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Biome hazard creation for Blastronaut game
Bachelor's Thesis (9 ECTS)

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Abstract:

This thesis describes different aspects of building imaginary worlds and the implementation and testing of new biome hazards for a video game named *Blastronaut*. The purpose of the hazards is to make the game more enjoyable to the player by adding more challenge and overall playtime. The thesis begins with an explanation of what to keep in mind when making unique worlds for video games. Then it describes different ideas for new content to add to the biomes in the game *Blastronaut*. Finally, it describes the details of the implementation process, user testing and the conclusion of this thesis.

Keywords: Imaginary worlds, *Blastronaut*, testing, biome creation, Godot, video games.

CERCS: P170 Computer science, numerical analysis, systems, control

Bioomidele ohuelemendi loomine mängu Blastronaut

Lühikokkuvõte:

Käesolev lõputöö kirjeldab kujuteldavate maailmade ehitamise erinevaid aspekte ning kirjeldab kuidas loodi uusi bioome ja ohuelemente videomängu *Blastronaut*. Ohuelementide eesmärk on muuta mäng mängijale nauditavamaks, lisades rohkem väljakutset ja üldist mänguaega. Lõputöö algab selgitusega, mida mängumaailmade loomisel tuleb silmas pidada. Seejärel kirjeldatakse erinevaid ideid uue sisu lisamiseks Blastronauti bioomidesse. Lõpuks kirjeldatakse bioomide loomise protsessi, viiakse läbi kasutajatestimine ja analüüsitakse selle tulemusi.

Võtmesõnad: Väljamõeldud maailmad, *Blastronaut*, testimine, bioomide loomine, Godot, videomängud.

CERCS: P170 Arvutiteadus, arvutusmeetodid, süsteemid, juhtimine (automaatjuhtimisteooria)

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1. Introduction

Invoking curiosity in players is a useful action in video games. Curiosity is very important in everyday human life because it helps us become better and improve as humans. There are a few definitions of what curiosity is, but generally it is a need to learn and discover something new [1]. Environments for games should be understandable enough to the players. There should be enough familiarity but also enough unexpected and new features. This unexpectedness invokes sensory curiosity, which is invoked by a change of sensory stimuli. In games the main way for getting this effect is using visuals or audio. Another type which is brought out by new functionality is cognitive curiosity. This is achieved by giving the user enough information about something new to keep them engaged until they know most of it [2].

The end goal of this thesis is to explore creating interesting worlds for games and to design different new hazards for biomes in *Blastronaut*. Previously, *Blastronaut* only had one planet that contained all of the available content in the game. With the components added in this thesis, the game will have five different planets, each with its unique look and content.

The first section of this thesis talks about different aspects to keep in mind when creating imaginary worlds and gives a short introduction to what *Blastronaut* is. After that, there will be the different concepts that were implemented as a part of this thesis. Then, the process of how they were carried out will be discussed, and lastly, the results and conclusions of the implemented content will be presented.

2. Research & Blastronaut

This chapter aims to introduce the game *Blastronaut* and research some other similar games. Introducing *Blastronaut* helps better understand the game and helps it be compared to the other researched games. Researching planets and environments of similar games is helpful for making good decisions for *Blastronaut*.

2.1 Blastronaut

Blastronaut is a procedurally generated open-world sandbox game that takes place on an alien planet. The player is an astronaut miner who uses different explosive mining tools and jetpacks to get new resources from blocks and monsters and explore an unknown planet (Figure 1). The game contains various tools which help you go deeper into the planet. A procedural generation algorithm is used for the game world, which creates a unique world based on a seed.



Figure 1. *Blastronaut* Gameplay

The world contains different resources, enemies, tools and buildings. The procedural generation generates content in two different places – above the ground, where there are different rockets, shops and terminals, and below the ground, where the different unique

biomes are located. The biomes are made of blocks that each have their own strength and require different weapons to mine through. They also contain different resources, enemies and structures.

2.2 Similar games

There are already many space exploration games available to the general audience which have received a lot of feedback and criticism. Many of these well-known games have a very similar game loop, where the player finds themselves on an unknown planet on which they can move around and gather resources. This is very similar to *Blastronaut*, so researching the good and bad of such games could be very helpful for designing good planets. This chapter studies four popular space exploration games for guidelines on making good content and what to avoid. There will also be a chapter for world-building to find out how fantasy worlds are created.

2.2.1 No Man's Sky

No Man's Sky is a space exploration game that had a negatively received launch but it improved greatly over time. On Steam, 78% of 226,000 user reviews are positive. The reviewers of this game like that the planets of the game have many different aliens and plants. The majority of the planets have their own unique flora and fauna, which makes exploring them interesting and fresh (Figure 2). The downside brought up by some of the reviews was that the planet generation was somewhat poor. They are very big and often empty, which makes exploring such planets boring. It is important to avoid such issues in *Blastronaut* by reducing the amount of meaningless space in and on planets as much as possible.



