the form described in 5.2 will be made available to anyone as required, and may be used in publications. Physical notes will be kept secure inside the researchers laboratory which is protected by the University controlled CARDAX system, inside a secure drawer, before being securely destroyed at the conclusion of the study. A copy of all

anonymized results will be stored in the FCMS Archive for 5 years following the conclusion of data analysis.

6. Minimise harm to participants

'Harm' includes pain, stress, emotional distress, fatigue, embarrassment and exploitation.

6.1 Where participants risk change from participating in this research or related activity compared to their daily lives, identify that risk and explain how your procedures minimize the consequences.

There are no obvious harm risks. The test will be conducted on everyday equipment. A computer set up on a desk with standard computer chairs with no wheels. The chosen controllers are designed to be played comfortably for long periods of time.

6.2 Describe any way you are associated with participants that might influence the ethical appropriateness of you conducting this research or related activity – either favourably (e.g., same language or culture) or unfavourably (e.g., dependent relationships such as employer/employee, supervisor/worker, lecturer/student). As appropriate, describe the steps you will take to protect the participants.

A number of Participants may have been students in a class that the researcher was also a student in, But the researcher has never talked with them (outside of a 10 minute presentation) therefore no compulsion to participate will exist.

6.3 Describe any possible conflicts of interest and explain how you will protect participants' interests and maintain your objectivity.

Participants that are family members or close friends of the researcher will not be accepted as they are more likely to give influenced results.

7. Exercise social and cultural sensitivity

7.1 Identify any areas in your research or related activity that are potentially sensitive, especially from participants' perspectives. Explain what you do to ensure your research or related activity procedures are sensitive (unlikely to be insensitive). Demonstrate familiarity with the culture as appropriate.

It's possible that some Participants could take offense to the black and white player concept and mistakenly think that it represents ethnicities. If this is brought up by a Participant, the researcher will explain that these colours were chosen because they provide the highest contrast, and it could work with any 2 contrasting colours such as red and blue. Black and White were also chosen to give the game its monochrome aesthetic. The characters also have the exact same attributes (identical running speed and jumping height). The black and white colours can be reversed and it would have no effect on gameplay.

7.2 If the participants as a group differ from the researcher in ways relevant to the research or related activity, describe your procedures to ensure the research or related activity is culturally safe and non offensive for the participants.

See 7.1

Appendix C

Participant Information Sheet and Research Consent Form

Participant Information Sheet

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Ethics Committee, Faculty of Computing and Mathematical Sciences

Project Title
Black and White World Game (working title)

Purpose
This testing is conducted as partial requirement for Bachelor of Computing & Mathematical Sciences. This project requires the researcher to choose a topic and conduct research on the topic through using surveys.

What is this research project about?
This research is to investigate how engaging this games concept is and if it could become a full game that brings new gameplay into the stale gaming industry.

What will you have to do and how long will it take?
You will be play testing a game. It is a 2 player game so you can bring along a buddy to play with. If you don't have someone to bring along then you can pair up with someone else at the site. You will both need to read this Participant Information Sheet and sign the supplied Consent Form. The game consists of puzzles which vary greatly in completion time. The completion time will vary based on your puzzle solving skills and how effectively the game has communicated its features to you, estimated time 10-20 minutes. The supplied gamepads range includes PlayStation 3 and Xbox 360 controllers, as well as keyboard. You will be asked to fill a brief questionnaire about the game. The study should take no longer than 30 minutes. You will be asked to give consent prior to the commencement of the study. If at any point you wish to discontinue the study, you can advise the researcher and they will facilitate an immediate conclusion of the session.

What will happen to the information collected?
The information collected will be used by the researcher to write a research report for the credit of a specific paper. It is possible that articles and presentations may be the outcome of the research. Only the researcher and supervisor will be privy to the notes, documents and the paper written. Afterwards, notes and documents will be destroyed. The researcher will keep a copy of the paper but will treat them with the strictest confidentiality. No participants will be named in the publications and every effort will be made to disguise their identity. A copy of all anonymized results will be stored in the FCMS Archive for 5 years following the conclusion of data analysis.

Declaration to participants
If you take part in the study, you have the right to:

- Refuse to answer any particular question, and to withdraw from the study / analysis has commenced on the data.
- Ask any further questions about the study that occurs to you during your participation.
- Be given access to a summary of findings from the study when it is concluded.

Who's responsible?
If you have any questions or concerns about the project, either now or in the future, please feel free to contact either:

Researcher:
Janik Singh - Janik333@hotmail.com
- 022 1280 153

Supervisor:
Bill Rogers -Coms0108@waikato.ac.nz

Research Consent Form

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Ethics Committee, Faculty of Computing and Mathematical Sciences

Black and White World Game (working title)

Consent Form for Participants

I have read the **Participant Information Sheet** for this study and have had the details of the study explained to me. My questions about the study have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I also understand that I am free to withdraw from the study, or to decline to answer any particular questions in the study. I understand I can withdraw any information I have provided up until the researcher has commenced analysis on my data. I agree to provide information to the researchers under the conditions of confidentiality set out on the **Participant Information Sheet**.

