an alternative paradigm

'an alternative paradigm'

an exploration into systemic design within a virtual game ecosystem, to elicit ecological consciousness.

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Abstract

This research explores the potential of utilising systemic design in the creation of a virtual game ecosystem to generate ecological consciousness, which is an alternative perception of the natural world that focuses on realising a mutual coexistence between humans, nature, and the non-human. Presently, systemic design within video games is not situated firmly within the academic realm, and this research proposes a definition for the term as designing game systems that are aware of each other, and therefore have the ability to interact. Through traversal of design research surrounding ecosystems and their position within video games, it was found that evolving game environments and their living components from background scenery to ecological models that have their agency foregrounded has the potential to drive philosophical ideology.

Employing the cyclic methodology of iterative design, the creation of the game artefact through numerous prototypes presents a thriving digital ecosystem, that embodies principles of systemic design and used reflective practice to investigate how to coalesce it to provoke alternative environmental thinking. The eventual artefact presented is *Apis*, which is Latin for 'honeybee', the virtual reality game-world and its play endeavouring to foster ecological consciousness through observation, moments of enchantment, and limiting the player's ability to dominate and destroy. *Apis* demonstrates that designers don't have to shame, teach or punish the player to present moral precepts, and ecological consciousness was created through this enforcement of placing the player equivalent to bees or rain within its virtual ecosystem. This research has the potential to cast new shadows in the way designers can make, and players can think about games.

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All videos in this list were recorded by me, during the development of Apis.

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Critical Commentary

Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

signed:

date: 09.07.2022

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This thesis is dedicated to my granddad Peter Jackson, who sadly passed away while it was in progress. He helped raise me to believe I could achieve anything.

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chapter 01

Introduction

01

Introduction

This exegesis documents the practice-based research undertaken towards exploring systemic design within the creation of a virtual game ecology, and how their coalescence can cultivate moments of ecological consciousness within a player. This research produces a significant, playable artefact named *Apis*, that instigates enchantment through observation, and limits the player's ability to be a dominant, destructive force in order to promote and develop divergent ecological thinking.

This research project takes the position that humans as a species have severely impacted the environment and inhabitants that live within it. Utilising the medium of video games, I am approaching this outlook with an alternate to raising environmental awareness, and rather attempting to foster ecological consciousness. This alternative paradigm endeavours to give players a non-nihilistic position in which they could re-orient their thinking surrounding the environment.

This research also seeks to establish systemic game design firmly within the critical discourse surrounding game design academia, approaching it as an effective design tool to create virtual ecosystems that are more realistic and representative of natural ecological systems.

Through the distinctive interactivity of video games, systemic design can provide the means to create a virtual ecosystem that can develop connections with the user, to simulate the interconnectedness required for re-thinking human attitudes towards our ecology. Through traversal of design research surrounding ecosystems and their position within video games, authors Chang, Abraham & Jayemanne and Gualeni discuss how evolving game environments and their living components from background scenery to ecological models that have their agency foregrounded has the potential to drive philosophical ideology. Influenced by Morton's knowledge pertaining to ecological consciousness, this research develops a representation of this ideology in attempting to cast new shadows in the way designers can make, and players can think about games.

Employing an iterative design methodology, with emphasis on reflective practice, allowed the research to manifest its knowledge through the combination of prototypes and the critical contemplation they presented. The artefact outcome developed during this research applied systemic design to construct a simulated, autonomous ecosystem to encourage an alternative environmental thinking position, as well as exploring new strategies towards connecting game design processes around the biodiversity emergency in a way that avoids nihilistic worldviews.

Research Question

The research intends to explore systemic design as a tool for creating an autonomous ecosystem, and how this can foster a divergent environmental paradigm in players. Therefore, this exegesis asks the single research question:

"How can systemic design be utilised in the creation of a virtual, self-sufficient ecosystem within a game-world, to elicit moments of ecological consciousness within a player?"

chapter 02

Contextual Review

Keywords of the Research

Ecology

The term 'ecology' is encapsulated as "the scientific study of the interrelationships of organisms with their environment and each other," (Pimm and Smith, 2019). Originally derived from the Greek *Oikos*, meaning 'home' or 'household', ecology is often described as the study of the 'home life' of organisms (Begon et al, 2006). This includes the study of specific ecosystems.

Ecosystem

This research focuses specifically on the creation of these ecosystems, which are "the biological community together with the abiotic environment in which it is set" (Begon et al, 2006). This includes the plants, herbivores, carnivores, parasites, insects, decomposers, detritivores, and scavengers, within their environment and living conditions (Begon et al, 2006). An ecosystem is filled with varied relationships and interconnections that all rely on each other to balance and function.

Systemic Design

Systemic design has been defined for this research as game systems that are aware of and are able to interact with each other.

Artificial Intelligence (AI)

Artificial Intelligence, or broadly known as AI, are processes that are undertaken by machines, often to mimic human intelligence to perform tasks without human control (Burns et al, n.d). It is used in video games often to create non-player character (NPC) responsive or adaptive behaviours, without input from the player. These behaviours can "vary from navigation and pathfinding, to decision making" (Yannakakis, 2012).

Virtual Reality (VR)

VR stands for 'Virtual Reality,' which is a simulated environment viewed through a head-mounted device. Within video games, the immersive experience often allows players to interact with the virtual world, using motion-tracked controllers as hands (Bardi, 2019).

Ecological Conciousness

Ecological consciousness refers to a different way of perceiving the natural world, by realising a mutual coexistence with all the non-humans that surround us (Morton, 2016).

02

Contextual Review

> "Humans have stamped
> their impression
> on things they consider
> as ductile as wax,
> even if those things cry."
> (Morton, 2016, p. 23)

This chapter aims to contextualise systemic design in games, ecology and ecological consciousness, and the intersections between them, to investigate the research question and the possibility of creating a playable artefact that embodies all three concepts.

Ecology

1. The Paradigm

The interactivity of games creates a unique platform in which they can represent real-life contexts and simulations, giving players the ability to influence or observe through 'play.' (Salen and Zimmerman, 2004, p. 413). This project proposes that games and a representation of the ecology should be combined in order to promote new ways of thinking about the environment. In Gualeni's book, *Virtual Worlds as Philosophical Tools* (2016) he discusses if experiencing worlds that are not "actual" can change ways of structuring thought, and explores the potential of virtual, simulated worlds opening up avenues for philosophising (Gualeni, 2016). His research, influenced by theorists such as Heidegger, elaborates that the relationships humans manifest with artworks or artefacts "can establish new worlds and facilitate the emergence of alternative worldviews" (Gualeni, 2016, p. 38).

The prospects of an ecologically-accurate virtual world have been discussed by Abraham and Jayemanne as potentially contributing to an understanding of the accelerating environmental challenges facing the world (Abraham & Jayemanne, 2017). In Abraham and Jayemanne's paper aptly titled 'Where are all the climate change games?' they discuss how the extent of existing work built for environmental thinking are educational or 'serious' games[1], which lack the artistry and engagement to truly contribute to a new way of thinking about the current environmental crisis (Abraham and Jayemanne, 2017; Gualeni, 2016). Therefore, this research is positioned within their question of,

> *"What could artists working with digital games, as well as the mainstream games industry itself, be doing to encourage an ecocentric[2] perspective?" (Abraham and Jayemanne, 2017, p. 75)*

1. Abraham and Jayemanne comment that "a substantial number of environmental games are quite simple [...]and focus on the one-dimensional mediation of information" (Abraham and Jayemanne, 2017, p 77).

2. Ecocentrism finds value in all of nature. It "takes a much wider view of the world than does anthropocentrism, which sees individual humans and the human species as more valuable than all other organisms." Retrieved from: [https://mahb.stanford.edu/blog/statement-ecocentrism/]

1.1 Games with Ecosystems

In order to design an ecological game world, this research will analyse several attempts throughout gaming history with variable debated outcomes. Abraham and Jayemanne argue that the environment in most non-pedagogical video games can broadly fall into four distinctive categories: Environment as backdrop, where it is nothing more than an empty space in which movement takes place; Environment as resource, where the environment is something to be exploited and used; Environment as antagonist, where it is something to be destroyed; and environment as text, designed specifically to suggest a narrative (Abraham and Jayemanne, 2017). However, they contend that none of these models are "fully able to embody a perspective that avoids reproducing the same types of human-nature relationships that are so problematic towards the climate crisis" (Abraham and Jayemanne, 2017, p. 79). These 'problematic relationships' are described by Chang, who states that "a good deal of mainstream gaming[3] demonstrably rests on modes, mechanics, and corporate practices that are fundamentally anti-environmental" (Chang, 2020, p. 70). She notes that the ideal environmental content should bring the environment and its inhabitants to a level of importance equal to the player (Chang, 2019).

Within Chang's book, 'Playing Nature' (2019), she asserts that "games remain largely untapped in terms of their potential to create interaction within intelligent environments" (Chang, 2019, p.16). She focuses her research on how environmental criticism and game studies have much to gain from breaking disciplinary isolation and how game designers have yet to expand interaction within a game's environment aside from destructibility or dominance. She sees games as opportunities to suggest the power of non-human agency, rather than relegating them to the background of play. In this regard, she elaborates that meaningful environmental games should contain the "modelling of ecological dynamics based on interdependence" (Chang, 2020, p. 24). This highlights the importance of an artefact that contains weather, biomes, seasons, or species distribution to generate an environmental reality.

3. For example, games like Minecraft (Mojang, 2011), The Forest (Endnight Games, 2014), No Mans Sky (Hello Games, 2020) and Civilisation VI (Firaxis Games, 2016) are all completely different genres (sandbox, survival, exploration, and turn-based strategy), and all have gameplay revolving around the destruction of their environment in order for the player to survive.

Figure 2:1 //
Far Cry 4's upgrade system.
All these multiple upgrades require the skin/hides of various wildlife within the game (Ubisoft, 2014).
Retrieved from: [https://www.ign.com/wikis/far-cry-4/Crafting]
Copyright 2014 from IGN.

In addition to how video game environments are developed, there is the key issue of its inhabitants. In copious game environments that contain wildlife, they exist for the player as enemies or to be harvested for resources (Abraham and Jayemanne, 2017).

Two examples of this are clearly seen within two game franchises produced by the same company Ubisoft, in which violence against animals is actively encouraged. In Assassins Creed (Ubisoft, 2007 - 2020), and the Far Cry series (Ubisoft, 2004 - 2021), most wildlife is hostile towards the player, and will actively seek out and attack them for seemingly no purpose, whereas the few docile animals are used for resources, income[4] or sport[5]. In all the Far Cry games, hunting both docile and hostile animals is integral to progression, where the player requires varying resources from most of the creatures in order to upgrade their character's capacities[6] (Figure 2:1).

Whilst violence is a common use of ecology built for entertaining gameplay, this research is interested in the design of a systemic ecology that thrives on awareness outside of the player's personal gain, to witness AI agents and their emergent interactions with each other and their environment, and overall how they can be affected by the player's actions in a pro-environmental way.

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4. Specifically, in Assassin's Creed 4 (2013), whale hunting is the main source of the player's income.

5. FarCry 6's cockfighting game is an example of this; A minigame in which the player plays as their rooster vs another, in very bloody and violent combat.

6. Video Game Blogger, Zwahl, calls these principles an "engine for exploitation, where every entity is part of a checklist, where all life is a resource, where creatures are reduced to entertainment." (Zwahl, 2020)

Ultima Online

There are drawbacks to an interactable thriving environment that gives the player the ability to disturb it. Ultima Online (Mythic Entertainment, 1997) implemented a basic ecosystem as a background to the player's combat-based gameplay, using animals as a minor resource. Herbivores ate grass, predators ate herbivores, and players could kill them both. In a video produced by Ars Technica (2017), the lead creator Richard Garriot tells the story of how they [Mythic Entertainment] spent years creating a virtual ecology that players destroyed the moment it went live. As Ultima was an MMORPG[7], this meant the game had thousands of people playing it simultaneously. Garriott describes the launch of the ecology feature as,

> *"Players ran over the world like a swarm of ants, that consumed every living thing as fast as it was possible to spawn it."*
> *(Garriott, 2017)*

As soon as a creature was spawned in-game, the nearest person killed it for its resources, or "just because it was fun" (Garriott, 2017). Potential fixes were considered and trialled, such as decreasing the resources dropped on creature death or increasing animal spawn rates. Conclusively, the developers could "not keep up with the rate that the players massacred anything and everything that moved" (Garriott, 2017) and removed the ecology system entirely.

Conceptual curiosity is the impulse to engage in exploration to seek information, and the desire to find things out (Alexandra et al., 2016; Kreitler et al. 1975). As "curiosity lies deep at the heart of play" (Alexandra et al., 2016, p. 3) players will explore all the actions and interactions available for them to play with. Alexandra et al note that, "players will have expectations about the possibilities of their environment, and they work to verify if their expectations are accurate" (Alexandra et al., 2016, p.8). Once the players saw they could hunt the AI animals for resources, it became a mechanic provided to them by the developers, and they used it to simply play the game. In terms of creating an ecology that is built for observing interactions, the systemic world built in this research project should remove the potential for violence. Instead, the world should encourage the player with more neutral play mechanics, supporting the projects' point of deep ecological thinking, rather than destruction.

7. MMORPG stands for "massively-multiplayer online role-playing game." Retrieved from: [https://www.dictionary.com/browse/mmorpg]

Rain World

An example of an ecosystem built less for the player's intervention and resource-harvesting is showcased within the game Rain World (Videocult, 2017). The game contains its own carefully crafted ecosystem, of which the developer Jakobsson describes his creatures as not just existing to be an obstacle for the player, but existing perpetually for themselves (Priestman, 2017). As a 2D platformer, where the player's main objective is to avoid or mitigate the danger they find themselves in (Figure 2:2), Jakobsson approached the design of their game differently. Instead of designing the creatures around the player's behaviour, Jakobsson described their process as "from the angle of 'how can I make this creature behave in such a way that it can find food and move around and get back to its home before the night comes'" (Jakobsson, as cited by Priestman, 2017). It produced a realistically built ecosystem that continually performed even when the player wasn't watching. This highly influential concept reinforces the systemic design notion of making agents "feel less like set pieces" (Chang, 2020, p. 72) to back up the player's experience of the game and encourages the sense of a living, interconnected world, as well as providing inspiration to begin the design process from the perspective of the ecosystem, not the player.

Figure 2:2 //
Rain World's creatures (Videocult, 2017).
Retrieved from:
Priestman, J. (2017). *Crafting the complex, chaotic ecosystem of Rain World.*

Figure 2:3 //
Paper Beast (Pixel Reef, 2020). Retrieved from: Graham, P. (2020). *Review: Paper Beast.*

Paper Beast

"There is tons of data everywhere. But what's happening inside? Well, there are tiny bubbles of life emerging. And that's the Paper Beast world."
(Eric Chahi, 2020)

The VR (Virtual Reality) game Paper Beast (Pixel Reef, 2020) adopts a kindred viewpoint to Rain World's focus on an ecosystem design foremost. In Paper Beast, the creatures are less of an 'obstacle' to the player, instead, their presence being part of the core gameplay. The player is given no set objective or weapons, and the only game interactions involve picking up the creatures with telekinesis, or adjusting the terrain around them, to observe the simulation's adaptivity. The "beautifully bizarre origami-like animals" (Eric Chahi, 2020) are merely curious about the player, who poses no threat to them. The creature's behaviour is observant and complex, even having the ability to work together to knock fruit off trees.

Creative director Eric Chahi discusses how they approached the design of their game with the goal to create "incredible but credible wildlife," with physics, animal behaviour, and real-time reactions in relation to their shifting environment (Eric Chahi, 2020). He describes Paper Beast's world as containing bubbles of life, where everything in the simulation is connected. (Figure 2:3).

Paper Beast provides knowledge of the importance of focusing on relationships within the game-world, between creatures, their flora, and their environment, and it is these relationships that truly create simulated "life." The design of a systemic ecology thrives on awareness outside of the player, to witness AI agents and their emergent interactions with each other and their changing environment.

One of Chang's principles for achieving more environmentally intelligent games focuses on "foregrounding the agency and unpredictability of game ecologies" (Chang, 2019, p.38), which is what this project aims to achieve. I intend to accomplish it through an investigation into the programming and dynamic creation of an ecosystem, including using the environment as not a backdrop but as an integral part of the ecosystem. The paradigm that this project holds is to not see physical environmental laws as "fetters to imaginative world-building" (Chang, 2019, p.38) but instead see them as an opportunity to connect environmental thought and games, and accurately design these ecological relationships.

1.2 Ecological Models

Environmentality within games requires an accurate model of ecological states (Chang, 2019; Gualeni, 2016). Designing a functioning ecological model requires investigation into real-life behaviours and relationships. There are a lot of factors involved to maintain ecosystems and drive specific behaviours, in both animals and plants (Budaev et al, 2019).

These behaviours can be broken down to their core assumptions and models documented within ecological literature. Begon notes that "the challenge of ecology is to develop an understanding of very basic and apparent problems, in a way that recognizes its complexity, but seeks patterns and predictions rather than being swamped by it" (Begon, 2006, p. xi). According to Dickinson and Murphy, ecosystems can be analysed using concepts of system theory, an approach that provides general rules and predictive models [See Appendix 01] to understand complex ecological structures (Dickinson and Murphy, 2007).

Deriving from patterns and models documented throughout ecology books, the primary animal behaviours focused on for this research are those of needs (food or water), predation and reproduction. Baumeister (2015) claims these are the key survival motivations of animals. Choosing between motivations requires an animal cognitive system that must be able to adapt to situations, as well as its own needs, "by dynamically adjusting the information input in real time, including which stimuli to process and which to ignore" (Budaev et al, 2019, p.4). An animal's decisions, after being able to sense all the options available within their surroundings, should be based on their current biological priorities (Broom, 1981).

Plants within an ecosystem are equally vital[8], providing animals with food, shelter and camouflage (Begon et al, 2006). Incorporating the details of plant growth, reproduction or decomposition corresponding to relationships with their surrounding fauna will add integral ecosystem dynamics. These interconnected systems will be modelled in game by programming systems of AI agents with the responsive behaviours discussed above, within all the flora, fauna, insects, and environmental factors.

8. "It is clear that at the heart of ecology lies the relationship between organisms and their environments," (Begon et al, 2006, p. 3)

2 *Defining the Term*

As the area of academia surrounding game design develops, Salen and Zimmerman (2003) note that it is important to establish a critical discourse to expand and share knowledge within this emerging field. For this research, a clear interpretation of 'systemic game design' must be distinguished. In relation to game studies, systems are defined as "a group of interacting, interrelated, or interdependent elements forming a complex whole" which Salen and Zimmerman maintain that through this definition, all games can be understood as systems (Salen and Zimmerman, 2003). Correspondingly, the English definition of systemic means to affect the whole of something, rather than its singular individual parts[9].

The concept of 'emergence' has received more attention in academic game design literature (Ferreira et al., 2017). Defined as unexpected behaviour that occurs when simple game rules interact (Rabin, 2004), Sweetser discusses emergence in video games as non-scripted interactions between entities, built from a "globally designed game system" providing rules around the player's interactivity (Sweetser, 2005). Game developer Harvey Smith explained that if gameplay interaction is brought about by consistent rules, outcomes can come from relationships between these rules, and noted that "systemic gameplay lets the player innovate" (Smith, 2002). By naming the gameplay with emergence systemic, this research can infer that emergence is when rules interact, and systemic design is the process of designing these interconnected rules, and therefore their worlds [See Appendix 02].

Robin Walker, one of the developers of Half Life (Valve, 1998), talked about concepts of creating emergence through symbolic links which are the entities communicating to each other via code (2004). Sweetser identifies the gap for systemically designed games, insinuating that most game environments are unresponsive to players and events, their agents "unaware of their surroundings" (Sweetser, 2005, p. 6) which is something to be remedied with systemic design.

With these clear definitions of what systemic design can create, this project defines the method of design as such. My aim is to design game systems that are aware of each other and therefore have the ability to interact. Systems such as the environment, the weather, the natural elements, the time of day, the Artificial Intelligence[10], objects, and the player, all have a defined set of rules that enable them to behave accordingly in relation to other rules.

9. Retrieved from: [https://www.collinsdictionary.com/dictionary/english/systemic]

10. AI within a gaming context refers to enemies, non-player characters [NPCs] and animals.

Figure 2:4 //
The relationships between systems, originally designed to represent the overarching systems of emergence but can be applied to systemic design as a whole, "where the numbers represent an ensemble of agents, R = set of relations, P = shared properties." Retrieved from: Ferreira, N., et al. (2017). *Emergence in Game Design: Theoretical Aspects and Project's Potentialities*, p. 599)

These interconnections aim to make game worlds and their inhabitants seem like "more than mere set pieces" (Chang, 2020, p. 72). To realise systemic design, it is imperative to create a consistent, interconnected game world where systems can affect, influence or react to others in dynamic ways (Figure 2:4).