Figure 2. *No man's sky*¹ flora and fauna

Initially, when *No Man's Sky* came out, the planets had a huge problem with world-building, and the players stopped playing the game. There were promises of near-infinite planet exploration capabilities, but in the end, it turned out they were similar to each other. This is because life on the planets was generated with the idea to mimic real life genetics. Players of the game didn't notice some of the specific details, like spikes on hostile planets, related to certain ecosystems. The planets were also easily categorizable, and the lack of variety in flora and fauna was disappointing. In the end, the player lacked a story and the feeling of importance to their actions [3].

It is important to make the planets have unique flora and fauna in *Blastronaut*. This way, the players will definitely notice the variety of flora and fauna between the planets. Adding a storyline to *Blastronaut* could also be a good idea to add a feeling of importance to the player, but that is out of the scope of this thesis.

2.2.2 Starfield

Starfield is the worst reviewed game researched during the exploration of various space-themed games. According to Steam, only 61% out of 97,000 of the reviews were

¹

<https://wccftech.com/no-mans-sky-next-gen-update-detailed-4k60fps-and-ps5-support-for-dualsense-tempest-3d-audio/>

positive, which for a game developed by a big studio is not good. The majority of the player base didn't like the game, and one of the only positive aspects I could find some players agreeing on was that the planets are relaxing to explore and there were some planets with interesting flora and fauna (Figure 3). Other than that, there were many negative comments: low variety of planets, low amount of rewards from the planets and the limited exploration and purpose of planets. According to the reviewers, the limited exploration and purpose of planets made the planets uninteresting and bland. It also didn't help that the game had been developed for quite some time already and the price of the game was sixty euros at launch. Many promises made by the developers were broken.



Figure 3. Flora and Fauna in *Starfield*²

2.2.3 Astroneer

Astroneer is a rather well-received game, but the players didn't have too much to say about the planets in the reviews of this game. On Steam, 92% of 100,000 reviews were positive. The main good aspect of the game is that there are interesting objects to find on planets, and the only larger negative aspect is that the players get annoyed with having to start from scratch when they arrive on a new planet (Figure 4). This negative side of the game is also important to keep in mind when making the planets for *Blastronaut*. It would be bad if

² <https://overlayforge.com/blogs/starfield/>

the players got punished by going to a new planet and losing some progress instead of getting rewarded for doing a good job on the previous one.



Figure 4. *Astroneer*³ view from space

When designing *Astroneer*, the developers wanted to design the game following *paidia* design intention. *Paidia* is a game design intention that is less constrained and should allow the player more freedom of choice. With the help of this, they designed tasks for the player to solve using creativity. The developer intended to use *paidia* to create a game where the players can do what they want with the given tools. However, this does not mean that there are no rules at all [4]. For *Blastronaut*, giving the player as much freedom of choice as possible could be useful when exploring the planets. They shouldn't be specifically told what to do there but rather be given the tools and vague guidelines on how to use them.

Astroneer's environments are created using a mix of random generation and manually designed biomes. Using this method, they were able to have better control over how the planets look and play out for the player. This eliminated the problem of having the same challenges on every playthrough and gave the game much more variety [4]. *Blastronauts* generation is already very similar to this, using some premade templates and hand-crafted biome data to create fitting environments.

³ <https://killscreen.com/previously/articles/astroneer-will-take-humanitys-fight-nature-space/>

2.2.4 Outer Wilds

Outer Wilds was the game that received the most positive comments from its player base. According to Steam, 95% of 55,000 user reviews are positive. A wide variety of good elements of the game were brought out: immersive and well-designed planets, interesting gravitational effects, unique challenges on different planets and the volatility of the planets (Figure 5). The only negative side that the players had brought out was the small size and linearity of the planets.



Figure 5. *Outer Wilds*⁴ planetary hazards

Outer Wilds rewards “curiosity-driven exploration”, where the word “curiosity” is defined as a need for knowledge and “exploration” as information-gathering activities [5]. Rewarding exploration is important in *Blastronaut* because each planet in the game will contain something new and unique compared to previous planets. Said uniqueness will not be known to the players before they land on the new planet. The main idea of curiosity-driven exploration is for the player to have an unanswered question and a desire to find an answer to said question. Not revealing all the details is useful for keeping the player interested and excited for the new planets [5].

⁴ <https://www.gameinformer.com/review/outer-wilds/wonder-and-frustration-intertwined>

2.3 World Building

When creating a good world, there are five main structures which make a world whole: nature, culture, language, mythology and philosophy. All of these do not need to be present in every world though. In the case of *Blastronaut* the main structure here to understand well is nature. Nature connects all the material components of the world but the most commonly changed components are usually flora and fauna. By only changing these two things, the world itself will be familiar enough to the natural world. In most cases, world designers try to keep the nature aspect of their worlds close to realism [6]. To keep the planets of *Blastronaut* fairly similar to the player's current knowledge of real-life planets, it is a good idea to implement new and creative plants with simple but unique mechanics. Another possibility is to implement an already existing natural element, be it a plant or rain, and give it a unique twist. This way, the player can have a fun and enjoyable discovery experience that also has some similarities to real-world experiences.