I agree to participate in this study under the conditions set out in the **Participant Information Sheet**.

Signed: _____

Name: _____

Date: _____

Researcher's Name and contact information:
Janik Singh - Janik333@hotmail.com

Supervisor's Name and contact information:
Bill Rogers - Coms0108@waikato.ac.nz

Appendix D

Survey

ID: 001

Black and White World Game Survey

Scribble in the box to vote

How challenging did you find the puzzles?

Dark Souls		OK		What puzzles?

Do you like the Black and White style / aesthetics?

Sweet		OK		Lame

How did you find the controls?

Smooth		Average		Clunky

Would you like to play more levels?

I'd preorder		Ummm		Never

Rate the game overall

Great		OK		Poor

Appendix E

Approval Document

Faculty of Computing and Mathematical Sciences
Rorohiko me ngā Pūtaiao Pāngarau
The University of Waikato
Private Bag 3105
Hamilton
New Zealand

Phone +64 7 838 4322
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THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

22 May 2015

Janik Singh
C/- Department of Computer Science
THE UNIVERSITY OF WAIKATO

Dear Janik

Application for approval under the Ethical Conduct in Human Research and Related Activities Regulations

I have considered your application for a research project involving human participants entitled "Black and White World Game". The aim is to investigate how engaging this game's concept is and if it could become a full game that brings new gameplay into the stale gaming indudstry.

The procedure described in your request is acceptable. Participants involved in the study will not be identified in any resulting publications. At the conclusion of the project a copy of the anonymized results will be submitted to the FCMS Data Archive for 5 years

The Participant Information Sheet, Research Consent Form and questionnaire comply with the requirements of the University's human research ethics policies and procedures.

I therefore approve your application to perform the research project.

Yours sincerely

Masood Masoodian
Human Research Ethics Committee
Faculty of Computing and Mathematical Sciences

Appendix F

Recorded Statistics

rm_endtut1	63.65	16.88	16.67	13.97	7.25	4.92	16.48	20.87	12.58	12.65	28.3	7.58	18.48333
rm_endtut2	15.85	9.8	26.87	10.83	9.23	10.3	12.35	11.72	23.15	15.13	13.5	10.8	14.1275
rm_elevatortut1	17.1	46.47	22.17	9.5	14.23	6.97	18.18	16.37	19.57	13.68	15.43	15.8	17.95583
rm_elevatortut2	36.28	56.18	74.8	24.72	36.12	16.68	50.15	36.07	44.73	26	31.7	38.82	39.35417
rm_elevatortut3	242.23	124.42	139.2	53	38.13	28.53	127.47	86.32	79.13	53	134.28	59.23	97.07833
rm_block1	25.38	15.18	15.2	9.68	14.07	7.93	12.33	13.98	15.3	10.22	11.6	14.17	13.75333
rm_block2	26.32	15.95	68.12	10.43	16.95	12.45	21.87	16.37	21.25	14.5	16.22	16.25	21.39
rm_block2_5	41.57	26.18	82.73	23.3	34.93	19.68	22.83	37.82	52.35	24.03	37.42	26.22	35.755
rm_block3	79.43	43.02	158.07	43.67	46.82	34.62	64.8	42.6	99.83	46.15	54.35	54.95	64.02583
rm_fall1		17.67	13.08	21.93	12.78	8.13	13.17	17.92	40.83	11.9	16.68	12.38	16.95182
rm_fall2		14.75	39.42	14.48	13.5	7.37	14.8	11.77	25.37	13.32	13.28	9.83	16.17182
rm_loop1		7.32	11.58	5.37	9.17	7.05	13.73	15.52	6.67	5.23	10.72	4.45	8.800909
rm_loop2		79.75	168.73	53.67		67.32	145.57	73.8	96.42	68.15	73.5	66.32	89.323
rm_half2		15.32	180.68	21.97		41.38	101.97	21.28	130.42	48.82	23.6	32.92	61.836
rm_half1		133.17		42.7		27.8	32.72	29.52	62.83	21.25	40.45	82.8	52.58222
rm_gate1		19.88		12.08		14.43	9.88	15.02	14.95	13.57	22.38	16.67	15.42889
rm_gate2		8.75		14.23		14.02	12.97	101.83	18.07	19.8	14.93	25.12	25.52444
rm_gate3		116.97		39.18		51	92.32	90.97	51.6	39.3	106.47	75.58	73.71
rm_puzzletest1		59.6		58.68		58.9	110.02	56.33	103.83	88.9	119	54.28	78.83778
rm_puzzletest2				39.63		74.08	97.23	78.3	78.38	135.83	370.13	283.22	144.6
TOTAL 1P				523.02		513.56	990.84	794.38	997.26	681.43	1153.94	907.39	820.2275
													AVERAGE 1P