2.1 Systemic Design in Games

Games have been showcasing elements of systemic design since the original Doom (id Software, 1993) introduced the exploding "red barrel"[11], when hit with the player's bullet. Aspects of the world acknowledge and respond to the players' interaction - but too often just the player. Crawford and Muriel state that most video games revolve around this notion that the player is the protagonist, and "the one in charge of manipulating the flow of what is happening on the screen" (Crawford and Muriel, 2020, p. 147). Similarly, Gualeni claims that most virtual worlds within video games are predominantly developed and structured around the player's ability to perceive them[12]. He discusses how "objects that are too far away from a player, those whose sight is blocked by other objects, and those that are momentarily irrelevant for gameplay effectively do not exist as far as the game states are concerned" (Gualeni, 2016, p. 90). These common design notions lead to elements of the game world ignoring each other, and only being able to interact with the player.

11. The red barrel implies the containment of gasoline, and when combined with the bullet from a player's weapon causes an explosion.

12. With exceptions, such as the previously discussed Rain World (Videocult, 2017).

However, the Far Cry series (Ubisoft, 2004-2019) extends interaction behaviour to elements of the game-world, where if enemies and wild animals come in contact with each other, they will engage in combat rather than ignore one another[13]. Their systems are interconnected, not just to the player. In this one aspect, the game does not "just react to [the player's] input" (Arsenault and Perron, 2009). Instead, the simple rules (of animals being aware of enemies) lead to complex gameplay experiences (Nacke, 2014) [See Appendix 03 for example].

One of this research's most prominent influences towards defining systemic design was Nintendo's Zelda: Breath of the Wild (2017). Zelda has been praised by reviewers as a dynamic, living world where "each element of the game engine affects other elements" (Bolano, 2018). When it rains, the whole game-world is affected. NPCs and creatures seek shelter (Figure 2:5), the ground becomes a muddy landscape, rocks become too slippery to climb, and campfires, or Link's fire-magic, sputter out. The rules are consistent - there is no form of fire that resists water, and NPC's and the environment are aware of the weather state, and behave accordingly.

13. Ubisoft have utilised this as a tactic to defeat some enemy camps, as sometimes there will be a caged predator in the camp that the player can free from a distance, and the predator will cause damage to the enemies in their vicinity.

Figure 2:5 //
NPCs take shelter from the rain in The Legend of Zelda: Breath of the Wild (Nintendo, 2017).
Retrieved from: [https://annyllel.tumblr.com/post/670124040357314560/embed]
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These relationships between all factors in the game world can be likened closely to the core concept that ecosystems exist through their relationships. In order to represent a thriving ecology, the project should contain creatures that are aware of each other and their environment, which is why systemic design has been chosen to explore this research.

Ecological Consciousness

3 Environmental Awareness?

"The simple idea that everything around us
may somehow be impacted by our presence,
let alone our actions,
is a tenet of ecological thinking."
(Alenda Chang, 2020, p. 71)

Ecological thinking can be misconstrued as the political, social or educational goal of raising 'environmental awareness.' (Code, 2006, p. 24). It is no secret that our environment and climate are under serious duress (Axon, 2017; Morton, 2007; Abraham et al, 2017; Almassi, 2012; Darr 2019; O'Sullivan and Taylor, 2004). While awareness on the benefits of living sustainably is supported by environmental writer Axon as an important first step to alternative living, he notes that "the provision of information alone does not necessarily lead to lifestyle changes," (Axon, 2017, p. 16) suggesting tailored teaching of specific acts and behaviours to support the environment.

However, the argument of environmentally-friendly societal transformation through 'awareness' is fought strongly against by authors such as Sinnott-Armstrong (2005) and Sandler (2010), who name the theory 'inconsequentialism.'

Inconsequentialism contends that one individual isn't enough to make a difference, and does no harm *or* good with their personal actions, hence making 'awareness' unnecessary unless the change is on a corporate or global scale (Almassi, 2012; Sandler, 2010; Sinnott-Armstrong, 2005; Darr, 2019; Axon, 2017).

When it comes to environmental principles within the field of video games, Bayrak suggests that "games could act as tools by creating awareness to ignite transformation from within society" (Bayrak, 2019, p. 141). Bayrak's claim was attempted through 'Eco' by Strange Loop Games (2018), a multiplayer game that centres around maintaining balance in a highly volatile ecosystem. An article by Fjællingsdal and Klockner, Gaming Green, investigates Eco as a tool for environmental awareness.

If resources are gathered without replanting, the environment becomes barren and collapses. Water gets visibly polluted from use of materials, and species can be wiped out by player demand for resources (Figure 2:6). Eco's objective was to provide players with knowledge on their environmental impact, based on the notion that "understanding the link between one's own actions and subsequent environmental decline could lead to pro-environmental behaviour" (Fjællingsdal and Klockner, 2019, p. 3). However, through the study, they found that while Eco reinforced an understanding of biological systems, representing a "promising classroom tool," there was a lack of motivation to engage with the thinking behind the game itself, due to the pedagogical agenda.

Eco presents what Abraham and Jayemanne (2017) have discussed as 'environment as resource'; meaning although the player receives hefty consequences for their actions, the point of the game is still to survive, cut down trees, collect resources, build shelters, and utilise the environment for their own purposes. A players' conceptual curiosity (Alexandra et al., 2016) won't stop them from cutting down trees, as that is the mechanic that has been provided to them, and even though the water may become polluted from their actions, they still continue to do it, *as that is how to play the game.*

Figure 2:6 //
What was once a thriving natural landscape is now industrialised and polluted in Eco (Strange Loop Games, 2018).
Retrieved from: Fjællingsdal, K. S., & Klöckner, C. A. (2019). *Gaming Green: The Educational Potential of Eco – A Digital Simulated Ecosystem.*, p. 3).

Video Game critic Alice Bell played Eco. She "saw that my little homestead was the centre of a zone of one-woman destruction," claiming feelings of despondency, as all she wanted to do was live in the woods peacefully, but even just meeting her needs necessitated the ruination of her world. She ends her piece with the statement that Eco "overly demonstrates" how much impact we can have on our environment, and that trying to save the world but instead continually causing more issues "feels like just as bleak an outcome as annihilation" (Bell, 2018).

In contrast to Bayrak's belief of igniting societal transformation through video games, Kunzelman's deep scepticism that video games "can convince or entrain their players into accomplishing concrete goals when it comes to the current environmental catastrophe" (Kunzelman, 2021, p. 31) encompasses climate games that enforce the only outcome borne from the conditions of our current world are destruction and focus entirely on the negative effects (Kunzelman, 2021). He describes them as 'smothering', and are more likely to generate nihilistic worldviews, similar to Sinnott-Armstrong's feelings of inconsequentialism.

Acknowledging these varied paradigms on environmentally-focused video games, this research avoids concepts of awareness, pedagogy, or nihilism, and instead takes an alter approach towards thinking about the environment, known as ecological consciousness.

3.1 What is Ecological Consciousness?

Ecological consciousness was described in 1982 by William Devall as,

> *"Human experiencing, participating in the mystery of Nature; in which the observer is not alienated from the observed."*
> *(Devall, 1982, p. 181)*

Ecological consciousness refers to a different way of perceiving the natural world: Focusing on and realising a mutual coexistence with all the non-humans that surround us. In which humans must "[realise] that nonhumans are installed at profound levels of the human - not just biologically and socially but in the very structure of thought and logic. *Coexisting with these nonhumans is ecological thought, art, ethics, and politics"* (Morton, 2016, p. 159). Morton's book, Dark Ecology, argues that current human thought is primarily entrenched within '*agrilogistics*,' his term for how humans and corporations think of nature and non-humans purely as a resource for monetary gain (Morton, 2016). The notion of ecological consciousness presents an alternative worldview, one that may encourage pro-environmental thinking. One that places humans and nature on an equal footing, positioning humans inside and *as a part of ecology*.

To say that ecological consciousness is not already a paradigm held by existing cultures would be a narrow-minded claim. New Zealand Māori have a holistic relationship with the ecosphere, seeing themselves integrated into the balance within ecosystems, rather than superior to it, and recognizing the dependence of the interrelationships between all living things (Harmsworth and Awatere, 2013). The Māori worldview can seek to understand the environment through the term 'whakapapa' meaning the "connection, or genealogy between humans and ecosystems and all flora and fauna" (Harmsworth and Awatere, 2013). Acknowledging that ecological consciousness is an integral part of various cultures[14], this project takes a modern, Westernised[15] lens, addressed by Morton that the current state of humankind and natures' relationship is that "humans have stamped their impression on things they consider as ductile as wax, even if those things cry" (Morton, 2016, p. 23).

14. I also inquired into other cultures who hold similar beliefs. In Salmon's interview with Laguna Native American, Silko, he expresses the indigenous belief of "Iwigara," the total interconnectedness and integration of all life, spiritual and physical. (Salmon, 2000)

15. Otherwise known as Eurocentrism, described by Hobson as "Western civilization as the subject of, and ideal normative referent in, world politics". (Hobson, 2012).

Morton presents a philosophical viewpoint towards inspiring an ecological consciousness, believing that "instead of serving up lashings of guilt and redemption, might ecological criticism not engage the ideological forms of the environment?" (Morton, 2007, p. 140). He elaborates how the "imaginative capacity of art forms, such as video games," can bring about potential ideological change. Games, in particular, provide reflection from inside an experience, which Morton suggests is a more powerful medium than others to encourage this change of ideology, such as an emerging ecological consciousness (Morton, 2007). These ideas within the game industry have already been identified by Abraham and Jayemanne, who ponder that "perhaps the most powerful [games] are those that actively work to reconfigure our notion of the human-nature relationship" (Abraham and Jayemanne, 2017, p. 88).

Jane Bennett supports Morton's claims on ecological consciousness being catalysed away from negative emotions such as guilt, as "one must be *enamoured* with existence in order to be capable of donating some of one's scarce mortal resources to the service of other" (Bennett, 2001, p. 4). She discusses the term 'enchantment', which entails being "struck and shaken by the extraordinary that lives amid the familiar and the everyday" (Bennett, 2001, p. 7). She further discusses how moments of 'enchantment' with the everyday world can drive ecological thought, as the natural world functions as a reservoir of enchantment, the contemplation of life provoking a sense of wonder and joy.[16]

Bennett further notes that enchantment, and wonder, can be cultivated through deliberate strategies, such as "giving greater expression to the sense of play, [or] honing sensory receptivity to the marvellous specificity of things" (Bennett, 2001, p.4). Chang supports this from a video game perspective, noting that "games, like the natural world, can provoke curiosity, interaction, and reflection" (Alenda Chang, 2019, p.2) [See Appendix 04]. These ideas of creating 'wonder' through a video game ecology could be the answer to Abraham and Jayemanne's question of "how might games contribute to developing an ecological awareness that recognizes our interdependence with the non-human world?" (Abraham & Jayemanne, 2017, p. 76).

16. She elaborates with this poignant quote about scientific discovery aiding enchantment, where "mere plants, ants, and ideas turn out to have a degree of complexity and material efficacy that humans have hitherto ignored or underestimated. New scientific practices and instruments render these capacities sensible to us, and we are both charmed and disturbed by them" (Bennett, 2001, p. 171).

3.2 The Answering of my Question

The research concludes that designers have yet to expansively evolve environments and their living components from background scenery to ecological models that have their agency foregrounded. This research asserts that systemic design can be used effectively to create accurate representations of natural ecosystems within a virtual space, as it focuses on awareness and interaction outside of the player, or even the player's perception. Gualeni focuses on the possibility of utilising these representative virtual worlds to achieve experimental and philosophical goals, his research concluding that "videogames can be employed to communicate and negotiate philosophical ideas and hypotheses, materialise interactive alternatives, [...] and disclose new phenomenological possibilities" (Gualeni, 2016, p. 91). He believes that these new perspectives can be materialised through virtual worlds, giving rise to the pursuit of new philosophical inquiries (Gualeni, 2016). The materialisation of a thriving, systemic ecology within a significant, playable artefact aims to promote and develop divergent ecological thinking, as well as casting new shadows on the way designers could make games and players' could think about them.

Through analysis of case studies, this project aims to position the player away from ecologies fraught with endeavouring to eliminate its creatures or destroy its environment; To allow them to exist outside the player's perception and make the ecosystem the priority of play, avoiding situations and consequences that create a sense of nihilism. Through the lens of inspiring ecological consciousness, this project intends to position the player in a living, systemic ecology that avoids a tale of dystopia and centres on reconfiguring our notion towards our natural world. Through creating moments that dismiss provocation of feelings of superiority or guilt, and instead promote feelings of joy that allow us to rethink our presence in the natural world. By removing the potential for destruction, violence, and dominance, this project aims to bring the nonhuman world into equal prominence with the human (Chang, 2019).

chapter 03

Methodology & Methods

03

Methodology

The outcome of this research project is to explore the creation of an ecosystem using elements of systemic design, with the overall intention of eliciting ecological consciousness through the combination of these concepts. Developing this knowledge required a practice-based research approach[17], as the artefact produced is the basis of my contribution to producing this knowledge, by researching and learning through doing, and generating new data through experiential activity (Gray and Malins, 2004).

Iterative Design

Coulton and Hook claim that "in research through game design, our aim is to produce knowledge which comes through the iterative critical and reflective practice." (Coulton and Hook, 2017, p103). In order to embody these proven ideas, this research employs the methodology of iterative design, with the principal methods adapted and utilised for my personal process and way of thinking.

The core pattern for iterative design is when ideas are continually conceptualised, prototyped, tested and evaluated (Macklin and Sharp, 2016; Salen and Zimmerman, 2003). This cycle is repeated in a loop (Figure 3:1), where evaluation of prototypes can produce new ideas or solutions to repeat through the sequence again, allowing the researcher to base design decisions through successive iterations. Critical evaluations in this methodology were combined with reflection, with reflective journaling being added as a method throughout the process.

Iterative design has been chosen for this research project as I am driven by curiosity[18] to design a multiplex system that instead of focusing on player-system interactions, the complexity occurs in the background, and limits the player's ability to disrupt this system. Alternatively, it focuses more on contemplation and observation to elicit a greater understanding. Iterative design allows me to create and experiment with prototypes and contemplate each mechanic critically to see if it is a detriment to my research, as traditionally I work game mechanics in without considering their impacts, in order to give the player more to do. As iterative design's core paradigm is to continually experiment and assess, my practice can create and solve new challenges perpetually throughout the making process. This can shift my perspective on game design, and allow me to develop my knowledge and skills as a practitioner (Candy, 2020).

The iterative cycle used for this project starts with visual conceptualisation, generating ideas and recording them into observable forms, such as brainstorms or sketches (Gray and Malins, 2017), as well as conducting appropriate research to aid in the validity of these ideas.

17. A clear definition of practice-based research is outlined by Candy as "an original investigation undertaken in order to gain new knowledge, partly by means of practice and the outcomes of that practice" (Candy, 2006).

18. This curiosity is discussed by Candy, noting that "Many practitioners are driven by a curiosity that breeds a state of restlessness and a compulsion to move out of their comfortable, familiar zones. This engenders a state of uncertainty and can be fertile ground for generating new questions in an ongoing search for greater understanding" (Candy, 2020, p. 50).

Figure 3:1 //
Iterative Design Cycle.
Retrieved from: Macklin, C., & Sharp, J. (2016). *Games, design and play: a detailed approach to iterative game design.* p. 155.

The chosen concepts are then rapidly created into playable prototypes: physically making the designs into a form in which they can be interacted with and which they can be tested by playing them (Salen and Zimmerman, 2003). Through playing, they can be evaluated and reflected upon critically. The iterative design cycle emphasises playtesting prototypes, as by playing and experimenting with concepts physically, my practice is able to base design decisions on evaluating successful or failed iterations, or generating further ideas from those iterations. The playtesting conducted for this research is known as "internal playtesting," (Macklin and Sharp, 2016, p. 160) which is carried out by myself, rather than outsourced externally. By using a reflective practice to evaluate the successive prototypes, designers are able to find the optimum solution to the given problems (Candy, 2020). An extra step added to my methodology is reflective journaling, where these reflections are documented to allow me to effectively communicate with myself on how and where to progress with my practice (Candy, 2020). The cyclic process then returns to conceptualisation, having produced new concepts from evaluations, learning what is to be improved upon, or what prototype to create next. After all the essential prototypes have been crafted, they can be assembled to make the final project, and refined until the research question has attempted to be answered.

Methods

Throughout the research, I will employ a range of different methods to enquire knowledge through my creative practice.

Visual Conceptualisation

The process of this project's design begins with conceptualising ideas that could be potential solutions to the research problem, and representing them visually. The visualisation of ideas encompasses many techniques, such as brainstorms, sketches, lists, diagrams, concept or mind maps, storyboards, 3D modelling, and so on (Gray and Malins, 2017). These tools are used to produce representations of game ideas, mechanics, themes, worlds, levels and aesthetics, carried out before and throughout the game-making process (Coulton and Hook, 2017). Research into biological texts to prompt and corroborate ideas will also be integral to guiding the validity of my ecological simulations. Externalising designs and thoughts into a communicative form can highlight qualities of the idea that were unarticulated or unintended and can generate new or developed concepts from existing ones (Back and Waern, 2017).

Prototyping & Playtesting

"Games do not manifest in sketches, but by being played."
(Back and Waern, 2015, p. 344)

After visualising ideas, the next stage is to shape chosen concepts into physical, playable creations, otherwise known as prototyping. These prototypes should be made using only the elements needed to make them functional into a rough, playable state (Fullerton, 2008). Schell recommends that every prototype should be designed to answer a question, whether it is about a technical aspect or the gameplay (Schell, 2014). Prototypes should be rapidly produced into a form that allows them to be played by the designer, to experiment with concepts and allow the designer to focus on a piece of the game's mechanics or design, to see how they function, look, or play (Fullerton, 2008). Even in an unpolished state, they can establish the gameplay or whether the designer's problem has been answered (Schell, 2014).As the intentions or predictions of gameplay can differ vastly from the actual play experience, (Salen and Zimmerman, 2003) prototyping allows the designer to formalise ideas and isolate problems so they can discover what works before implementing them into the final game. Therefore, no time is wasted on fully developing the first idea, and working for months on a polished, aesthetically-pleasing game that doesn't embody the intended play and has to be abandoned (Fullerton, 2008; Schell, 2014).

Since the artefact is technologically intricate, playtesting is integral[19] as it is the only way to know if the programmed mechanics are functional (Fullerton, 2008). There are numerous ways to execute a playtest, such as enlisting others to play in a controlled experiment[20], but for this research, playtesting is being conducted by myself. By playtesting throughout the design process, as well as fixing errors, designers can gain an insight into how players experience the game, reveal what is or isn't working, and adjust accordingly (Fullerton, 2008). Changes, revisions and refinements are then made, established from the outcome of the playtest[21].

As part of the research's key focus is eliciting the philosophical perspective of ecological consciousness, elements of 'evocative experimental design' during prototyping need to be considered, which is discussed by Back and Waern as a design experiment not focused on refining a game or looking for optimal design solutions, but to elicit more abstract qualities (Back and Waern, 2015). Through prototyping and playtesting, by not only focusing on gameplay or technical creations, I can explore the abstract notions and the thinking that my artefact could evoke. As I "understand more about the behaviour and experiences that a design choice will evoke in players," (Back and Waern, 2015, p. 344), I will consider the player's behavioural outcomes within certain prototypes.

19. Fullerton believes that "playtesting is the single most important activity a designer engages in" (Fullerton, 2014, p. 277).

20. "Two of the most basic kinds are internal and external playtests. Internal playtests among the designers of the game are essential—and often the first kind of playtest the team engages in. External playtests are equally important and can involve friends, other game designers, the target audience, and more." (Macklin and Sharp, 2016, p. 160).

21. Iterative coding is a step process: "1. Run your game. 2. Navigate through your game to the part you want to test. 3. Test it out. 4. Write code. 5. Go back to step 3" (Schell, 2014, p. 112).

Evaluation

During and after the playtesting of each prototype, the prototype is reflected upon and evaluated (Coulton and Hook, 2017). As evaluation is to ascertain the value of something, and to judge or assess its worth (Gray and Malins, 2017), in this regard it assesses the viability of the prototypes, or relevance and benefit to the research project. It considers the discoveries made through playtesting, and enables designers to critically dissect and reflect on this knowledge. By "making a work and then reflecting on the process and outcomes, it is a pathway to understanding some of the underlying questions and assumptions." (Candy, 2020, p. 51). As the prototypes often had a question they intended to answer, through evaluation designers can ask themselves to what degree did the prototype answer the question, why or why not, how they felt about it, and what could be done differently (Gray and Malins, 2017). Candy discusses how "reflection [in creative practice] plays a vital role and enables the practitioner to learn from the process and its outcomes" (Candy, 2020, p.71). This 'learning' is crucial to the iterative design methodology, as designers are able to consistently improve practice and therefore the project, as iterations are ameliorated and knowledge is gained from evaluating each iteration. Without evaluation, "alternatives are not considered, comparisons are never drawn, and assumptions are never challenged" (Coulton and Hook, 2017, p. 103).