2.4 Research Conclusion

Players expect space-themed games to have interesting and cool planets to explore. In a few of the researched cases, the players have yearned for planets' uniqueness and content. Therefore, it is necessary that the planets in *Blastronaut* are recognizable and vary greatly from each other. This will keep the players curious about exploring any of the planets they have not yet gotten to. Various flora and fauna are useful for creating uniqueness between planets and other interesting effects.

Adding an overall story throughout the planets alongside the exploration could also help keep the player interested in playing the game. This would give them a greater purpose other than just discovering new content on the planets. Since *Blastronaut* has a system for adding custom building templates, it could be an easy way to add structures filled with lore content on different planets. Depending on the player, this could add extra personal investment when found.

3. Content Ideas

The purpose of this chapter is to describe what kind of content ideas were made up as a part of this thesis. These also include the ideas that were not implemented. At the end, there is a description of how the planets are going to work.

3.1 Spreading grass

This plant on the ancient planet spreads its seeds around in the nearby environment upon being destroyed. It also emits a temporary poisonous cloud, damaging the player when they stay in it too long (Figure 6). The main idea of this concept is to have the player be more cautious in certain areas of the underground because if the player tries to keep destroying the plants, it will continuously become more dangerous.

The plant will shoot out three seeds upon destruction, flying left, up and right. When colliding with a block, it destroys the block and creates an identical plant in its place.

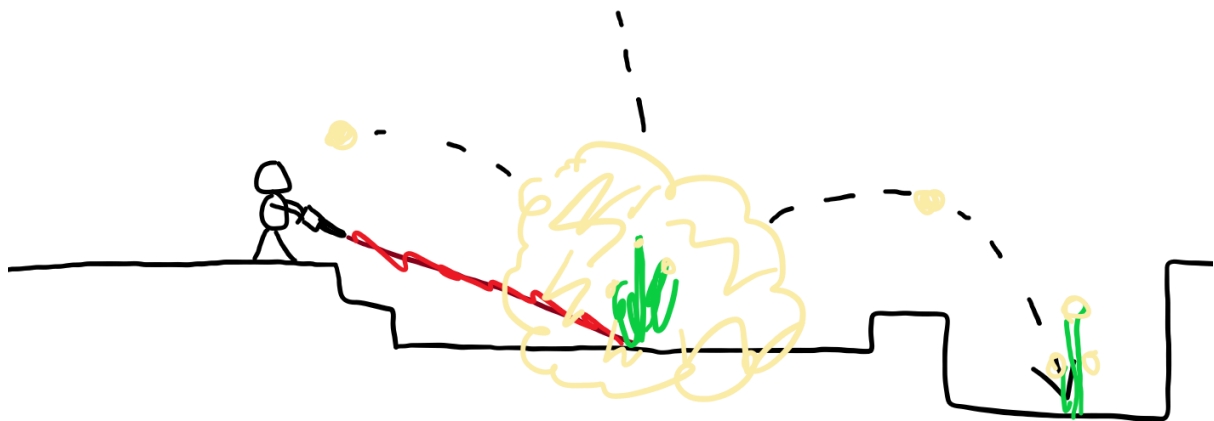


Figure 6. Spreading grass concept image

3.2 Black hole

This is a spatial anomaly that occurs on the alien planet. The black hole appears in some places underground, absorbing any blocks and entities that come in contact with it (Figure 7). It becomes bigger over time, eventually stopping after some amount of time and staying there as a stational hazard. When the player comes in contact with this anomaly, they will receive damage rapidly but can still escape from the black hole's pull if they act quickly.

This is a very dangerous hazard in the world that the player must avoid at all costs. The point of this idea is to have the player be more cautious when exploring the underground caves.

There was also another variation of this concept, where the black hole is less dangerous. It would still pull in the player and the blocks, but instead of damaging the player, it would teleport the player to a different black hole location, after which they would both disappear. This wouldn't make the planet more dangerous but would rather add a new way to explore the different parts of the planet.



Figure 7. Black hole concept image

3.3 Oxygen plant

The oxygen plant would be mainly located on the water planet, attached to a block. This plant would generate oxygen as bubbles which float towards the surface of the planet until they hit a block. Upon contact with anything else but the player, the bubble would pop, and the oxygen would be wasted. Colliding with the player would restore a fixed amount of oxygen to the player so they could keep exploring the planet's depths underwater (Figure 8). Currently, there is no oxygen system for the player when they are underwater, so that would also need to be added alongside the plant. This shouldn't be too hard to implement since the game already has a mechanic similar to this.