rm_endtut1	2.5	2.32	13.6	12.77	2.87	5.68	2.87	6.43	4.85	11.4	4.88	4.25	13.57	7.17	4.17	4.75	6.47	6.502941
rm_endtut2	5.9	7.08	6.37	5.68	6.37	6.55	4.93	4.53	7.35	8.88	5.63	5.78	7.48	9.63	5.52	6.78	10.83	6.781765
rm_elevatortut1	8.67	8.73	13.3	7.47	12.1	17.42	3.88	13.45	12.87	11.95	10.2	11.3	8.08	14.82	4.52	13.07	8.63	10.61529
rm_elevatortut2	10.8	39.75	22.53	14.7	16.28	19.43	20.37	20.25	18.47	46.72	18.03	29.95	27.5	15.18	16.1	18.23	23.87	22.24471
rm_elevatortut3	63.15	84.1	157.32	75.18	85.75	67.83	60.25	77.97	153.45	61.3	50.35	139.32	35.53	29.95	49.47	55.87	93.12	78.81824
rm_block1	12.45	17.27	9.18	9.88	4.67	7.2	6.27	6.78	7.32	9.32	7.8	7	15.4	4.57	4.92	5.48	11.87	8.669412
rm_block2	9.12	14.72	6.88	8.52	12.85	9.35	8.6	7.47	15.33	11.6	11.05	10.67	11.52	8.8	9.2	10.27	8.75	10.27647
rm_block2_5	25.38	12.15	19.53	12.27	28.35	37.83	12.77	32.52	23.93	20.42	21.85	21.27	20.35	17.67	14.1	20.7	32.75	21.99059
rm_block3	28.73	20.32	21.02	57.67	30.13	45.18	18.55	34.97	42.27	29.05	20.77	24.97	54.07	40.28	26.02	32.12	29.35	32.67471
rm_fall1	6.17	4.65	5.92	8.1	5.65	12.05	5.98	6.9	14.22	9.73	7.42	7.32	16.15	8.58	6.78	8.4	7.58	8.329412
rm_fall2	6.33	7.08	6.2	6.13	6.62	7.63	6.63	7.55	7.5	14	6.4	6.78	8.32	7.27	6.47	7	6.68	7.328824
rm_loop1	3.7	5.92	3.13	2.7	3.43	3.62	2.48	4.78	3.17	7.77	3.85	3.47	3.53	3.85	3.67	3.42	4.17	3.921176
rm_loop2	65.1	103.87	40.6	41.25	85.37	116.32	44.08	65.25	68.02	149.3	67.35	97.27	89.75	60.43	54.88	75.58	34.27	74.04059
rm_half2	33.87	82.05	29.02	9.9	41.22	43.67	41.17	50.02	59.52	62.07	8.97	29.7	49.58	12.47	29.48	43	39.62	39.13706
rm_half1	25.15		20.25	29.37	13.78	23.88	33.67	46.25	32.13	95.97	17.75	14.03	29.83	18.47	21.63	17.43	32.08	29.47938
rm_gate1	9.5		9	9.57	4.77	8.02	6.78	9.32	9.85	10.85	11.15	8.07	18.7	8.03	9.05	9.63	6.65	9.30875
rm_gate2	33.47		7.47	16.18	13.1	14.6	9.18	11.28	13.25	10.97	11.45	14.3	10.17	11.25	12.95	11.13	18.4	13.69688
rm_gate3	54.52		34.93	45.17	84.83	37.42	32.68	64.27	42.13	54.88	48.02	52.9	44.82	45.5	29.78	57.35	83.82	50.81375
rm_gate4	64.48		47.27	30.88	68.3	52.52	13.2	22.35	35.07	57.53	44.58	41.52	43.03	65.83	20.45	35.43	28.83	41.95438
rm_puzzletest1	73.3		39.62	34.33	52.85	94	31.73	81.78	138.58	79.48	44.77	96.67	42.38	63.78	29.87	47.7	104.18	65.93875
rm_puzzletest2	80.35		80.48	50.18	53.02	154.62	42.97	102.45	45.15	55.8	41.12	59.93	97.72	73.25	66.85	98.95	44	71.6775
TOTAL 2P	622.64		593.62	487.9	632.31	784.82	409.04	676.57	754.43	818.99	463.39	686.47	647.48	526.78	425.88	582.29	635.92	609.2831
																		AVERAGE 2P