However, as a practitioner, I am aware that my own assumptions and tacit knowledge can be biased in the evaluation of my artefact[22]. Therefore, as knowing what is a 'good' or 'bad' prototype is subjective, evaluations should be undertaken with a criteria in mind to make judgements (Gray and Malins, 2017). This criteria can be developed from the prototype's question, on whether it answers it, relates to the aim of the research, or opens new avenues of inquiry. Discovering failure of prototypes through reflection can be a positive outcome, as the designer can learn in what aspect the concepts need to be improved, or which design direction to avoid entirely (Macklin and Sharp, 2016). Pieces of the design that worked can be developed or added to the next prototype, possibly to make something better (Schell, 2008).

Since the artefact's prototypes being created are pieces of a larger, interconnected web, this means that new ideas can also emerge as relationships are considered (Candy, 2020). These ideas that arise from the evaluation of prototypes can create new concepts for the next prototype, flowing back into the first stage of the iterative design cycle (Macklin and Sharp, 2016). These ideas can be researched and visualised, and therefore the theoretical framework and practice can develop together (Candy, 2020).

22. Coulton and Hook go into depth on the issues of a designer's own assumptions; "The experience and subjectiveness of the designer often plays a significant role within the research. This can lead to both the process and artefacts of designing being affected by the culture of, and the tacit knowledge held by, the designer throughout the creative process" (Coulton and Hook, 2017, p. 100).

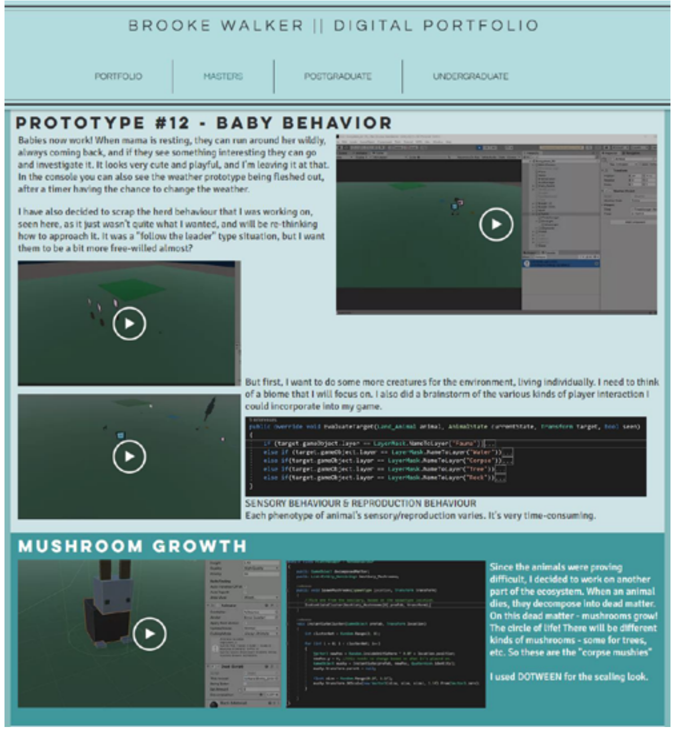


Figure 3:2 //
A snapshot of my blog, that was used as my reflective journaling tool. Access is at: https://imbrookew.wixsitwe.com/digitalportfolio/masters-artefact

Reflective Journalling

"By making artefacts, individual practitioners create tangible outcomes to contemplate, appraise, evaluate, reassess and revise: in effect, they are mechanisms for reflection." (Candy, 2020, p. 128)

Reflective journaling is a method added to my iterative design methodology, after evaluating prototypes. Gray and Malins describe it as a journal or diary that stores a range of information or media, which is added to and consulted on a regular basis. (Gray & Malins, 2017).

In this case, the journal that will be used is an online blog, where I will record videos of prototypes as they are created and developed, add them to the blog and write personal reflections on the prototypes alongside biological and theoretical research to back my designs up critically. Candy discusses the benefits of reflective journaling, as it enables designers to record and respond to their own intuitive instincts on how to progress their practice, and return to these later for even further reflection (Candy, 2020). Gray and Malins call it a "structured and deliberate research method, a framework for helping to expose and explore various models of practice [...] and have more effective conversations with ourselves" (Gray & Malins, 2017, p. 114).

As the project develops and grows extensively in terms of varying mechanics, changes and experiments, keeping a blog with development videos and reflections can help structure and organise my thoughts and progress. Reading my reflections might help me find new relationships and expand old concepts, as well as aiding me in asking new, critical questions, and performing more research to develop my practice.

chapter 04

Critical Commentary

04

Description of Practice

Apis is a virtual reality experience that places emphasis on the observation of the game world's self-sufficient, thriving ecosystem. *Apis*, which is latin for honeybee, only allows the player to interact with the game with a watering can and the ability to plant seeds. These interactions became integral to the core embodiment of eliciting ecological consciousness through *Apis*, by limiting the players potential for dominance and destruction and placing them in an equal prominence to the environment. *Apis*'s world contains examples of herbivorous and carnivorous mammals, reptiles, amphibians, birds, fish and insects, all set in their own dynamic community.

The final artefact produced is an amalgamation of continuous iteratively designed prototypes. Figure 4:1 represents the process of the research project, with all the individual prototypes that were created, tested, evaluated and reflected upon.

Each iteration often began with research; if it was a biologically-based idea, scientific research was undertaken in order to better understand the processes and behaviours carried out by animals, plants or the environment. The ideas that emerged from the research were sketched out, and added to the reflective journal.

As the artefact created for this research involved complex, intertwining systems, prototyping and playtesting allowed me to break the systems down into solitary aspects and mechanics, that were developed and assessed individually. The prototypes were programmed with C# and tested in the Unity engine. This enabled me to efficiently refine them until they worked as intended and establish their necessity to the project, or reject non-functioning ideas that were irrelevant to the design. The final prototypes were evaluated, documented within my blog and reflected upon, and were either refined and improved upon later in the process, or discarded entirely.

Overall, I made 27 prototypes, refined into one final project.

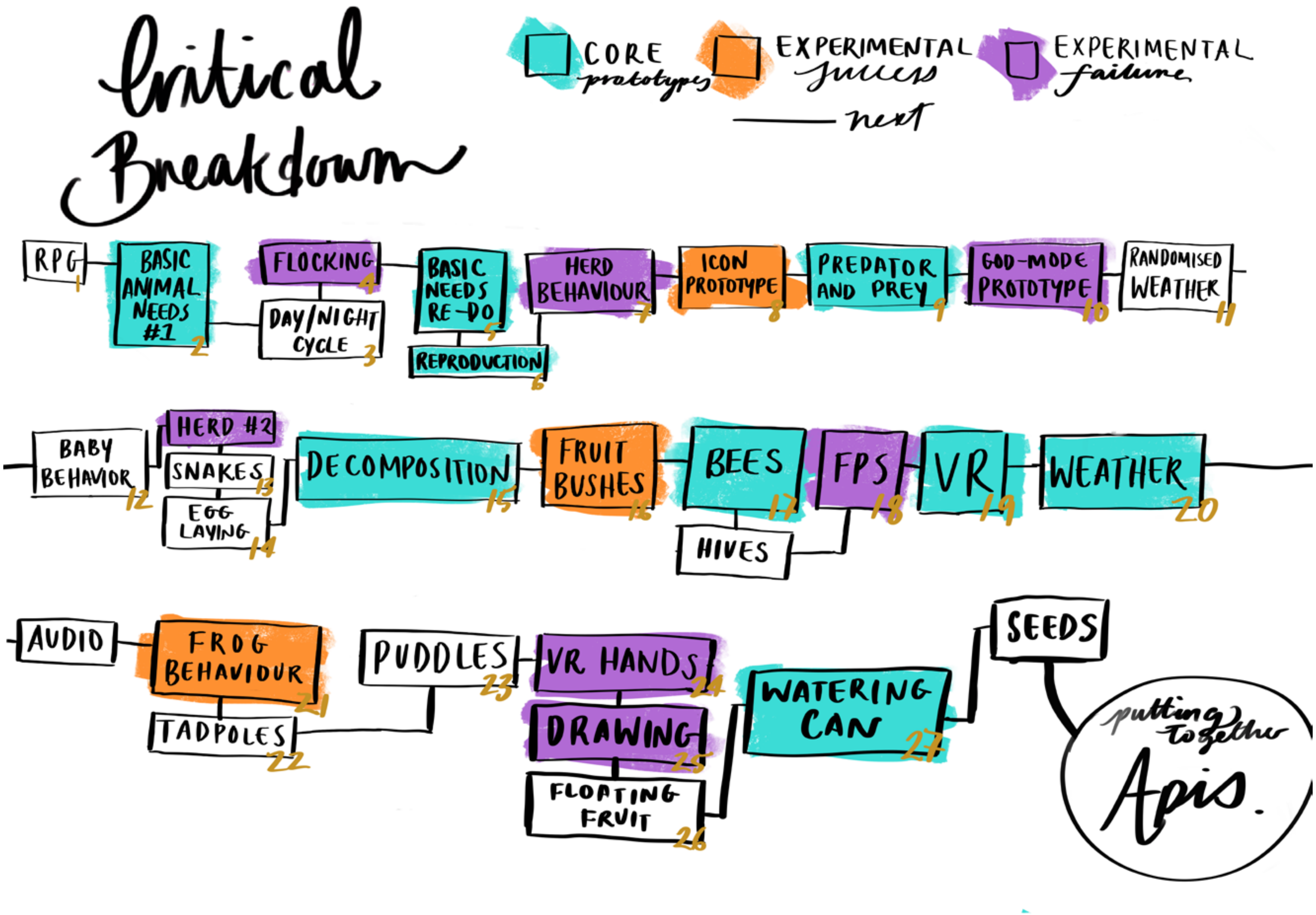


Figure 4:1 //
An overview of *Apis*'s prototypes.

Critical Commentary

04

Part 1:

The Ecological Intricacies of Herbivores & Carnivores

Beginning as a Simulation

"What are the important elements to create a dynamic animal AI system, that can function independently?"

As the research question focuses specifically on the creation of an ecosystem, *Apis* contains a simulation of animal and plant behaviours within their own simplified ecological community. Gualeni mentioned that in order for a virtual, behaviour-based world to function within a gaming context, it needs to be comprehensible. He argues that otherwise "the simulation could not meaningfully disclose a [virtual] world to its users" (Gualeni, 2016, p.49). Similarly, Chang places emphasis on the importance that meaningful environmental games require accurate modelling of these ecology dynamics, and to foreground their agency (Chang, 2019).

An ecosystem is not a singular entity; but a cohesion of elements with innumerable varied relationships and interconnections that all rely on each other to balance and function (Begon et al, 2006). I chose to manifest the knowledge acquired through the following programmed behaviours, utilising systemic design throughout the process to explore the first half of the research question.

Apis looks simple on the outside, but is highly complex on the inside. Each animal within the game world has several scripts that function as their brain; it makes decisions, by observing everything it comes across. It reacts and behaves in relation to its own needs, to others, to danger, to environmental stimuli, to the weather and time, and to the player.

When starting the initial prototypes, sketches were completed on the relationships and behaviours within an ecosystem, based on biological research (Figure 4:2). These ideas were narrowed to the most essential systems required to form a self-functioning ecosystem (Figure 4:3), as "trying to understand the complexity of the real world, it is necessary to make abstractions and to simplify the hugely varied and changing world" (Dickenson and Murphy, 2007, p.25).

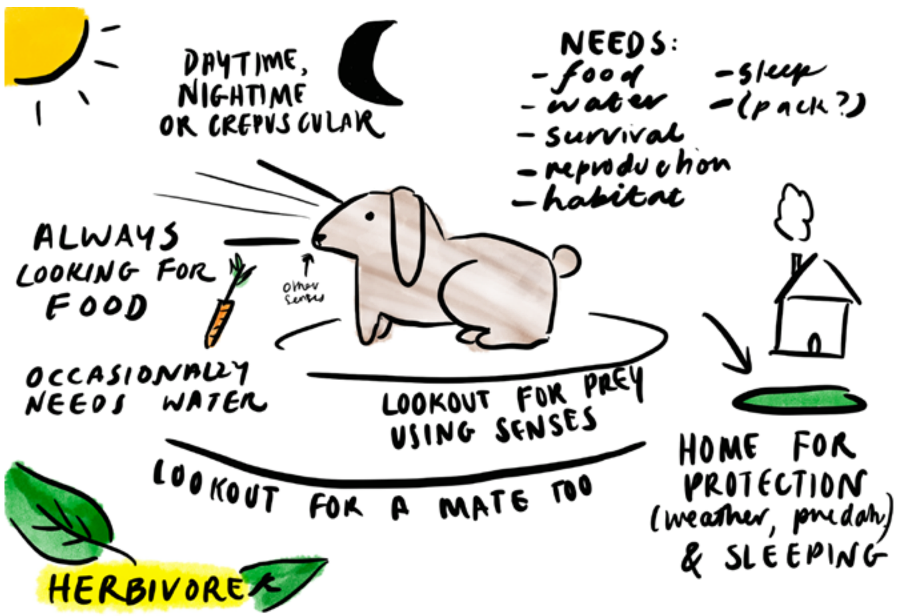


Figure 4:2 //
A rabbit's proposed behaviour.

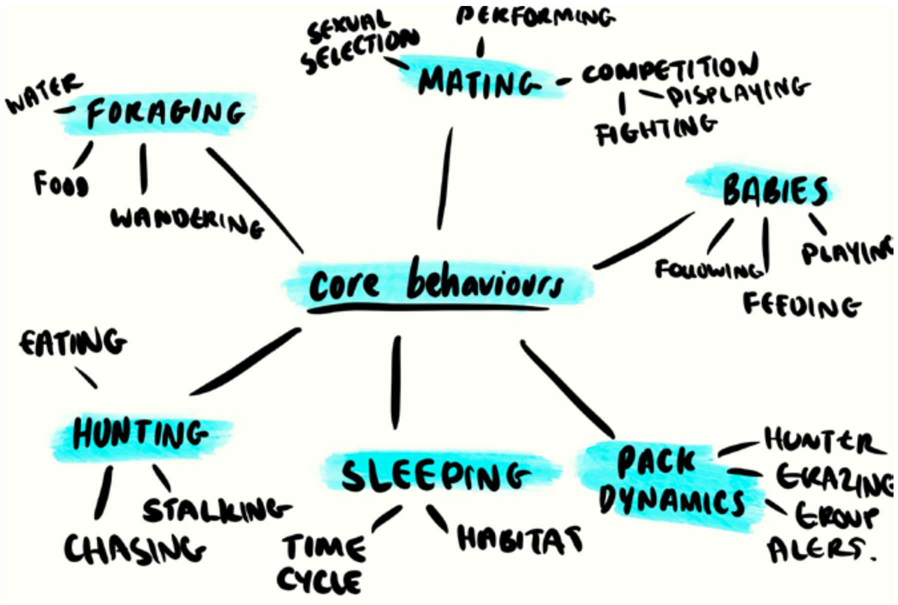
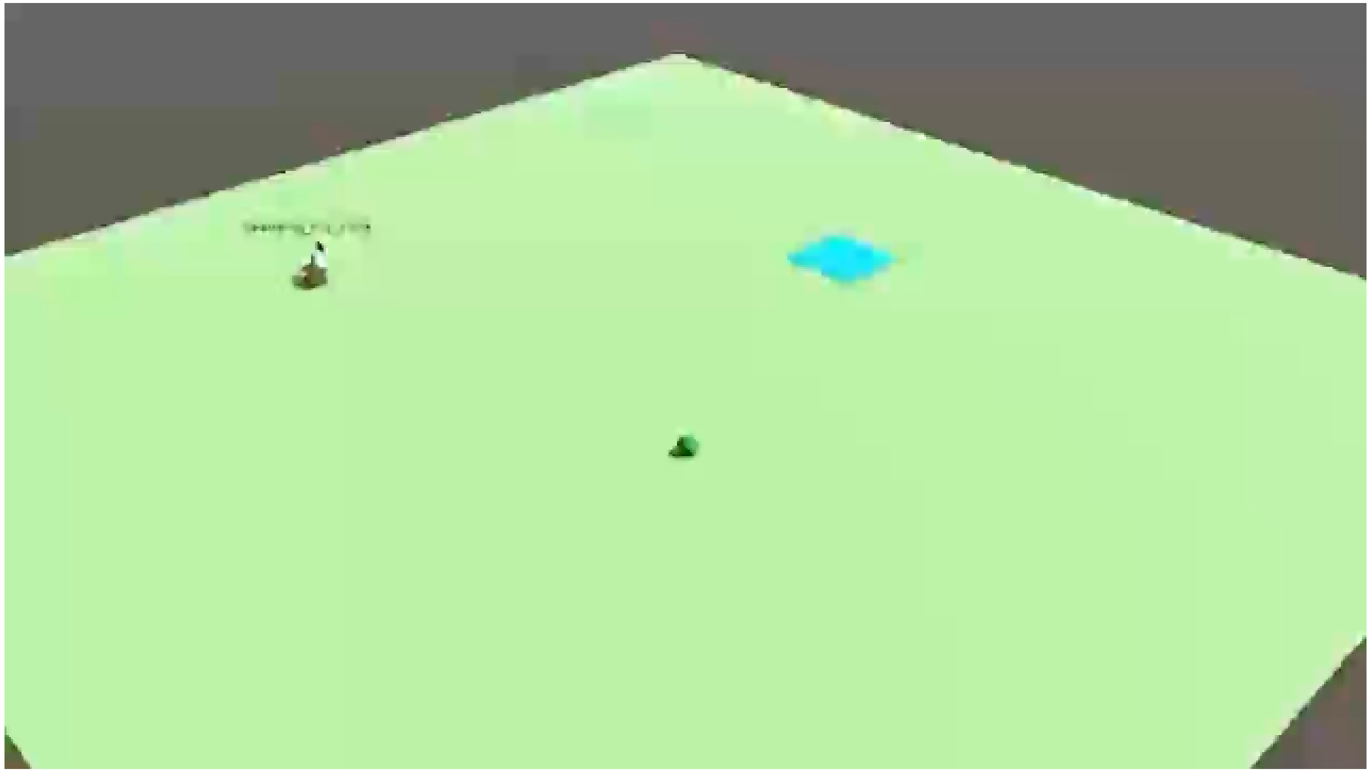


Figure 4:3 //
The initial conceptualised core behaviours that I wanted to prototype.



Video 4:1 //
This video of the first finished sensory prototype shows how the creatures base decisions on their highest priority need. See [Appendix 05] for a breakdown of this development.

As "most animals are motivated to obtain food and water, to engage in reproductive activities, and to seek safety from predators," (Baumeister, 2015), the animals have an increasing value for each of their hunger, thirst, and reproductive urges[23]. These are their needs that they base the majority of their decisions around[24]. In order for the animals to detect their surroundings to fulfil those needs, they needed senses and the ability to move around, to act on their decisions (Broom, 1981; Baumeister, 2015). I felt that giving the animals this capability enabled them to exist for themselves, which added a sense of life to them. The animals are aware of their surroundings, and enact their own behaviours based on their internal desires, without a player even being in the game (Video 4:1).

Reflection of the first sensory prototype implied that if an animal was hungry enough, they would ignore all other stimuli and focus only on their search for food. This was found to be contradictory to Budaev et al, who noted that choice between available options is fundamental for all animals, and to make efficient survival decisions it "requires integration of various types of information and weighing conflicting needs" (Budaev et Al, 2019, p. 1). Principles of systemic design, such as an awareness of all surroundings, were lacking in this first prototype. Therefore, to embody both biological and systemic behaviour, the animals needed to be conscious of all nearby stimuli and react accordingly.