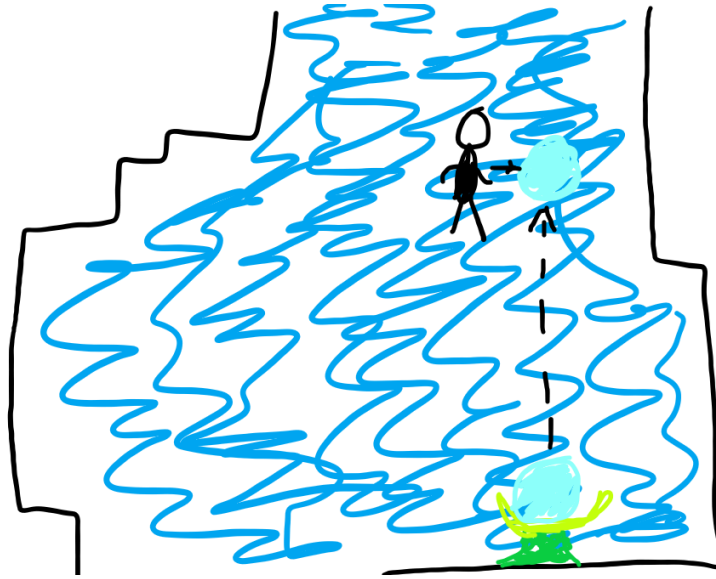


Figure 8. Oxygen plant concept image

3.4 Planetary effects

There are also some ideas for adding different effects on planets, like acid rain, meteor showers and different gravitations on planets. The effects of the acid rain and meteor shower would only be experienced on the surface of the planet (Fig 9). Most of the gameplay is inside the planet, although the player might not see them often. There is also the problem of the meteor shower destroying some of the player-made builds or other important structures in the game, so there would need to be a solution for that as well. Adding different gravitations on planets could be an easy way to add a little bit of variety to the player's movement. Reducing the gravitational pull could possibly make exploring more fun, while increasing it would probably make it more difficult.

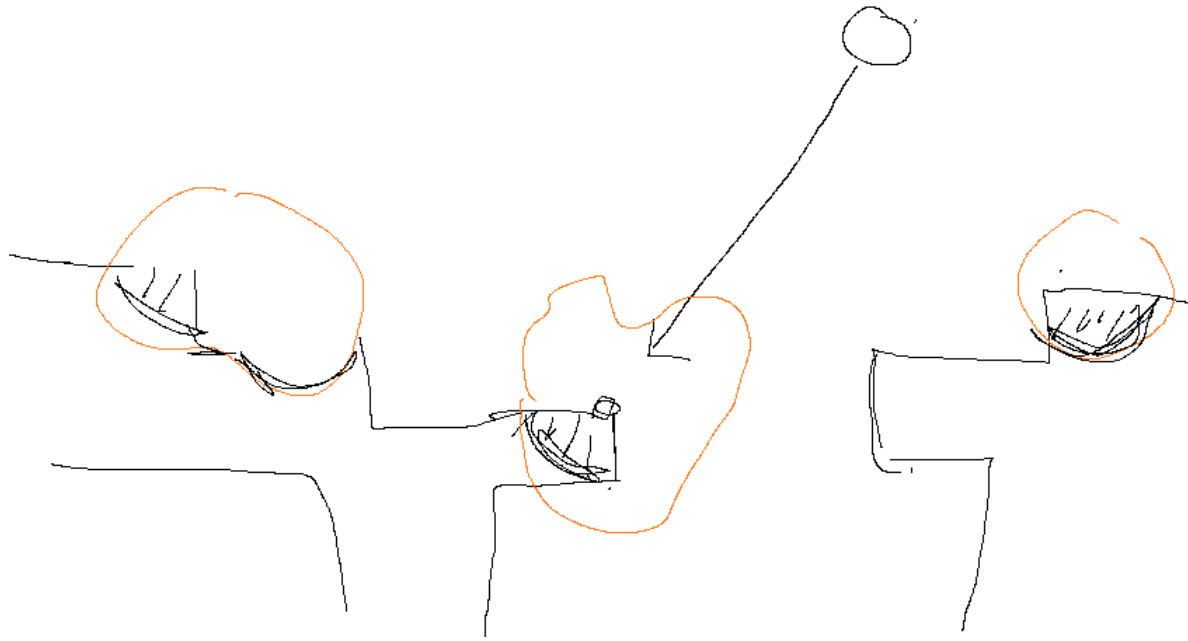


Figure 9. Meteor shower concept image

3.5 Planets of Blastronaut

The main element to tie the previously mentioned ideas together is to implement all of the new and existing content in *Blastronaut* onto different planets. These planets are mainly separated by using already existing biomes, and two new biomes will be added. Every planet should have its unique looks and mechanics, whether it be new enemies to fight or new hazards to avoid. Players need to be excited about flying to a new planet, so using the “curiosity-driven exploration” used in *Outer Worlds* seems to be the best concept for creating said excitement.

There are 5 planets in total: main planet, ancient planet, water planet, crimson planet and alien planet. The main planet is the starting planet for the player, where they will learn the basic mechanics of the game. The planet consists of the few first biomes the player would have most likely met in the previously implemented singular planet: the main biome and the jungle biome. After completing most of the quests doable on the first planet, the player will be able to travel to other planets. The second planet they will be able to explore is the Ancient planet. This planet mostly consists of the ancient biome, but there will also be a new undergrowth biome. This biome will contain the new spreading grass to give the player a new and interesting challenge to look forward to. After the ancient planet, the water planet will be unlocked for the player to explore. As the name suggests, there will be a lot of water on this

planet, and almost everything underground will be submerged. On the next planet, the crimson planet, there are a lot of spikes everywhere. When moved into them too fast, the player will get damaged. There are also hostile creatures who explode when you get too close to them. Lastly, there is the alien planet, where the black holes will be added with a new mesa biome. On the alien planet, there are two types of enemies: ones that explode and shoot out some projectiles and ones that shoot lasers at the player. The new mesa and undergrowth biomes mentioned are for adding visual variety, and they are used to safely implement new hazards (Figure 10).