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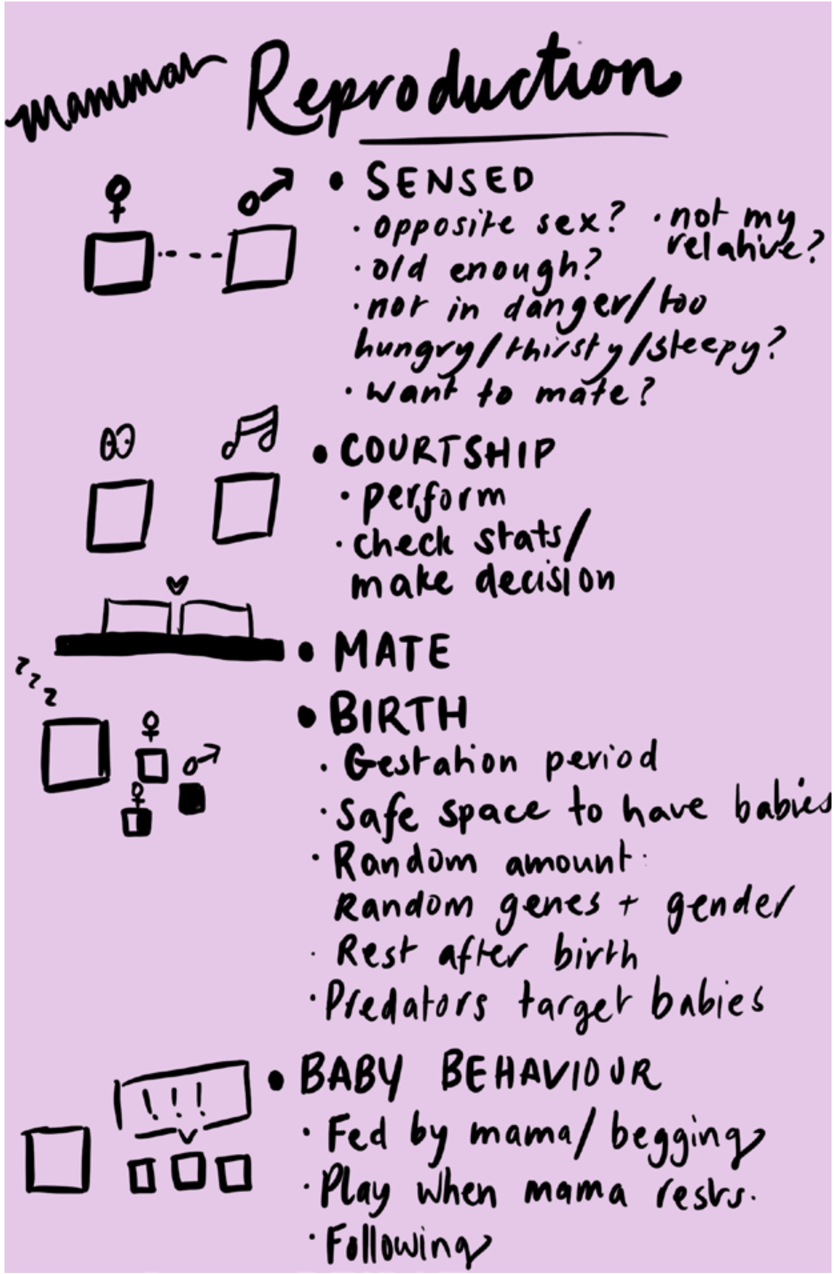
23. Upon reaching and consuming food or water, their values decrease by a certain amount, but continue to rise. This is known as the cycle of satiation (Baumeister, 2015, p. 5).

24. Unless their safety is compromised, in which Budaev et al note that "if the dominant state of the organism is fear, then hunger, thirst, and sexual drive systems are suppressed proportionally to the fear arousal" (Budaev et al, 2019, pg. 6).

Figure 4:4 //
Conceptual sketch of the pipeline, to create a reproduction system.

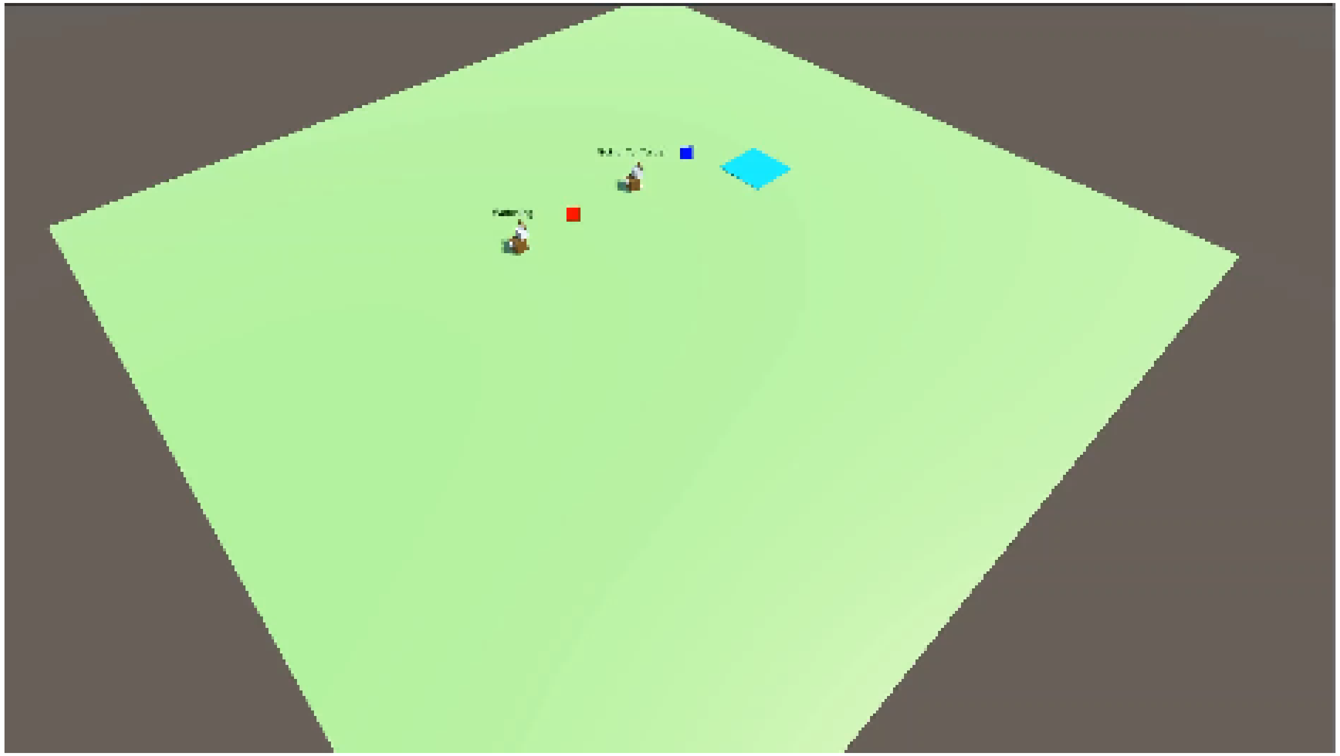


The prototype was re-created, so instead of specifically searching for a target, the animal senses everything it comes across, and assesses all objects detected in relation to the animals key biological priorities - i.e hunger, whether it's edible, thirst, if it's a threat, or able to be mated with.

Utilising their senses on the world around them, all of the animals engage in behaviours such as foraging, resting, eating, drinking, sleeping, reproduction[25] (Figure 4:4; Video 4:2; Figure 4:5) and predator-prey interactions[26] (Video 4:3). I concluded that since these are essential for the survival of numerous species (Breed and Moore, 2016; Dickenson and Murphy, 2015; Begon et al, 2006; Broom, 1981), these actions were integral to conveying functioning, self-sufficient animals within an ecosystem.

25. Reproduction, or mating, is central to survival of a species. Breed and Moore note that "mating is a simple act with the most profound possible outcome: the production of the next generation." (Breed and Moore, 2016).

26. Predation is the consumption of one organism (the prey) by another organism (the predator), in which the predator hunts, attacks and eats live prey (Begon et al, 2006).



Video 4:2 //
Reproduction enables the simulated rabbits to continue to grow as a species.

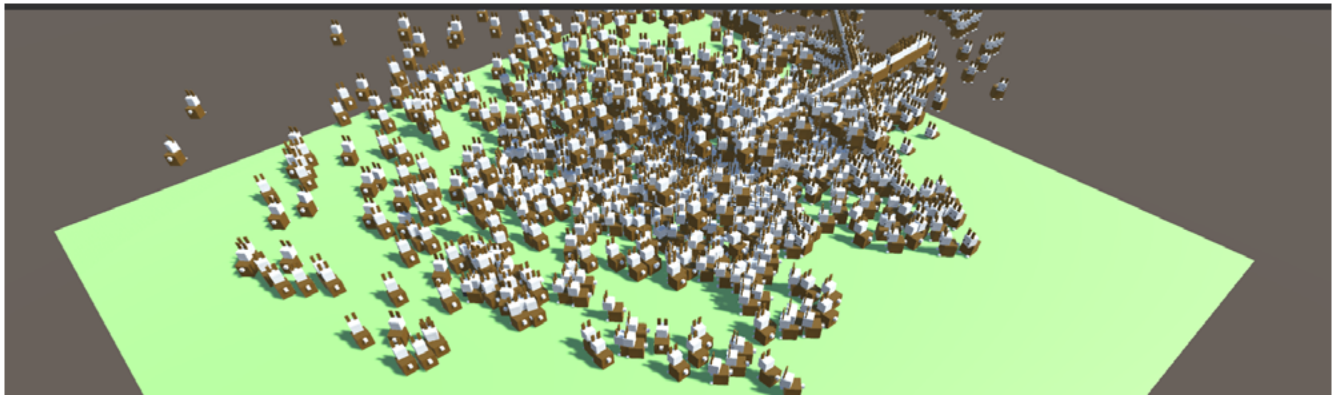
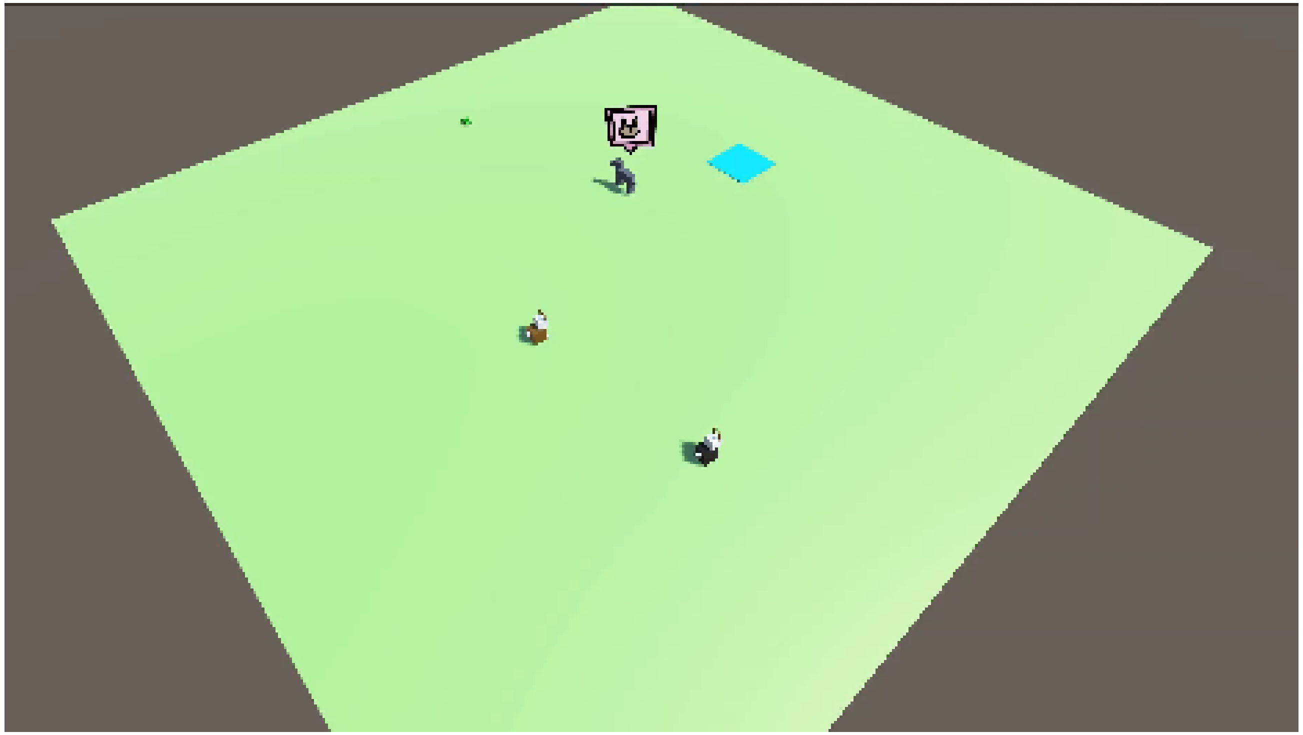


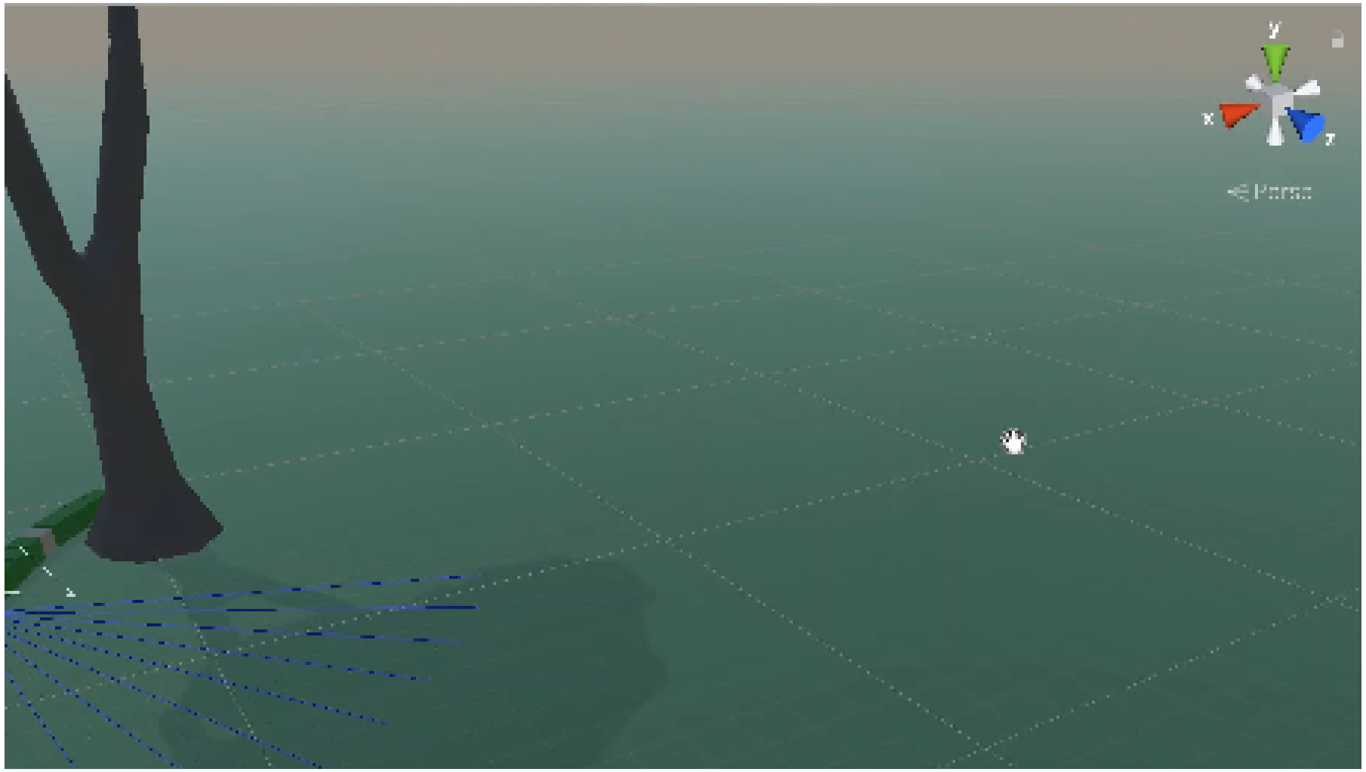
Figure 4:5 //
An error was discovered through playtesting, of rabbits reproducing every frame.

Already, the prototype with only three animals that contain two core behaviours - mating, and predation - showcases systemic design. During playtesting, there were several outcomes that occurred in-game. If the two rabbits find each other first, they can mate, reproduce and keep their species alive. However, if the wolf finds just one of the rabbits first, he will hunt and eat it - therefore ending any chance for the rabbits to reproduce again. The player has no input yet, so it is the systems interacting in a specific way that produces the differing, emergent results.

As systemic design is a key part of the research, being able to see it working as intended gave me confidence that it would be a useful tool for adding more connections and systems into the artefact. As the player is currently merely an observer in *Apis*, this allows the artefact to behave autonomously. Incorporating more unique responses for the player to witness, and not interfere, felt like a step towards what Bennett and Chang discuss as cultivating a reflection on "the marvellous specificity of things" (Bennett, 2001, p.4), which in turn assists in eliciting moments of ecological consciousness, as discussed in Chapter Two.



Video 4:3 //
Creation of the predator/prey relationship.



Video 4:4 //

This video showcases the reptiles who lay their eggs in safe, sheltered spots (Linzey, 2020), allowing them to hatch into miniature adults after a time. Their reproduction differs from the mammals showcased above.

Reproduction between the rabbits also prompted showcasing behaviour of the mammal offspring being able to play with their siblings, and being fed by their mother (Breed and Moore, 2016). These ideas of mammal reproduction also brought about the importance of showcasing another taxonomic class of animals (Figure 4:6). For a comprehensive ecosystem, I needed to represent at least another form of reproduction carried out by other groups, like egg-laying. Reptile behaviour was developed for a new prototype, with their ability to lay eggs that hatch into small reptiles (Linzey, 2020, p. 225) was functional, and essential to portraying a dynamic ecosystem simulation (Video 4:4).

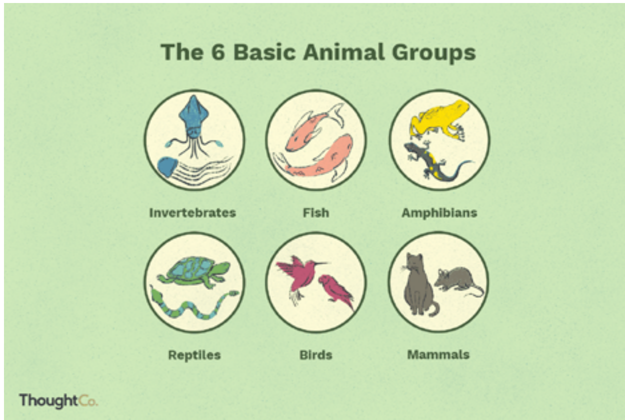
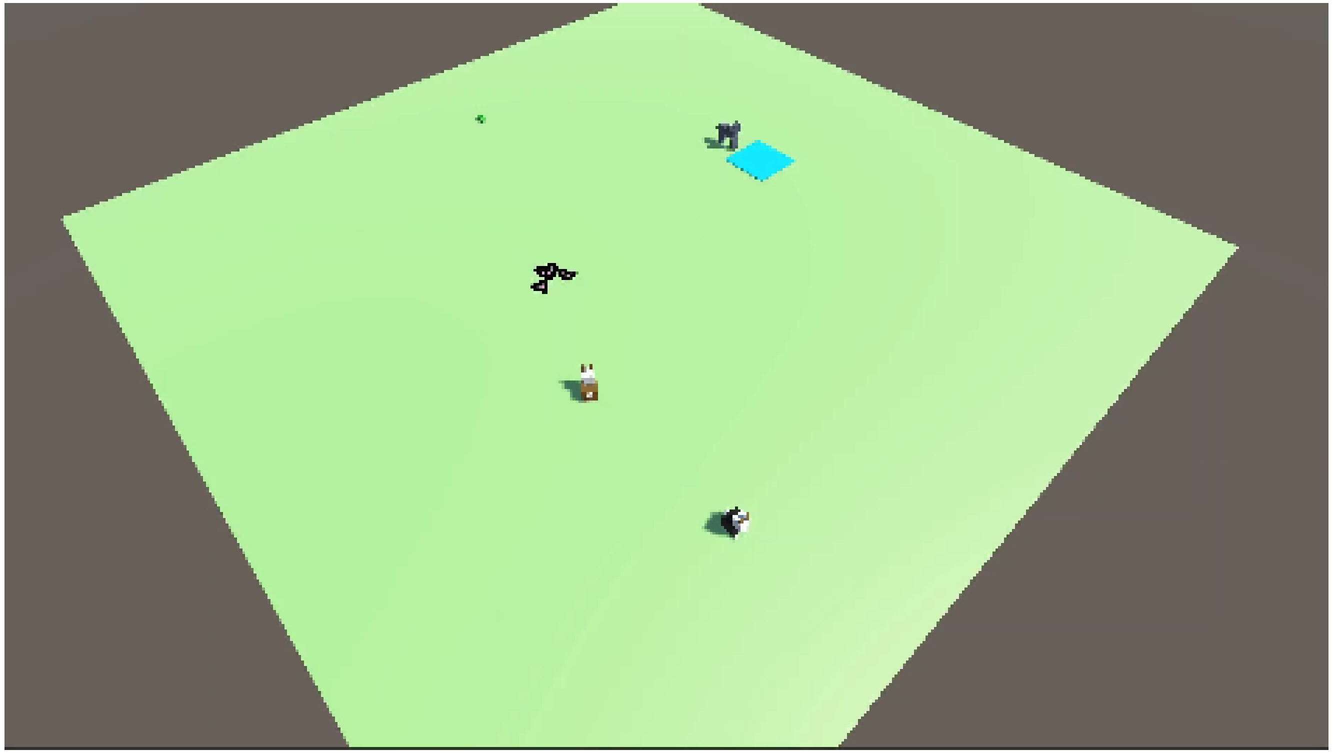


Figure 4:6 //

Image representing the 6 basic animal groups, otherwise known as 'taxonomic classes' (Begon et al, 2006). Retrieved from [https://www.thoughtco.com/the-six-basic-animal-groups-4096604] Copyright n.d, by ThoughtCo



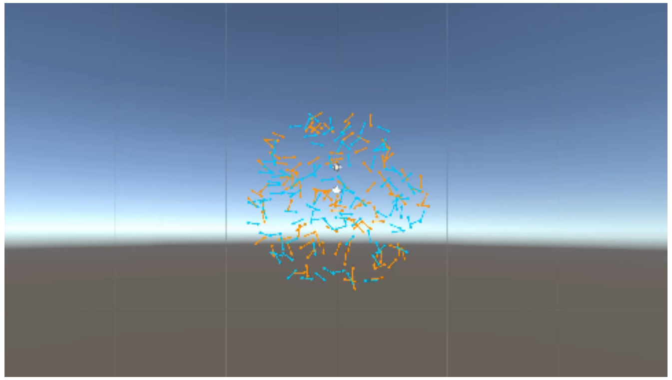
Video 4:5 //
A demonstration of predators prioritising young prey.