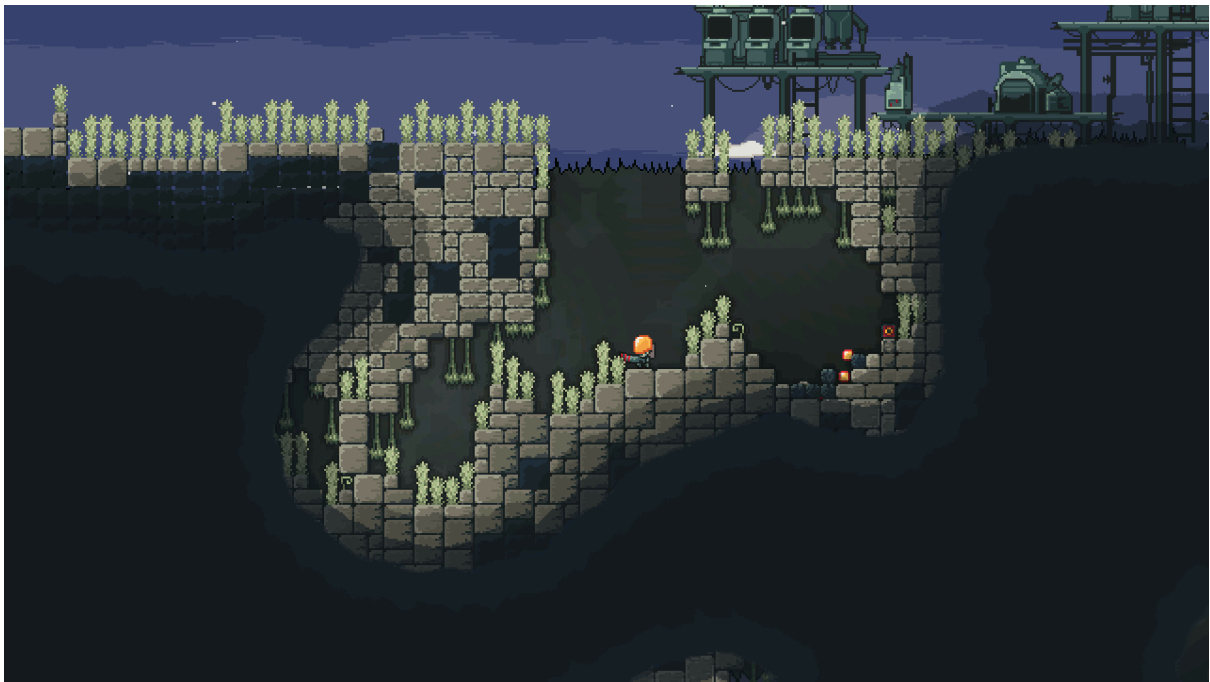


Figure 10. New mesa biome

4. Content Creation Process

This chapter describes the implementation of the previously made-up ideas, including using previously existing systems in the game and making up new methods and rules.

4.1 Spreading Grass Implementation

Implementing the spreading grass was the first practical task. At first, it was needed to understand the base code of the project. The spreading grass was a pretty good piece of content to work on for studying how features were implemented in the game, because it is a fairly simple idea. There were already many reusable and modifiable parts of the base content to suit the needs of the spreading grass. Some examples of this were the poison cloud and the grass seeds which pop out upon destruction. The poison cloud was added a timer node to implement the expiration of the cloud, and for the seeds, the colour and properties of one of the existing projectiles were changed. There was also extra functionality added to the seed to spawn a plant instead of exploding. Visuals for the plant and the poison effect of the plant were added after the functional implementation.