An Evolution towards Systemic Design

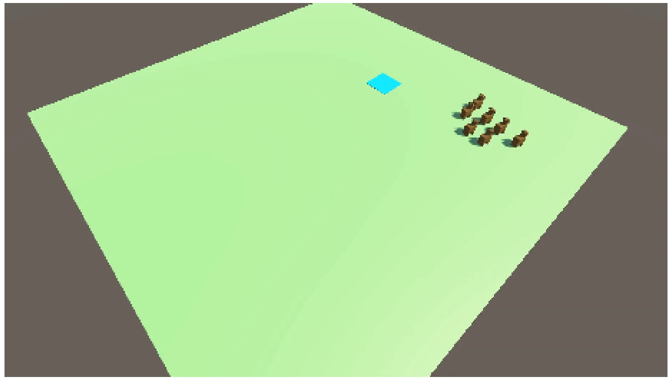
Within these basic behaviours, complexity was added as the prototypes evolved and needed to interact with each other. Considerable attention was paid to core aspects of systemic design outlined in the contextual review, such as each component of the game being aware of and able to affect other components.

A particular aspect that demonstrates the layering of more complex systemic design ideas into the artefact is when the predators are hunting a mother mammal who has children (who are programmed to follow her). Initially, if the predator deigns the mother as their prey, they will chase her and attack only her, even if her babies are lagging behind and the predator is within reach of them. In order to embody systemic awareness, if the currently chased prey has offspring that is closer than the prey itself, the predator changes its target to that offspring, as it is easier prey[27] (Video 4:5). This was an unfortunately morbid experiment that showcased the natural reality of an ecosystem.

27. Research found that "big predators consequently specialise on prey that can be pursued most profitably: the immature, the lame and the old." (Begon et al, 2006) Hence, the predator should target the baby if he is within reach, to conserve his energy. I found that for these behaviour cycles, I was researching some weird things - i.e "Does the predator kill a baby first, even if the mother is bigger?" or "What do baby animals do when their mother dies?"



Video 4:6 //
The 2D Flocking experiment.



Video 4:7 //
The 'mechanical' looking herd behaviour.

A Herd of Failures

A notable failure within the development of *Apis* were the attempts at herd behaviour, which was initially a core behaviour to the artefact. The first experiment began with the programming solution called "flocking", discussed by Reynolds (1987) as an alternative approach to scripting bird flocks, schools of fish or herds of animals. For an animal to participate in the 'flock', Reynolds asserts it must have behaviours that coordinate its movements with its 'flockmates' (Video 4:6). Opposed to scripting each member independent of each other, 'flocking' focuses on agents that navigate according to its own perception of its actively changing environment[28]. These ideas related to systemic design's fundamental awareness of their surroundings, and integration within their ecosystem.

As animals can live in groups for advantages such as hunting, defense, and foraging (Breed and Moore, 2016), an iteration of the flocking prototype was attempted in 3D space to simulate this. After rapidly prototyping, evaluation found the herd looked too mechanical, opposed to the criteria of living, cognitive animal behaviour (Video 4:7). Continuous attempts were made, including the ability to graze, flee or raise young as a group [See Appendix 06].

When the functionality couldn't be fixed to showcase natural movement, further reflective practice found it non-essential to the survival of the ecosystem. As it wasn't specifically an integral element towards raising ecological consciousness, as the ecosystem individuals can survive without it, I moved on to more important areas of the research. Therefore, these prototypes were assessed as failures, although I may attempt these behaviours in future work, as they have the potential to portray distinctive, unique interactions.

28. These are collision avoidance, velocity matching and alignment with nearby and fellow flockmates (Reynolds, 1987).

Video 4:8 //

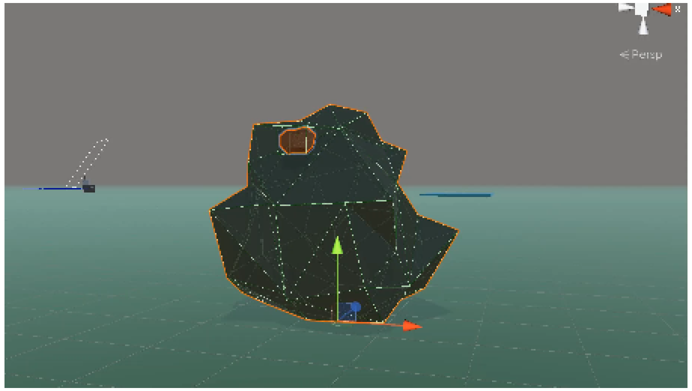
This video showcases that when the 'decomposition' reaches zero, the animal's flesh fully disintegrates and a random amount of mushrooms, with random sizes and positions, spawn around the bones. (Animal assets by Omuabuarts Studio.)

The Circle of Life

An integral aspect of the animal's lifetime was developed after observation of the simulation found that when the creatures died of starvation, or were hunted, their bodies just stayed there; as I hadn't yet programmed what to do with corpses. Research found that when plants and animals die, their bodies become a food source for other organisms (Begon et al, 2006). Their bodies decompose[29], which are then broken down by decomposers and detritivores (Begon et al, 2006). The specific decomposers that I designated to represent this system are mushrooms, as Begon et al. note that "the process of decomposition usually starts with colonisation by fungi and bacteria [...] and they tend to undergo population explosions on newly dead substrates" (Begon et al, 2006, p. 327). This emergent idea was used to incorporate a link between fauna and flora in *Apis* (Video 4:8).

By having the mushrooms grow on animal corpses, the mushrooms rely on the animals to die in order to grow and feed. The mushrooms are then edible by herbivores; This creates a mutual, cyclical reliance on each other, and exhibits integral connections between animals and plants within an ecosystem. Interdependent relationships like these are significant to show to the player as they create clear correlations on why limiting human interference in *Apis* is necessary, as if they were to even destroy one piece, they could potentially affect them all.

29. Defined as the "gradual disintegration of dead organic matter" (Begon et al, 2006, p. 326).



Video 4:9 //
These fruit bushes produce fruit that grows and drops from the bush, and is edible by herbivores.

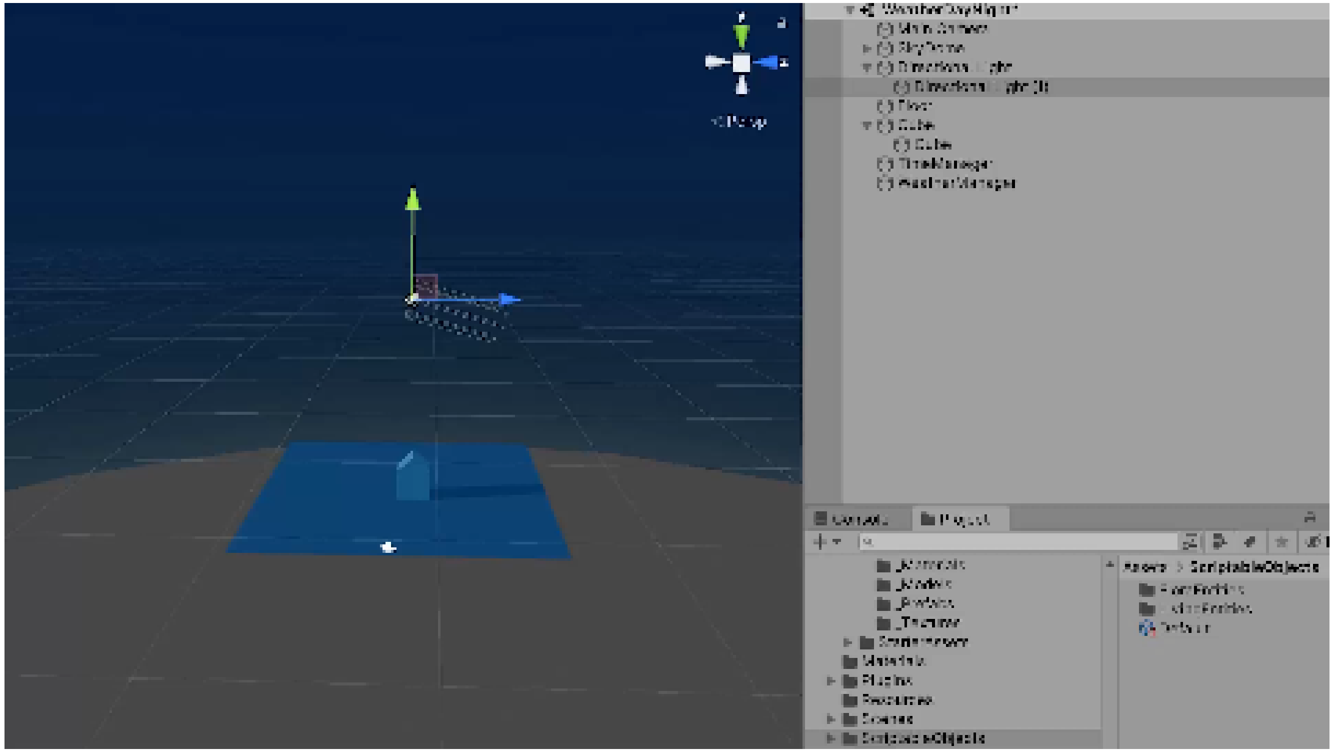
Through continuous observation of the simulation, I discovered that the herbivores were dying of starvation after increasing their species through reproduction, because the rabbits outnumbered their food sources. The implementation of fruit bushes provided a steady source of continuous plant food for the herbivores to survive on as their numbers grew (Video 4:9). This was another key component towards bringing the systemic ecosystem to life, as it presented a balanced system that can sustain itself, through a relationship with their environment.

Reflections on all these prototypes show that they embodied their criteria of creating a successful, autonomous simulation of animal behaviour, that begins to showcase an interconnected ecosystem. The animals can survive, feed, reproduce and die in their own structured life cycle, with the surrounding flora both sustaining them and emerging from their misfortune. It even functions without a player.

As the designer, I often had to observe the ecosystem for flaws and bugs, but also found myself entranced by the way *Apis*'s virtual creatures seemed to show a semblance of virtual, independent life. Through the use of connecting individual systems with different, emerging behaviours, the player is able to witness the reliance between each individual piece of the ecosystem. They are able to see that it all functions as a cohesive element; if one aspect is to malfunction, the whole ecosystem collapses. This can be said about humans within ecology; When we interfere through destruction or captivity, we can dismantle entire ecosystems (O'Sullivan and Taylor, 2016).
Morton outlines how humans are in need of a re-enchantment of the world around us, quoting Daniel;

"The sky probably is falling. Global warming is happening. But somehow it's not going to work to call people to arms about that and pretend to know what will work. People don't want to feel invalidated in their lives and they don't want to feel that they bear the responsibility of the world on their shoulders. This is why you shouldn't teach kids about the dire straits of the rain forest. You should take kids out to the stream out back and show them water striders."
(Daniel, as cited by Morton, 2007, p. 10).

I intend to re-enchant the player's world, by "showing them the water striders" - but instead of 'water striders', a systemic, thriving, interdependent community of flora and fauna. Through observation, *Apis* aims to delight, and leave the player with a memorable experience to reflect on, and facilitate consideration of the ecology all around them.



Video 4:10 //

One of the first prototypes undertaken was the beginning of a simple day/night cycle, utilising lighting, basic colours and shadows to represent the cycle.

Part 2:

It's Raining Bees & Frogs

The Weather Outside is Frightful

Apis began to showcase more of this potential through the development of other features and creatures. As the prototypes started to intertwine and develop complexity, the criteria began to shape into questions such as, *"Is it a successful dynamic ecosystem, or a failure? Why?"* and *"How is this dynamic ecosystem eliciting contemplation about our ecology?"*

Apis contains a day and night cycle with changing weather that utilises cloud shaders, gradient sky colours, lighting changes, particle effects and puddles. These were used to demonstrate the environmental climate to the player. The importance of a dynamic atmosphere system was outlined by authors Chang, Gualeni, and Abraham and Jayemanne.

The cycle of day and night is heavily involved within *Apis*'s animal behaviours. Sleeping was determined as one of the animal's core simulated behaviours, as "sleep, or sleeplike states, occur in all vertebrates" (Breed and Moore, 2016). Due to certain behaviours being entrained only to occur at explicit times[30], *Apis* has a distinguishable day and night cycle (Video 4:10). The animals are conscious of the current time, and base their actions of returning home, sleeping, and waking up on this system.

30. This sleep is determined by an animals' internal biological clock that runs on a 'circadian rhythm', which is a 24-hour pattern of behaviour entrained to the day-night cycle of the natural world (Breed and Moore, 2016).

Video 4:11 //
How the sky changes based on the weather and time of day (Environmental assets by Staggart Creations.)

The weather in *Apis* is integral to creating an environmental reality, as well as showcasing a systemic awareness within the virtual ecosystem. Abraham and Jayemanne discuss the four typical modes of environmental representation in video games. *Apis* presents a fifth; the modelling of an environmental reality that has a systemic effect on other systems within the game.

Apis expresses different atmospheric conditions, utilising five distinct weather states: clear, overcast, rainy, stormy, and misty. The skybox bases its colors and lighting on the time of day, but also takes into consideration the current weather state [See Appendix 07]. The weather affects the wildlife and the environment throughout *Apis*. Animals, insects and even plants are aware of the weather and act accordingly. As part of the prototype's criteria was to embody a systemic awareness, having the weather become an essential part of the ecosystem's behaviour demonstrates a successful prototype (Video 4:11). This also curates another layer of environmental affect for the player to witness, showing them the different, emergent behaviours occurring based on the animal's climate and time.

Plants are also affected by the rain or sun. Seeds planted by the player or dispersed by the bees can grow naturally through cycles of rain and sunshine. Additionally, puddles can generate through rain, and dry up later in the sun. While a light rain doesn't affect the animal behaviour, a strong storm causes the mammals and birds to attempt to seek shelter until it passes (Begon et al, 2006). Including these small behaviours emphasises the animals' systemic response to their environment, and simultaneously allows the player to observe the animal's connected relationship with the virtual world surrounding them.

To showcase the correct weather state to the player and to the wildlife, particles and shaders were integral technical tools (Figure 4:7). Particle systems were utilised to represent raindrops and their impacts when hitting objects, becoming heavier when the system reaches a 'storm' state[31]. The implementation of audio further reinforced the simulation's accurate modelling, with birds chirping during a sunny day, crickets singing at night, and rain that alters based on its heaviness. Adding these sounds made the world of *Apis* feel fully immersive in the VR space, as well as reinforcing the 'realism' of the environment.

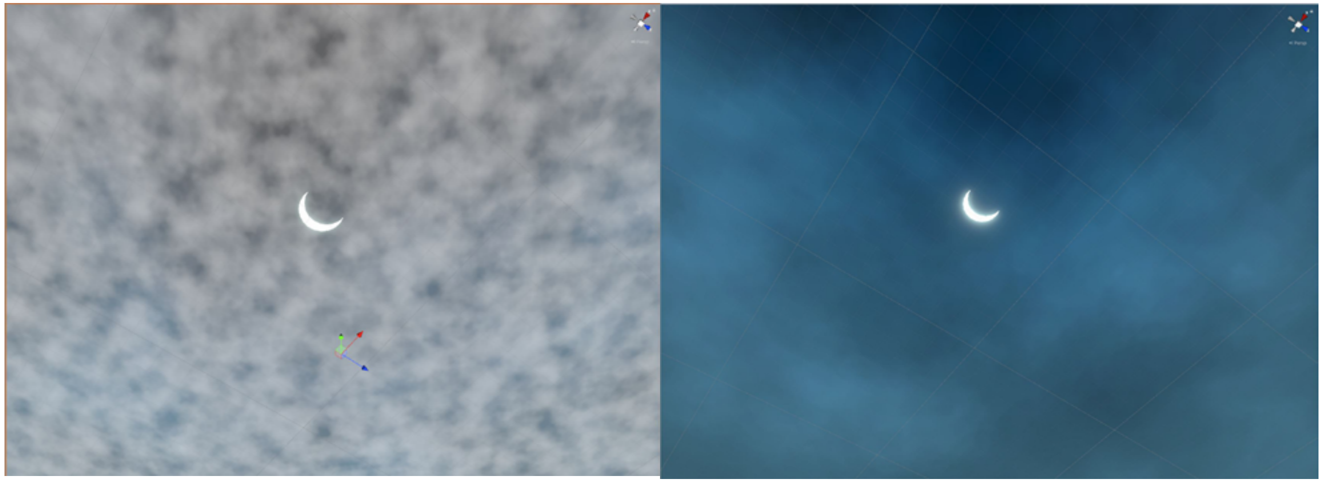
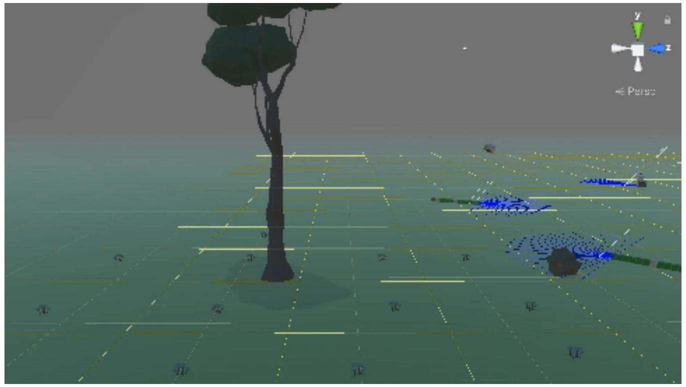


Figure 4:7 //
Trying to get realistic cloud coverage with different cloud shader experiments, using Unity's ShaderGraph. The image on the right is the final result. The final clouds have variable levels of density, scale and speed, with their amount and colour also deriving from the current weather.

If the project was to be continued into a PhD level, I would add other systems such as temperature, seasons, and different biomes. This could enable more factors to affect the wildlife and reinforce the innumerable ways in which the environment affects an ecosystem. However, the basic weather's prototype allowed me to explore the rudimentary implementation for the purpose of the research.

31. The addition of lightning particles [See Appendix 08] and thunder sounds was also used to communicate the presence of a storm.



Video 4:12 //
Using aspects from the old failed flocking prototypes, the bees were developed to have flying movement. This code was used again later for birds.

Busy Bees

The progression of *Apis* into a dynamic ecosystem that began to foster more moments of ecological consciousness was showcased particularly through the development of its bees, hence the title of the game. The bees themselves started off as simple, almost 'decorative' parts of the ecosystem that haphazardly flew around, landing on flowers at random intervals (Video 4:12).

However, it was found that the relationship between flowers and bees is more complex than that. Bees land on flowers to gain nectar for food, and pollen gets carried on their bodies over to other flowers. This is called pollination, and as "bees are the major pollinators of wild plants and crops in terrestrial ecosystems," (Brown and Paxton, 2009) they support reproduction, dispersal and growth in plants, trees, flowers and food-producing plants. Schowalter et al., (2006) further note that "pollination and seed dispersal are among the most intricate mutualisms between animals and plants" (Schowalter et al., 2006, p. 384). From this research, I deemed the functional implementation of bees to be an integral piece towards portraying an ecosystem, due to their interconnected actions between them and the survival of their environment.

Through the discovery of this mutualistic link of pollination, *Apis*'s bees' and flowers' systems were adapted to work in tandem with one another. When the bees visit flowers, they collect pollen and seeds, and when they visit another flower, these are transferred, causing more flowers to be generated and allowing the bees to collect more pollen. Since bees feed off pollen, if they don't find any flowers they can die of starvation, just like the ground wildlife. Certain herbivores also use the flowers as a food source, so the balance of this system can be upset through natural means if the herbivores begin to outweigh the speed in which the bees pollinate flowers.

The flowers and bees live in a perpetual cycle, feeding off one another to keep each other's species alive (Video 4:13). This cycle was further expanded on through the use of beehives, as returning to the beehive with pollen spawned another bee.

Video 4:13 //
Early footage of the beginning of pollination, which felt like a 'eureka' moment to the project as the two systems relied on each other to continue to function.