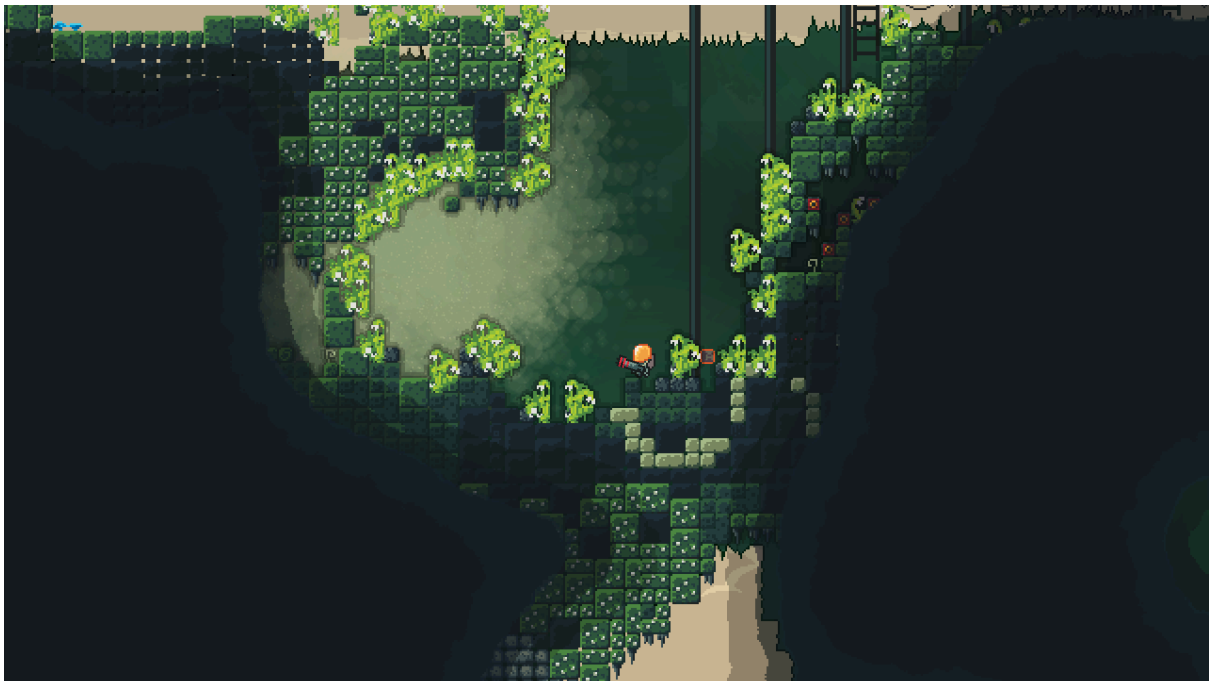


Figure 11. Spreading grass and the poison cloud from destroyed grass

4.2 Black hole implementation

The black hole was the second feature to implement for this thesis. Firstly, the effect of the spreading grass is taken as a template for the black hole. This base was modified by adding the expanding and the tile destruction effect of the black hole in the script. The functional effect added to the black hole was the pulling of the player towards the centre of the black hole. The pulling works by taking the normal vector of the player towards the black hole and calculating the pull force based on the player's distance from the centre of the black hole. A rotational functionality is added by turning the previously mentioned normal vector by ninety degrees and adding a force towards that direction as well. After the functionality was implemented, visuals were also added to the black hole (Figure 12).



Figure 12. Black hole in the mesa biome

4.3 Planet Creation

Firstly, all of the currently existing biomes were separated into 5 planets. In *Blastronaut*, there are different scenarios defined by data. These scenarios make up the different gameplay settings to create new experiences for the player. For the planets, 5 new scenarios were created with the parameters of the new planets. Amongst the parameters the most important parameter is the biomes list. In that list all of the biomes of the current planet will be present alongside a parameter to define the starting depth of the biome. This way,

there will be more incentive for the player to go deeper and discover some of the new biomes that are present there.

Biomes are also defined with a similar structure but with more important parameters to shape the planet. Each biome is defined as a separate JSON file and contains several important fields. Some of the most important fields here are the ones that define the biomes' resources, enemies and templates. The template parameter defines what kind of handmade constructions will be present in the biome. These constructions are made using the *Blastronauts* template creation tool. The tool defines small templates, which are 8*8 blocks big, and large templates, which are the size of a chunk and are filled with 8*8 of the small templates [7]. A master template was put together to test the functionality of the spreading grass and black hole as well. The master template contained one small template of the spreading grass and two black holes with placeholder art (Figure 13). This was then placed into one of the scenarios manually.