The artefact was considered to contain mechanics that enabled the creation of potions from resources harvested in the game world. As mentioned in Chapter Two, this is a common mechanic in games. However, *Apis* limits the player by removing the option for gathering resources, as this would enable the player to be able to upset this natural balance and destroy the ecosystem. In order to support the generation of ecological consciousness, and place emphasis on observation, I had to find other means of allowing the player to interact with the game, aiming toward an antithesis of Morton's (2016) *agrilogistic* perspective. Therefore, *Apis*'s player is only able to intervene in a positive way: Dispersing seeds, planting and watering them. If the player doesn't water them, the rain will eventually occur and water the flowers naturally. Planting flowers is a positive for all members of the ecosystem - the bees have more pollen, the rabbits have more food and the flower species will survive (Figure 4:8). Through *Apis* removing the possibility for negative intervention, the bee and flower cycle will continue perpetually, and the player cannot cause any fatalistic outcomes.

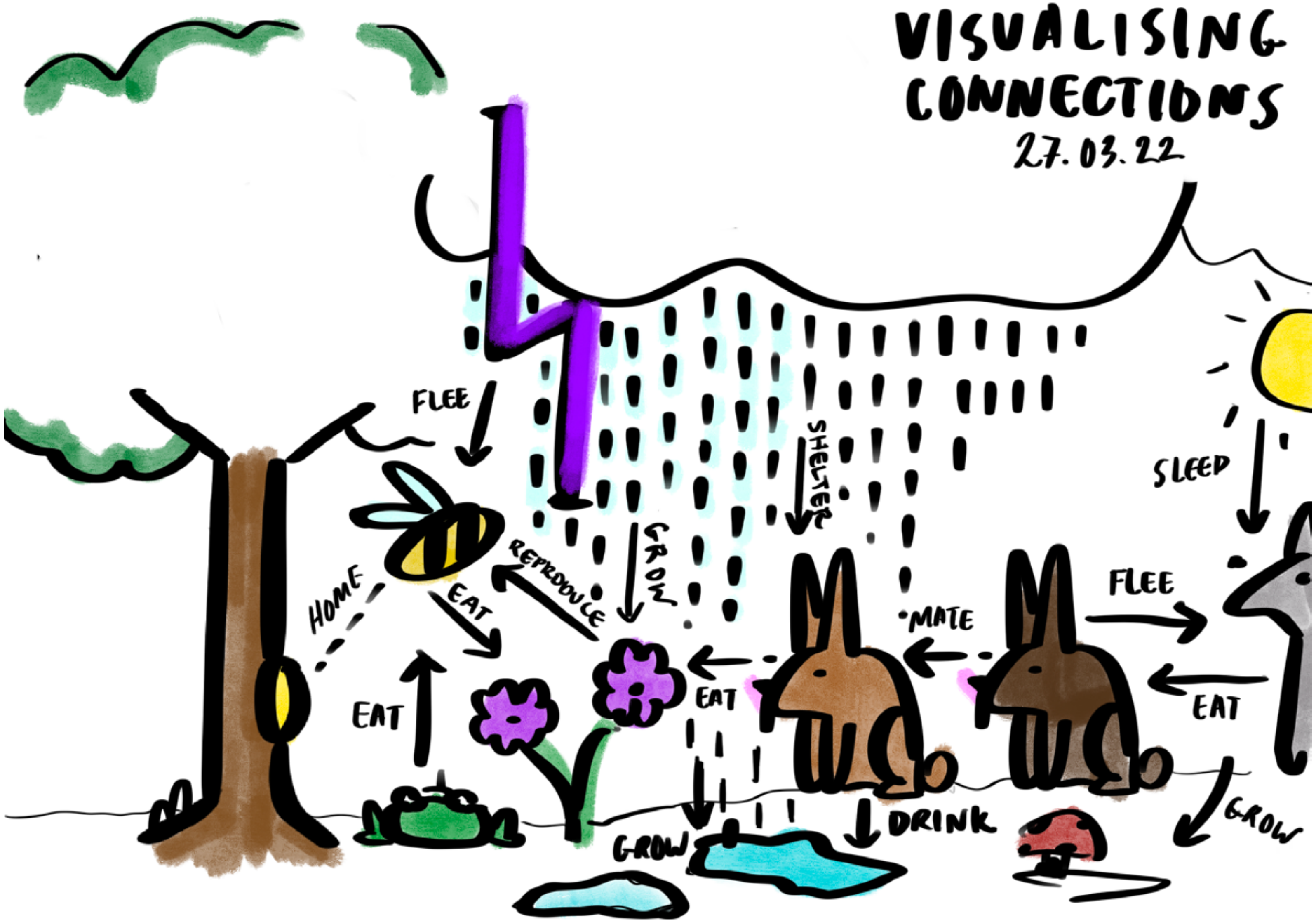


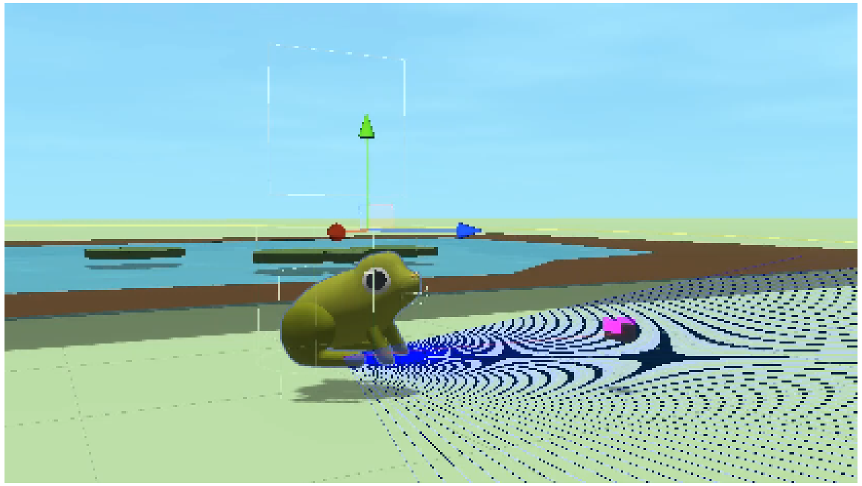
Figure 4:8 //
A sketch drawn after the bees were implemented, to help visualise the connections in the ecosystem, and see if anything important was missing.

Video 4:14 //
Bees go into the hive during a storm.

While developing *Apis*'s weather and environmental changes, the bee's behaviour was altered further. Research found that bees continue to operate and pollinate during light rain, but higher wind speeds and heavy rainfall causes them to return home, or prevents them from foraging altogether (Lawson & Rands, 2019).

Therefore, *Apis*'s bees developed to be wary of the weather. If there's a storm, they return home and don't come back out until it is safe to do so (Video 4:14). Similarly, research found that bees return to their hives at night to sleep (Kaiser, 1988). Enacting these simple notions based on atmospheric changes within *Apis* tied the threads of the whole dynamic ecosystem together. Bees and flowers rely on a mutualistic relationship, and behave accordingly to environmental changes. Their development felt like a key moment in *Apis*'s progress, as the evolution of these prototypes successfully created a small fragment of an ecosystem.

Bees are vital to our real-world ecosystem. Their contribution to maintaining biodiversity is essential to human survival (Brown and Paxton, 2009). Currently, they are facing a severe decline in population (Brown and Paxton, 2009). *Apis* limits the player to not see the game world as containing harvestable resources, but rather as an interesting observation. Creating ecological consciousness in *Apis* places emphasis on inspiring excitement and joy, rather than guilt, shame or nihilistic thoughts. Through playtesting, I felt a sense of happiness when I watched a bee meander over to a flower, which can be tied back to Morton's belief that "paradoxically, the best way to have ecological awareness is to love the world" (Morton, 2007, p. 201). Using *Apis*'s close showcase of the bees, plants and their relationship, the player is able to watch these essential creatures in action, perhaps feel some awe, and contemplate the severity if humankind were to continue with our current *agrilogistic* (Morton, 2016) paradigm, and lose them.



Video 4:15 //
Frogs have a unique way of acquiring food.

Video 4:16 //
Apis's Frogs lay eggs that hatch into tadpoles, that can swim around before going to the side of the pond and growing up into baby frogs.

Ribbit?

A notable mention of the project was also the development of the frogs. The desire to have different kinds of animals arose through my continual observation of the game in development. *Apis* intended to limit player interactivity as a strategy to foster ecological consciousness, by highlighting the beauty and intricacies of an ecosystem. To focus on observation, the 'observed' needed to be interesting and varied, as I discovered through playtesting that watching the same kinds of interactions repeatedly felt boring. To showcase variance in order to keep the player interested in observation, I created frogs and their unique behaviours of eating[32] (Video 4:15) and reproduction[33] (Video 4:16).

Reflection found that showcasing these little, specific environmental intricacies created moments of wonder. Since the animals in *Apis* don't see the player as a threat, they allow us to watch them carry out their everyday exploits. I was particularly enamoured as I don't see these unique mannerisms up close every day, and being able to witness them up-close, to "hone sensory reciptivity" (Bennett, 2011) without interference or fear, was used to foster ecological consciousness, as the ideology places emphasis on a mutual co-existence.

32. Frogs are carnivores, but most do not chase and hunt prey, instead utilising a sticky tongue to catch and bring their prey to their mouth (Linzey, 2020).

33. Frogs reproduce differently than mammals or reptiles. As they're part of the taxonomy of 'amphibians', they deposit their eggs in water, which hatch into aquatic tadpoles that eventually develop into frogs (Linzey, 2020).

Video 4:17 //
This is the first prototype that embodies the idea. Sprites were drawn in ProCreate by me, and implemented roughly into the current system, ideal for a prototype.

Simulating Communication

A simple experimental prototype was undertaken in the beginning of Apis, to think about how the simulation and relationships could elicit increased moments of ecological consciousness.

This prototype was to embody principles of Back and Waern's method of evocative experimental design, used to elicit abstract qualities and the thinking that my artefact is aiming to evoke from the gameplay (Back and Waern, 2015). In the beginning, to make analysing the functionality of the prototype easier for me as the playtester and developer, the current state of the animal was depicted in text above his head. However, I liked the communication between the observer and the simulation. Therefore, this experiment commenced with each animal having a small bubble that appears above their head when they're enacting certain behaviours or weighing a decision. The icon inside is used to represent that thought to the player (Video 4:17).

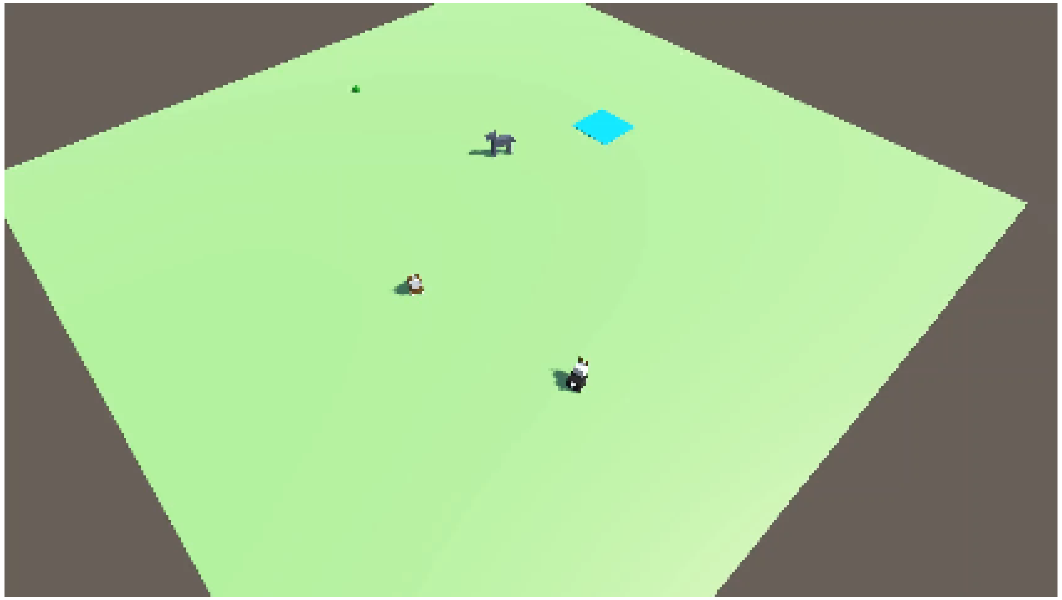
Figure 4:9 //
This image from the Sims 4 (Maxis, 2019) is an example of the way Sims convey their thoughts through images.
Retrieved from: [https://www.digitalspy.com/tech/a36109527/best-sims-4-expansion-packs/]
Copyright 2022 by DigitalSpy.

Figure 4:10 //
Untitled Goose Game (House House, 2019) is similar, except the player is the animal. They're the (mischievous) goose, and the man is clearly communicating his intentions, except with a picture instead of words.
Retrieved from [https://www.polygon.com/guides/2019/9/24/20880640/untitled-goose-game-garden-to-do-list-walkthrough]
Copyright 2019 by Polygon.

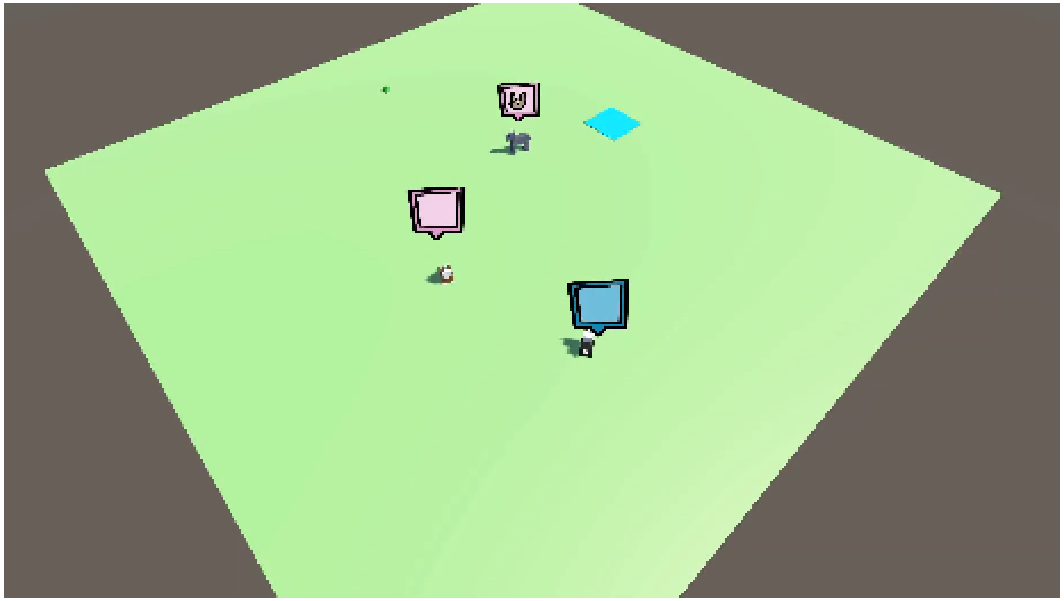
The idea for this prototype emerged from looking at games such as the Sims series (Maxis, 2000 - 2021) or Untitled Goose Game (House House, 2019), where images pop up above characters' heads to convey thoughts, emotions and intentions. As Sims 'speak' a language unknown in the real world, the way the player understands their thoughts are through images. This provides a mutual form of communication when the same language isn't spoken. Finch et al. discuss how "a picture can in effect ground the meaning to an object or concept in the real world and act as a convenient bridge over language barriers" (Finch et al., 2013).

Animals don't speak the same language as us; to imply they did would potentially remove some validity of the simulation, making it incomprehensible as noted by Gualeni previously. Having English written above their heads would also remove the potential for an Non-English speaker to be included in the conversation. In Chapter Two, I discuss Bennett's notion of 'contemplating and observing' environmental intricacies to create moments of joy, which was decided as a way to generate feelings of ecological consciousness in the observer. Therefore, this prototype explores how communicative images can be utilised to display the *specific* intricacies of their actions and decisions.

Video 4:18 //
Without icons.



Video 4:19 //
With icons.

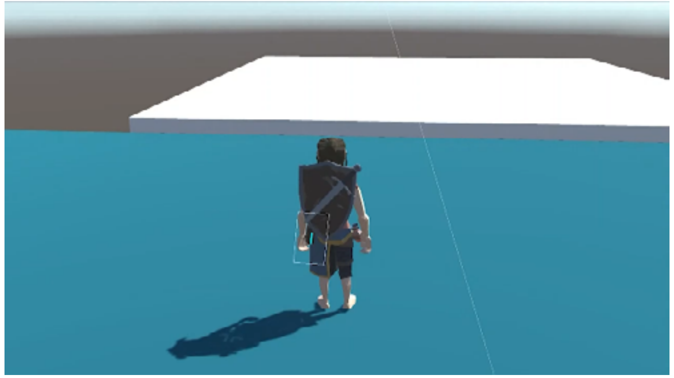


Through comparison of two videos of the predator/prey system (one without the icons implemented (Video 4:18), and one with them (Video 4:19) I noticed how much understanding it added to the prototypes and comprehending the behaviours being undertaken by the simulated animals. Through the use of these icons, the player is able to observe and understand the specific behaviours, activities and thoughts undertaken by the animals through a mutual form of communication. The prototype uses a sense of empathy, between the animals and player, by placing the "non-human" on a foundation of understanding to potentially elicit moments of ecological consciousness.

Part 3:

Incorrectly Interacting

The Wrong Direction



Video 4:20 //
I created 3D character movement, combat, magic, Enemy AI, an inventory system, interchangeable armour, weapons and spells, lootable chests and a character creator. (Assets by Synty Studios)

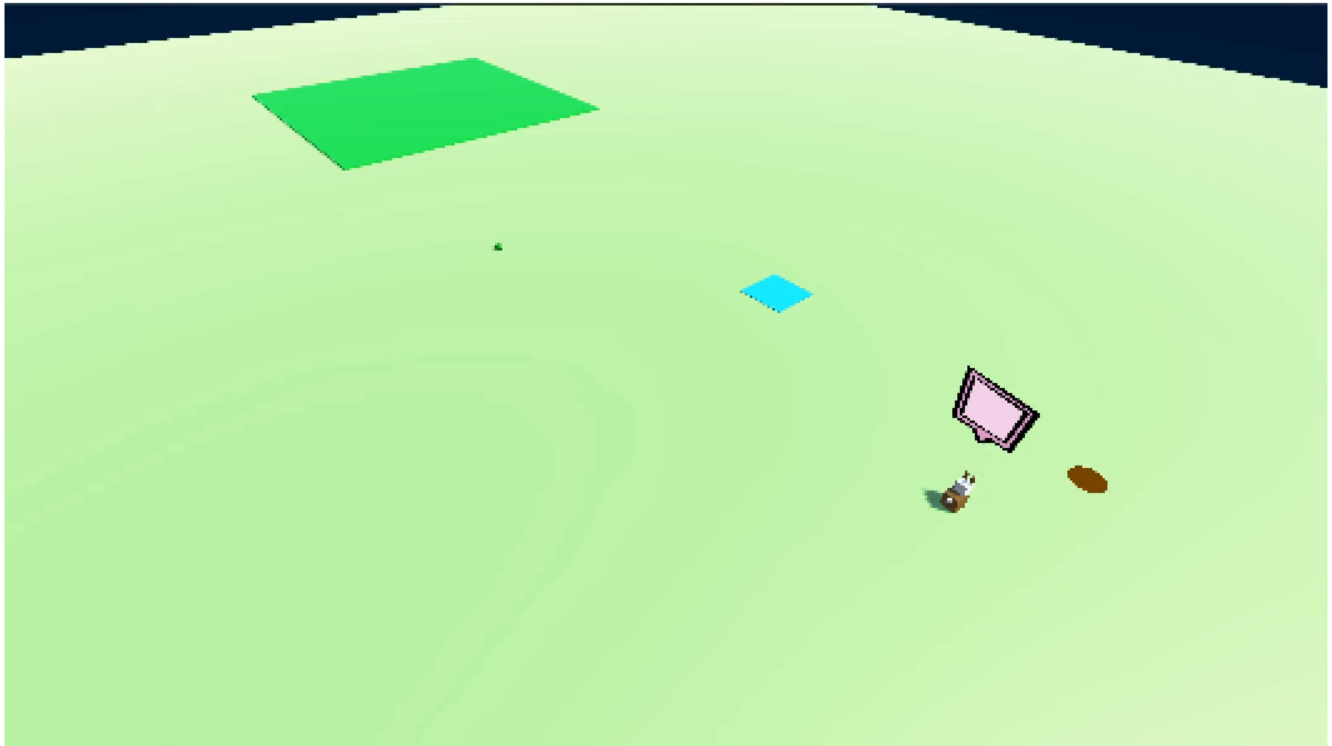
Apis didn't begin with prototypes that immediately embodied the ecosystem concept - rather, Apis began as '*Tidefall*', an RPG[34] that focused heavily on a fantasy story and complex player mechanics (Video 4:20). The idea was to have all the player interactions completed, and add the ecosystem in afterwards.