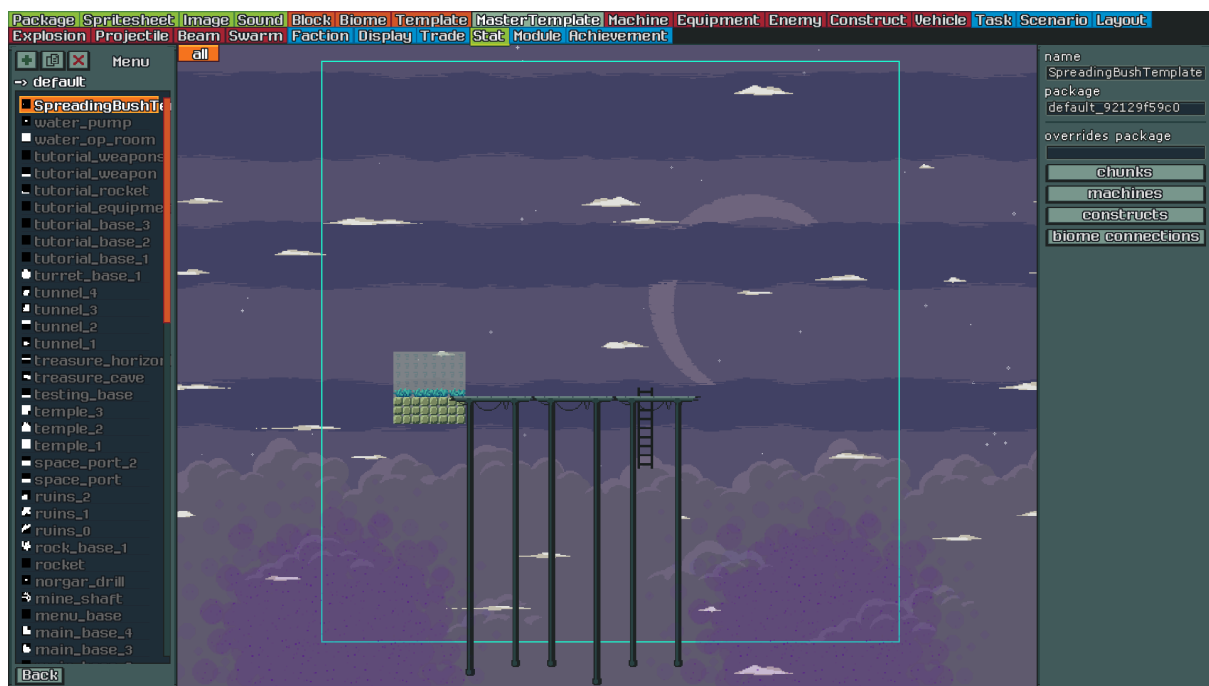


Figure 13. Master template which was used for feature testing

5. User Testing

After everything was implemented, user testing was carried out. For the testing, four biomes were selected for the player to try: two biomes already in the game and two new biomes. The two biomes already in the game are the jungle biome with gas clouds inside it and the crimson biome with spikes. The two new biomes are the ones with the spreading grass and the black hole. All of these biomes were tweaked by removing all of the distracting factors from the player so they could just experience the biomes and their unique effects.

A questionnaire was created to evaluate these new biomes. Firstly, the main purpose of the testing and the instructions on how to rate the biomes were made clear to the tester. The biomes were to be rated on three metrics on one out-of-ten scale: visuals, fun and intuitivity. The visuals category asked the player to rate how good the new biomes and features look and if they fit together. Fun asked them to rate whether the exploration of the biome was enjoyable or annoying. Lastly, the intuitivity category asked them to rate how understandable the functionality of the hazard was. There was also a question asking the tester to write down what hazard did they see in the biome. This question made it possible to see if they understood what they saw. An additional two non-mandatory questions were added to the end, asking the tester to write what they did and did not like. On each question page of the questionnaire there were links to the builds which contained the current biome to be tested. This was done to limit the chance of accidentally rating the wrong biome .

5.1 Results

A total of six people filled out the questionnaire. The test results show that the players rated the new biomes equally to the previously existing ones. Visually, both of the new biomes were rated higher than the older ones, with the crimson biome being rated the lowest. In the fun category, all of them were on average close to each other, but for some reason, the older biomes were rated more consistently, while the new biomes had either votes in two and three or eight and nine out of ten. In terms of intuitivity, the jungle biome had the highest overall rating. The lowest rated and most varied was the crimson biome and its spikes. Both of the newer biomes had very similar average ratings in all categories (Figure 14).

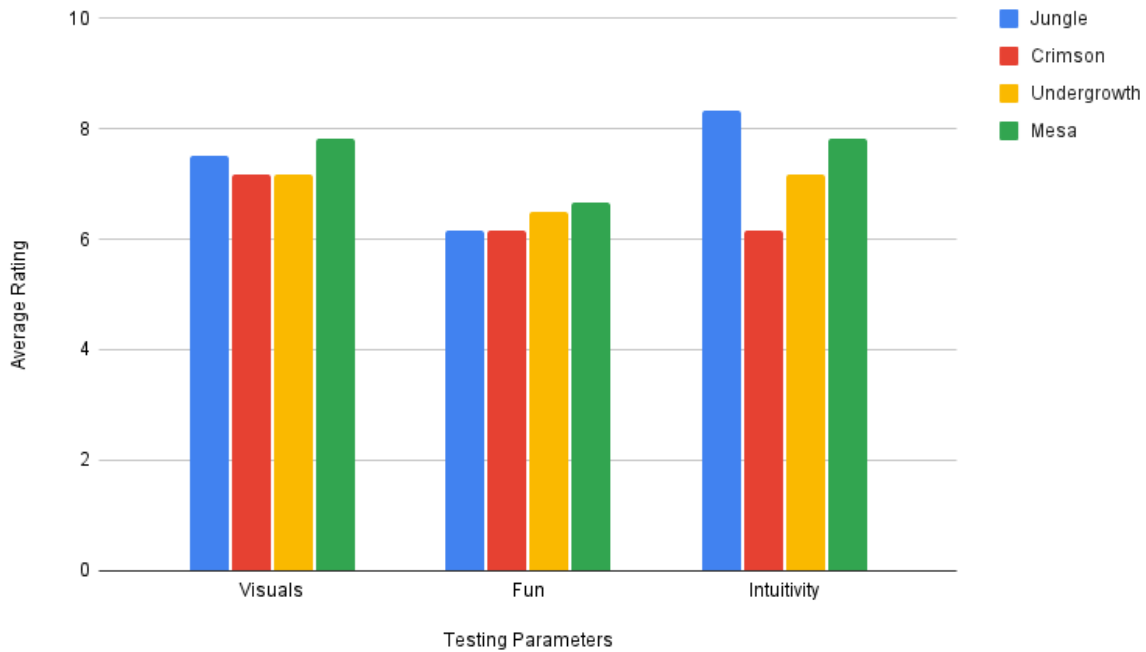


Figure 14. User testing results

Testers seemed to understand well what they saw in the biomes. Every answer to the question asking them to see what they saw in the biome was sufficiently written to describe the hazard. Some positive feedback for the spreading grass plant and the undergrowth biome was that players liked how unique it felt and found it an interesting concept. Negative feedback for this feature revealed that there were too many plants and that using mining tools was too hard. This difficulty was intended from the start but could perhaps use some tweaking if it created unenjoyable problems for the player. Positive feedback for the mesa biome and the black hole complimented the visuals of the entire biome and black hole. The functionality of the black hole was also brought out. The main negative side was the high density of the black holes. This problem is easily fixable by changing some of the variables in the code.

6. Conclusion

Curiosity is a very useful tool to get the players to explore a video game. This thesis explored four space exploration games to help develop enjoyable experiences for the game *Blastronaut*. Many examples and revelations were kept in mind when creating and coming up with the new hazard ideas.

As a part of this thesis, some new content was added, and the game's overall game loop was changed. The players could now travel between different planets instead of everything happening on a singular planet. All the planets are visually unique and recognizable by their flora and fauna. Two new pieces of content were added on the planets: the spreading grass plant and the black hole. These offer variety and more uniqueness to the planets to which they were added. New biomes and visuals for them were added across the planets to implement the spreading grass and black holes.

From feedback, the new features and biomes were well received by the players although there were some aspects which could potentially be changed in the future. The hazards were easily understandable and the concepts of the new ideas were positively received by the testers.

For future plans it would be nice to implement all of the planets into the game properly and keep properly polishing out the implemented hazards. It would also be useful to implement the other content ideas, test and polish them.

The author of this thesis would like to thank the supervisor, Jaanus Jaggo, for guiding me and providing useful feedback during the meetings and development. A special thanks to the CGVR lab for providing useful resources on writing and defending a thesis. Last but not least a huge thank you to the testers of the biomes and their hazards.

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Appendix

I. Questionnaire results as tables

The user testing responses are shown in tables 1, 2, 3 and 4.

Table 1. Jungle Biome

What hazard(s) did you find?	Visuals	Fun	Intuitivity	What did you like?	What didn't you like?
I saw a poisonous green cloud	7	7	9	-	-
Poisonous spore clouds	9	6	9	Very clear visuals	A lot of poisonous clouds.
Green fog	8	9	10	-	-
Gas	7	4	8	Gas looked nice	-
Poison cave	7	7	6	-	-
Poison gas	7	4	8	Mingling with the laser	There is gas everywhere

Table 2. Crimson Biome

What hazard(s) did you find?	Visuals	Fun	Intuitivity	What did you like?	What didn't you like?
Spikes that hurt you when you touch them	6	5	7	-	-
Floor an ceiling spikes	8	8	8	-	-
Spikes, grey falling bricks	9	8	6	Colour scheme	-
Spikes	7	3	5		Took me some time to understand that the spikes weren't just visuals
Thorns	8	9	9	-	-
Spikes	5	4	2	Mining straight down	Too easy to blow self up

Table 3. Undergrowth Biome

What hazard(s) did you find?	Visuals	Fun	Intuitivity	What did you like?	What didn't you like?
Plants that spread and make a toxic cloud when you destroy them	8	8	8	-	-
plants that spread temporary poisonous pollen and create more of the plants when destroyed around the area of the pollen.	9	9	8	Interesting concept for a hazard.	Smallest hazardous plants are very hard to notice but seem to produce clouds of the same size as big ones.
Green poison plants(?)	6	9	10	-	
Flowers spreading poison	7	3	5	-	Too many flowers
Spreading plants of poison	8	8	10	I liked the fact that the plants spread upon hitting them with my laser. That is something I have not seen before in games as such	-
Plants that emitted poison when mining	5	2	2	-	Could not use laser well

Table 4. Mesa Biome

What hazard(s) did you find?	Visuals	Fun	Intuitivity	What did you like?	What didn't you like?
Black holes that suck you in and kill you	10	9	9	-	-
Black holes.	9	8	9	Biome looks great. Black hole looks great.	Density of black holes is very high and they are all of the same size. Overlapping black holes look weird.
huge black holes	9	9	8	The black holes. Both the function and how they look	Colour scheme is a bit bland
Black hole	5	3	9	Black hole looks cool	Two black holes together look goofy
Expanding black holes of death	10	9	10	-	-
Black holes	4	2	2	-	Game was boring

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Biome hazard creation for Blastronaut game
supervised by Jaanus Jaggo

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