Through research for my contextual review, the central factor of Ultima Online's (Mythic Entertainment, 1997) ecology failure was giving the player the ability to dominate the animals with their weapons. This was discussed as a player simply exerting their 'conceptual curiosity' (Alexandra et al, 2016), merely utilising the mechanics provided for them to play the game. Concepts were drawn up in order to explore if both systems could still be involved in the game - such as having enemies, so the players might overlook killing the animals and perhaps focus on the enemies instead.

Overall, removing the power for violence became a fundamental aspect of the project, and vital in the process to elicit feelings of an equal, ecological consciousness.

Analysis of Rain World (Videocult, 2017) and Paper Beast (Pixel Reef, 2020) also placed emphasis on the significance of designing the gameplay around the ecosystem, making the ecology and its internal interactions the priority for the research to manifest. The third-person perspective also made me, the player, watch my own character's actions rather than observing the world built around it. Through researching and reflection, this prototype was abandoned, and *Apis* began.

34. Otherwise known as a 'role-playing game', in which the player "controls a fictional character (or characters) that undertakes a quest in an imaginary world. These often (but not always) contain skills, combat, quests, character classes, etc." Retrieved from: [https://www.techopedia.com/definition/27052/role-playing-game-rpg]



Video 4:21 //

The "god-mode" perspective prototype. The player is able to use their mouse to pick up and interfere with the animals.

An Experiment of Apotheosis

One of the experiments undertaken in relation to the player's interaction within the project was known as an 'omnipresent' perspective, or a 'god-game'[35] (Adams, 2014). The idea emerged from observing the simulation within Unity from a fixed camera perspective during development. The intention was that the player could pick up the creatures with their mouse, and move them around (Video 4:21). This was quickly prototyped, but reflection found that it didn't quite create the mutual co-existence between the player and the ecology, as it felt as though the player was 'god' and fully in control. This perspective is further described by Adams as a game where the designer "lets the player control the lives of autonomous people and creatures for better or worse, satisfying a desire to be omnipotent over a world of beings subject to the player's will" (Adams, 2014, p.359).
Being subject to the 'players will' was a key feature of *Apis* I had aimed to avoid; I wanted the player to observe the virtual world, not be in control of it.

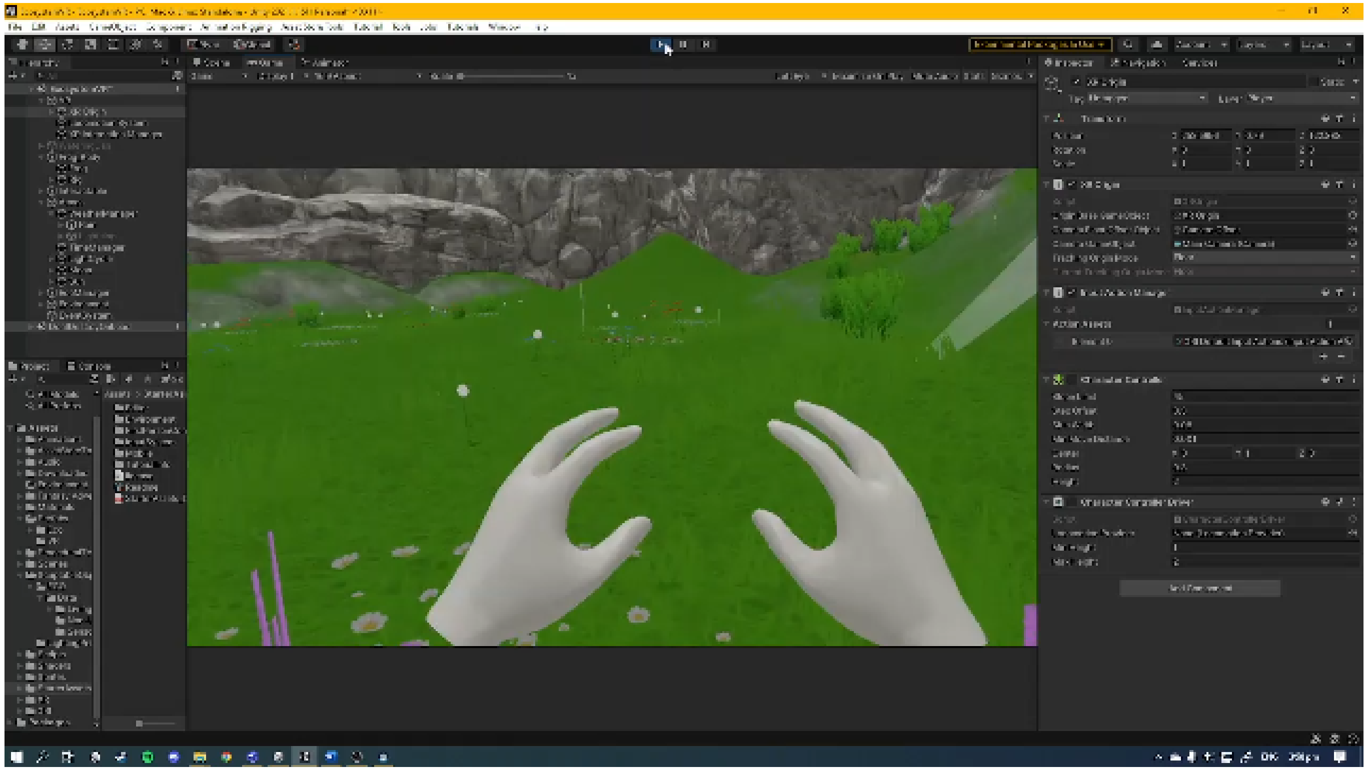
35. "in which the player can act upon several different parts of the game world at a time. For him to do so, you must give him a camera model that permits him to see the various areas that he can change; typically, an aerial perspective." (Adams, 2014, p. 581)

Video 4:22 //
Apis in first person doesn't manifest the research as it feels flat.

A New Perspective

Perspective of the player was a thoroughly investigated detail within *Apis*, as I hypothesised it would have an impact on the artefact's ability to elicit feelings of an equal, ecological consciousness, through the possible interactions and the way the player observes the game world. After third-person and omnipresent perspectives were rejected, *Apis* had a first-person perspective placed in it, which I assumed to be the last option. However, through playtesting it felt flat and boring, and I didn't feel like I could actually observe the ecosystem in an engaging way (Video 4:22).

Virtual Reality is a unique perspective in which it places the player inside the game-space, through the use of an encompassing headset. This had the potential to embody the research question, as I wanted the artefact to focus on contemplation and using that to elicit feelings of *equality* with nature. Placing the player inside this virtual world where they can look, move and exist with its' creatures created a more personal viewpoint in which to engage with the ecosystem.

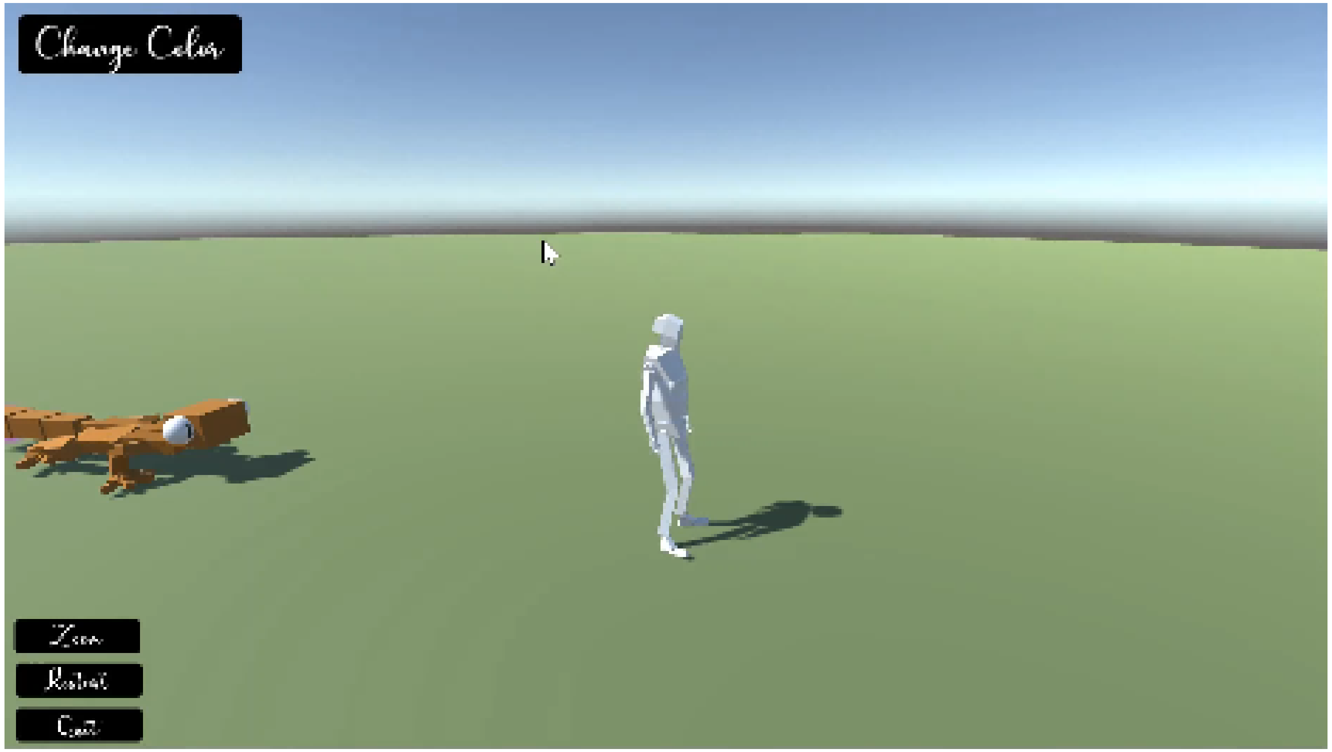


Video 4:23 //
A recording of my first interaction with *Apis* in VR.

Crushing Conceptual Curiousity

However, *Apis*'s biggest difficulty proved to be the notion of how the player could actually interact with the game. Contextual research showed that a player's *conceptual curiosity* will attempt anything the game allows them to do. A key part of VR is its interactivity (Bardi, 2019) as the player character has handheld controllers that are used to interact with the game world. I developed a character controller in which I made graspable hands in VR, with the ability to pick things up and throw them around. I also implemented movement and teleportation.

Placing the ecosystem within the VR-controlled space was a turning point for the research. The first thing I did as a playtester was pick up a frog and attempt to throw it (Video 4:23). I also could have fed it to a predator. This threw everything I had intended to achieve out the window. Through the research, I envisaged removing the potential for destruction, violence, and dominance. To elicit a mutual ecological consciousness, I needed to remove the player's power and place the player and the environment on an equal footing to incorporate the ideology. By throwing the animals across the space, or attempting to have them killed, I was a dominant presence that was able to intervene negatively, and destroy the ecosystem at my whim. This project was meant to avoid player participation making the environment worse, as that leads to inconsequentialism (Sandler, 2010; Sinnott-Armstrong, 2005; Axon, 2017).



Video 4:24 //
Post-graduate Gecko game, created by me in 2021.

This meant that my interactions needed a change of direction. Previously, for my postgraduate classes, I made a prototype where all the player is able to do is throw a ball for a procedurally-animated gecko (Video 4:24).

This was a simple game, with limited player mechanics and no concrete goals. This kind of minimalism and simplicity has been discussed by Jenova Chen, designer of 'Journey' (Thatgamecompany, 2012). He noted that "we build our games like a Japanese garden, where the design is perfect when you cannot remove anything else. I think that by doing that, the voice of your work is more coherent. If you have a lot of clutter on the top, the work may be more impressive, but you won't really know what it's trying to say" (Chen, 2012 as cited by Gualeni, 2016, p .77).

As the core part of the research is a thriving, functioning ecosystem, Apis needed to highlight that aspect clearly. The outcome of limiting the player's interactions is noted by Gualeni as "the interactive experiences of virtual worlds that allow for freer and more ambiguous types of play cannot lead to the emergence of a univocal and clear meaning" (Gualeni, 2016, p. 97). Essentially, he believes that the only way to communicate directly to the player is to guide them specifically towards understanding the research through restricted play.

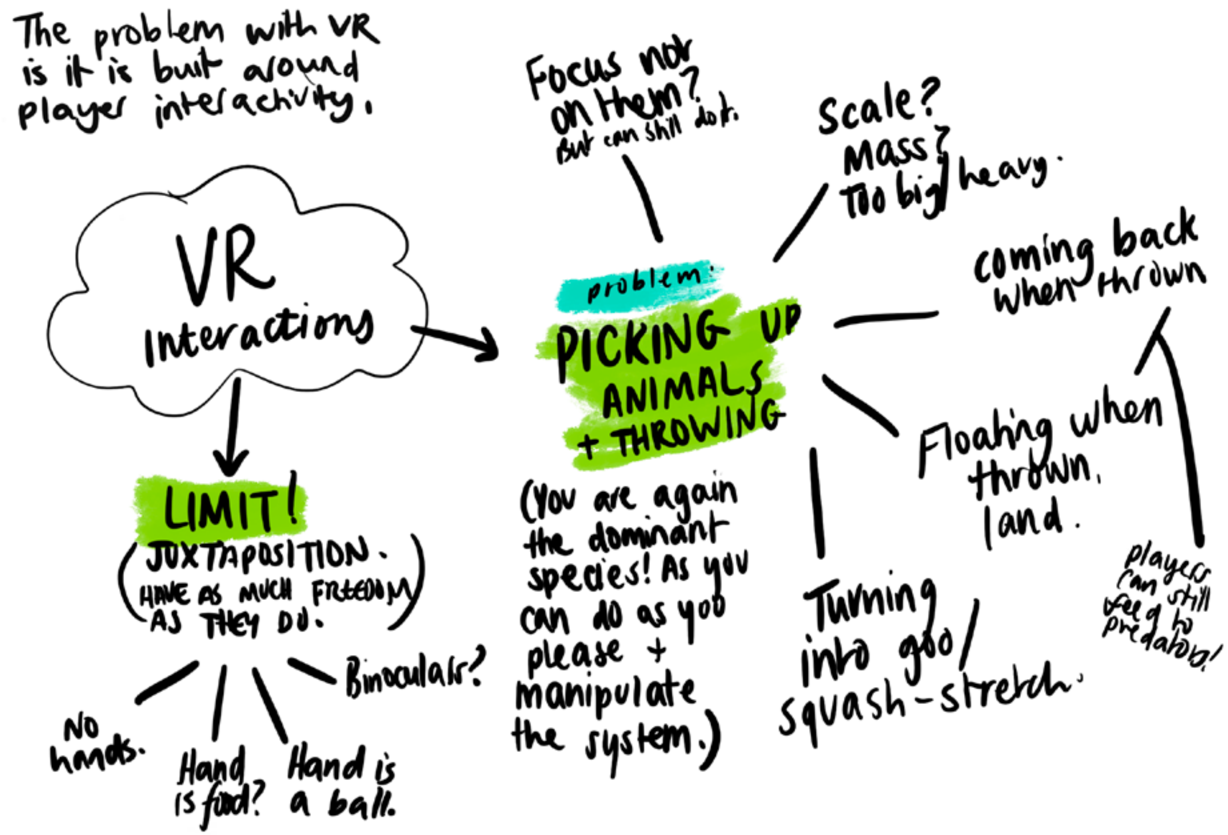
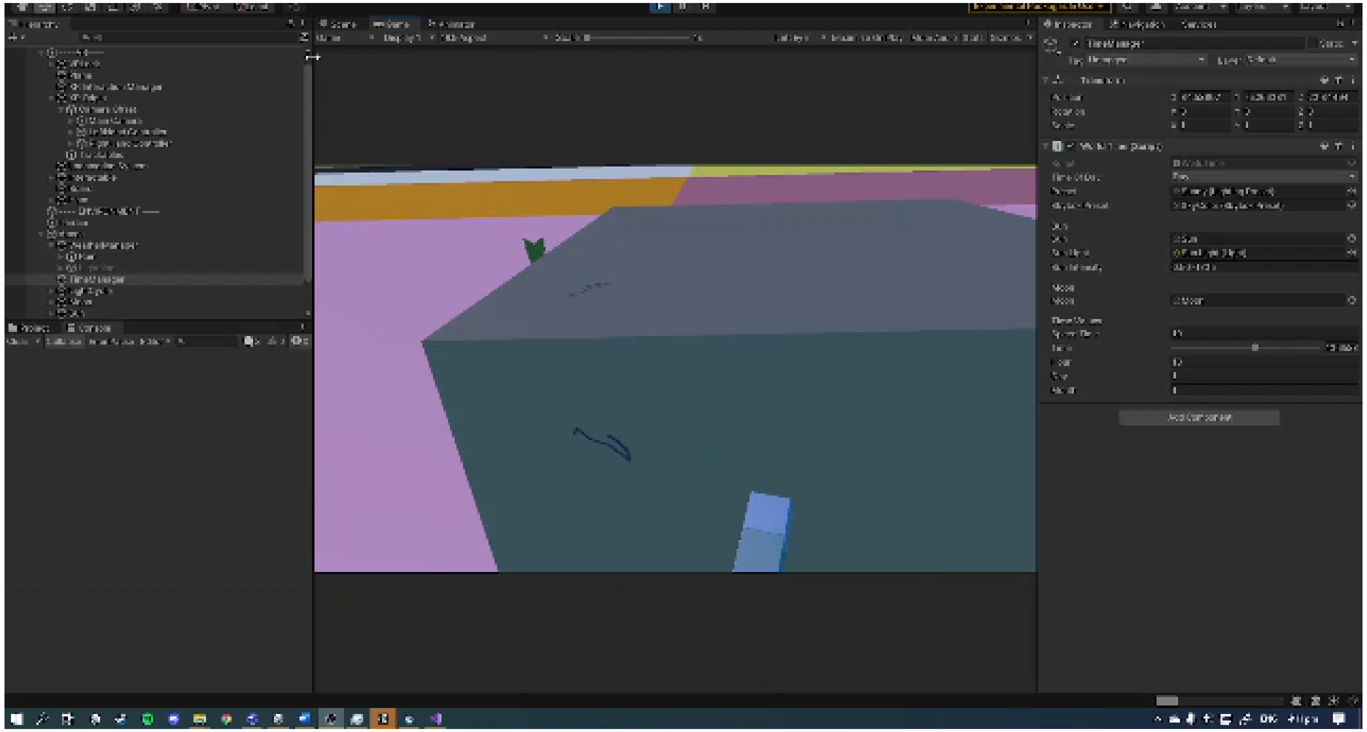


Figure 4:11 //
A sketch exploring "How can I make the player less destructive?"

However, I still wanted *Apis* to be engaging and allow the player to have positive, meaningful engagement within the ecosystem. Not only so the player is invested in the game-world, and gives them enough time to explore and experience the constructed enchantment, but as *Apis* is an interactive media, the player's interactions should contain the same amount of capability as the animals to demonstrate coexistence. I wanted the player to integrate themselves into the ecosystem to foster these moments of ecological consciousness. Therefore, considerations were made, as shown in Figure 4:11, on how a player could only be a positive influence, with different kinds of limits on their interaction and the game world's responses.



Video 4:25 //
The VR Drawing experiment.

An experiment was undertaken in which I made a VR pen that the player could use to draw on specific materials in the game world (Video 4:25). This was conceived as the player having a notebook in which they could wander around the virtual space and draw the animals that they saw. However, through playtesting, I found that I tried to draw on the animals, the trees, the rocks, and everything I could find. I was so distracted with trying this that I didn't notice the ecosystem around me, unless I was trying to draw on it. As it moved the player's attention away from the focus of this research, this idea was scrapped.

The next experiment involved being able to pick fruit from the fruit bushes, and feeding it to the animals as a positive interaction. In order to keep the world systematically designed, the fruit was developed so that if I threw it into the water, it even floated to later be able to feed the fish [See Appendix 09]. However, yet again, picking and throwing with the VR hands made me still eager to try to pick up the animals and abuse my power in the ecosystem.

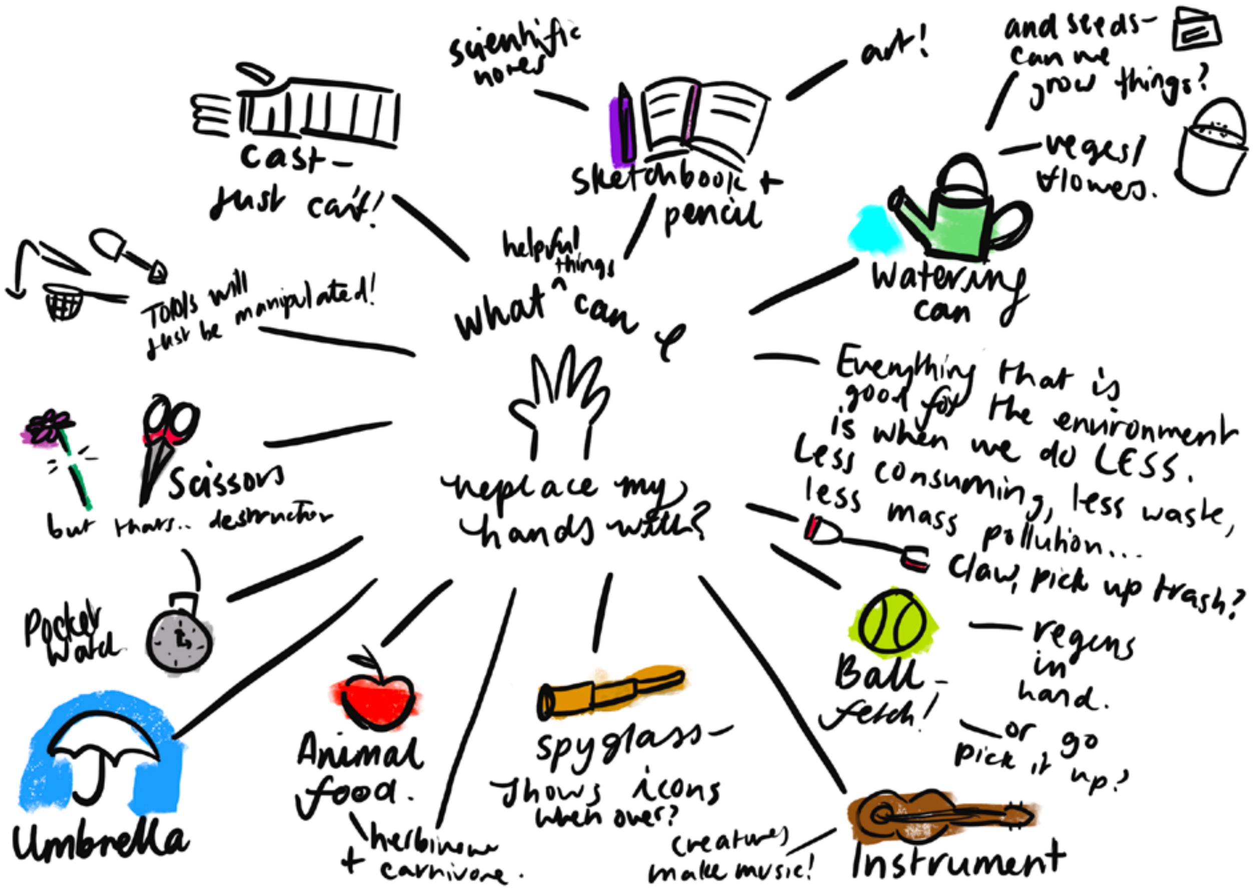
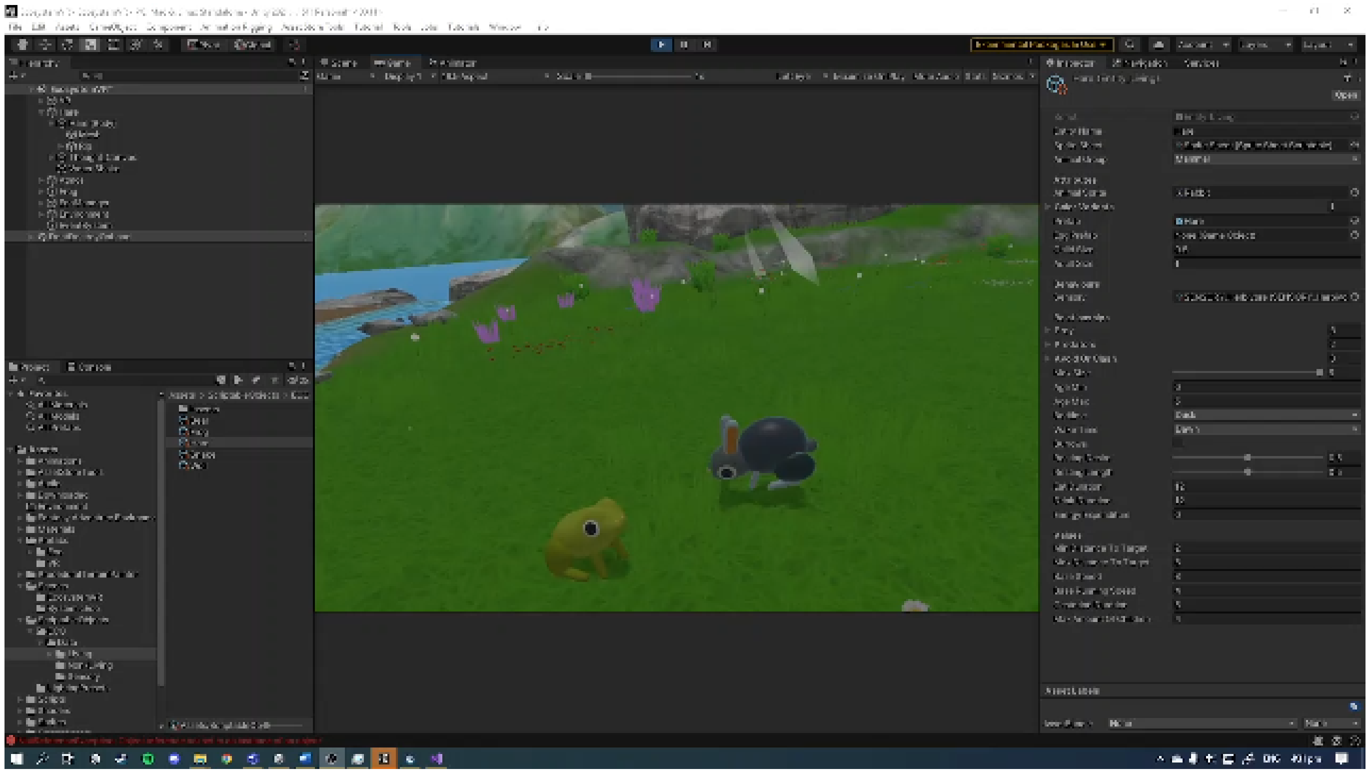


Figure 4:12 //
A sketch exploring "What can I replace my hands with?"

Due to the systemic nature of the game, there were so many ways the player could attempt to disrupt and damage the ecology. Making everything non-interactable would discredit the 'systemic design' portion of the research, as well as possibly disappointing players once all of their ideas for interaction were rejected (Sweetser, 2005). Therefore, I decided to remove the VR hands entirely, and replace them with something less dominant (Figure 4:12), that would allow me to signal to the player the specific interactions Apis required to convey its message of mutualism. Since I wanted to avoid destruction and harmful playtypes, I wanted specifically-designed tools that interacted in only a playful or beneficial way with the system.

Watering the Rabbits

Gualeni believes that to allow video games to disclose clear meanings, they should "direct player behaviour toward simple and non-negotiable objectives by offering very limited operative options" (Gualeni, 2016, p.97). Hence, I replaced one of the player's hands with a watering can. The other contained a bucket of seeds.



Video 4:26 //
The animals reaction to being watered with the watering can.

These tools required new mechanical, connected systems to be implemented in *Apis*. Again, considering what the player might do with the watering can is an important part of the research.

When given a watering can and an animal, the player can attempt to water the creature below them. To manifest systemic design, if the animal isn't in a life-threatening position, it will pause what it is doing and shake the water off in a frustrated manner, before returning to its current task (Video 4:26). However, this reaction meant that the watering can could be used to 'stun' an animal in place, annoying them continuously if the player waters them persistently, showcasing an anti-ecological dominance. Playtesting continued to reveal how players will use or abuse whatever system they're given, even if it's just a simple watering can. Considerations were made, such as *Apis*'s systems creating consequences for the player by removing the watering can and giving it back after a certain amount of time. However, I could simply repeat the behaviour. Instead, *Apis*'s animals react to the negative behaviour by shaking off the water once, walking away, and if the player tries it again, they will ignore them as they know they're not a survival threat - just an annoyance. This further reinforces how the player has *no power* here.

Seeds were also implemented in the player's other hand. The player is able to choose from a number of seeds they've collected from fully-grown plants, and throw them on the ground to plant them. Plants that are fully grown develop seeds that the player is able to then obtain and disperse, similar to that of seed-dispersing creatures like bees[36], or birds (Schowalter et al., 2006). For the seeds to grow, they need a combination of water and sunlight over a series of in-game days; however, even if the player abstains from this singular behaviour, the rain will water the plants anyway.

These interactions mean that the player is only able to contribute to the game's environment naturally, ***the ways that bees or rain do***. In fact, the player is "participating in the mystery of Nature; in which the observer is not alienated from the observed" (Devall, 1982, p. 181). As ecological consciousness is an alternative paradigm that realises that the non-human are at the same level as us (Morton, 2016), placing the player in an equivalent position enables them to contemplate and view themselves as a thread within the ecology. The player is a natural part of the ecosystem, exhibiting a mutual coexistence between them, and the non-human surrounding them.

Through this, *Apis* aims to leave players with reflection on their own position within the environment, and rather than shaming them from an anti-ecological standpoint, allow them to focus on the enchantment and wonder that surrounds them everyday. While this won't fix problematic behaviour, it provides a memory of a positive activity, that perhaps will influence future decisions, or beliefs.

"We can't mourn for the environment because we are so deeply attached to it - we are it."
(Morton, 2007, p.186)

36. Apis's bees also naturally disperse these seeds through their pollination behaviours.

chapter 05

Discussion & Conclusion

05

Discussion & Conclusion

This exegesis documents the research's attempt at combining notions of systemic design with a virtual ecosystem, and exploring how to establish a new frame of ecological thinking from this synthesis. At the core of this exegesis was the notion that currently, "humans have stamped their impression on things they consider as ductile as wax, even if those things cry" (Morton, 2016).

Apis does not allow human dominance. The trees in *Apis* are not destructible, nor used for resources; they're shelter for reptile eggs, and mammals escaping thunderstorms, and homes to beehives, bird nests and edible fruits. The animals exist for no-one but themselves, surviving within their environment without manipulation. Flowers are not harvestable, nor mere decoration; they are pollinated by bees, grown by rain and provide food for herbivores. Humans are not allowed to make the nature and animals in *Apis* cry. The game takes away the player's ability to dominate and destroy, instead promoting wonder, joy and delight with only positive interactivity. Personally, I found *Apis* created ecological consciousness through the enforcement of observation and how we are placed mutually within its virtual ecosystem.

Iterative design proved to be an effective methodology to investigate these assumptions, by placing emphasis on critical reflective practice. Prototyping allowed manifold experiments to explore answering the research question and discover the potential of both systemic design and video games' ability to pursue philosophical enquiry. The process of creating Apis challenged my traditional approach of thinking about and designing games, as the research question forced reflection on every design decision made; not on whether it was fun, functional, or even impressive, but what it meant to the research. It pushed my understanding of game design away from my usual making of mechanics-heavy, story-based games, and demanded that every connection and relationship be considered, to each other and to the artefact as a whole.

I believe that *Apis* answers the research question put forward at the beginning of this exegesis.

The outcome of *Apis* was not one of overwhelming success, nor failure. It was not a polished, perfected game, but a large, iterated and refined prototype that explored multiple research opportunities. I found that systemic design proved to be an effective tool for creating the ecosystem as a designer, by breaking the complexity of an interconnected ecosystem down into individual systems, and being able to develop the pieces individually without becoming overwhelming or missing important connections. Systemic design was also fascinating as a player, enforcing wonder and discovery over how things were connected, and their interactions. At the beginning of this research, I believed that enchantment was one way to elicit ecological consciousness, but through iterations, I found that I had to limit the player substantially in order to be able to showcase this enchantment to a player; if the player was given too much power, they wouldn't just observe, but use what they were given, like functional hands in VR. To place the player inside an ecology and make them look, player behaviour was directed toward simple goals by limiting offered operative options (Gualeni, 2016), such as removing their hands and replacing them with helpful, non-destructive tools. *Apis* is a systemic game that reframes players' potential interactions, allowing for new and improved critical thought.

Contributions & Future Research

This exegesis treads into defining systemic design, and proving its' advantages towards game design in order to establish it firmly within game academia, and as a potential tool for future designers. Systemic design allows game inhabitants to respond to their surroundings, which means players explore more, improving the quality of gameplay and player interest (Sweetser, 2005) and providing new experiences for players.

The research also contributes towards meaningful environmental representation within video games, showcasing other modes of gameplay that involve the environment without focus on destruction or pedagogy. Apis demonstrates that designers don't have to shame, teach or punish the player to present moral precepts. This embodies thinking discussed by Chang, Abraham and Jayemanne, Gualeni; They believed the creation of an ecological reality that avoids reproducing problematic human-nature relationships within video games have the potential to guide thinking towards new, non-dominant philosophies, and "facilitate the emergence of alternative worldviews" (Gualeni, 2016). Apis emulates these suggestions, even extending to representing ideas from Morton, who pondered video games as a tool for showcasing the ideology of ecological consciousness.

Furthermore, the process of crafting Apis in relation to the research, contributed heavily to my own knowledge, understanding and ability. My skills as a game designer and researcher have improved, as well as my understanding of systemic design and how to potentially use it in the future. Not only do I understand more about the biological world surrounding me, but ecological consciousness started as an unfamiliar perception of the world; now, it is a worldview I endeavour to acclimate myself to. Additionally, crafting Apis into a tool for meaning reoriented my thinking towards designing games. I discovered that it doesn't have to be the design or content of the game that can create significance; but potentially how the game allows the player to use it.

Apis was a small segment of what it could be. While the artefact embodies the research undertaken in order to create it, both exploratory and biologically, it has the capacity to broaden in detail. Every ecological book I read provided new information on the complexity of an ecosystem. *Apis* provided a basic representation, and could develop further and showcase more representations, more specifics, and potentially with other types of gameplay. Limitations within the research were the restrictions of internal playtesting; being objective and not separating the designer from the player could produce biased results, as there is pride as a designer in what you make. The next stage for *Apis* is to allow others to play it, and refine the work based on player feedback.

Continuation into a PhD could inspire additional discussions and research specifically surrounding systemic design, to situate it more firmly into the academia of game design research. Similarly, research for this project has opened avenues of further exploration into ideas surrounding conceptual curiosity (Alexandra et al., 2016), as I would be interested in experimenting with player limits without losing the traditional 'fun' often associated with video games.

To Conclude…

It is a well-known fact that humans as a species have desecrated our natural world, and severely impacted the ecosphere and inhabitants that live within it (Almassi, 2012; Darr 2019; Axon, 2017; Morton, 2007; O'Sullivan and Taylor, 2004; Gualeni, 2016). However, *Apis* doesn't try to teach the player how to save the planet, nor make them feel guilty, fatalistic or inconsequential. It merely produces a form of representation, manifested as a VR experience, that allows them to enjoy a space in which they aren't the villains of this virtual world; hopefully aiding the player to believe as though they are a piece of this ecosystem, existing with the environment, rather than against it. While *Apis* won't fix our current climate crisis, it is a solid first step towards video games embodying alternative environmental paradigms, and re-orienting our thinking.

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Appendix

Appendix 01 // A Systems Theory example

The Lotka-Volterra model (Volterra, 1926; Lotka, 1932) began to develop in 1920, using a differential equation suggesting that two biological species could fluctuate in perpetuity. If the herbivores are abundant, then the population of carnivores will increase, causing a decrease in the total number of herbivores as the carnivores consume them. When these herbivores become insufficient to feed the carnivores, some animals die of hunger and the reproduction of herbivores will flourish until it reaches a level equal to its initial value. This cycle continues repeatedly (Bacaer, 2011). This theory, however, assumes that no other environmental factors, other species or habitat conditions can affect these two fluctuating species (Begon et al, 2006). This is why the model is a simplified, abstracted theory.

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Figure (Appendix 01) //
An example of a Lotka-Volterra oscillation, observing the populations of Canadian Lynx and Hare. Retrieved from: [https://www.mun.ca/biology/scarr/Hudson_Bay_population_cycles.htm]

Appendix 02 // Systemic Design Sketch

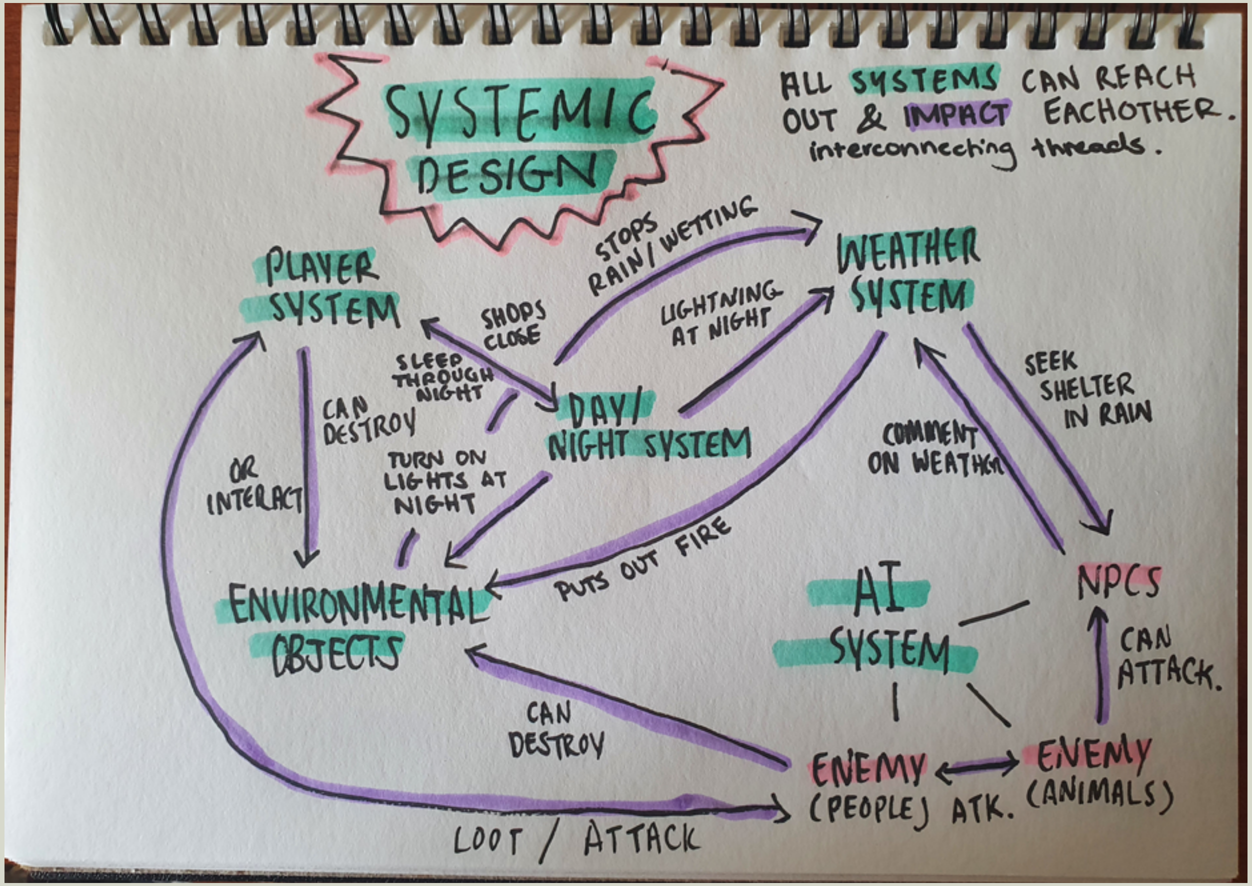

Figure (Appendix 02) //
A sketch that demonstrates my personal understanding of systemic design, specfically for an RPG style game.

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Appendix 03 // Systemic Design's Potential for Surprises

Systemic Design's emergent, dynamic reactibility, while promoting unique interactions, can have unfavourable surprises for developers. Dwarf Fortress (Bay 12 Games, 2006), is renowned for its complex and realistic simulation mechanics, and impressive attention to detail (Davis, 2019). Creator Tarn Adams spoke about an odd issue players discovered when his systems began to interact in unexpected ways. The code for Dwarf Fortress contains a lot of rules, including features that when liquid is walked through, it sticks to a character's feet. Adams had also integrated cat behaviour, including that cats lick and clean themselves, and absorb whatever they're washing off. Therefore, when alcohol was spilled on the ground in taverns, the cats got it on their paws, and after cleaning themselves, they ingested the alcohol, got drunk, and died from alcohol poisoning (Fenlon, 2016). This unexpected relationship between two seemingly non-connected systems created unique surprises for players and developers.

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Appendix 04 // Enchantment in Proteus

The game Proteus (2013) by Ed Key and David Kanaga embodies concepts of contemplation to spark enchantment. Proteus is known as a musical, ambient exploration game, only providing the player with the ability to walk and look around with no active goals. However, if you stop moving and just look, things occur - an aurora, sunsets, rain, meteor showers or fireflies appear. The world reacts through player contemplation, and has a beautiful soundtrack to accompany it. When frogs jump away, musical notes sound. Again, this game embodies the idea that the player is the significant factor in the world, but it also forces them to do nothing in order to instigate the beauty and wonder available, if they just stop and look.

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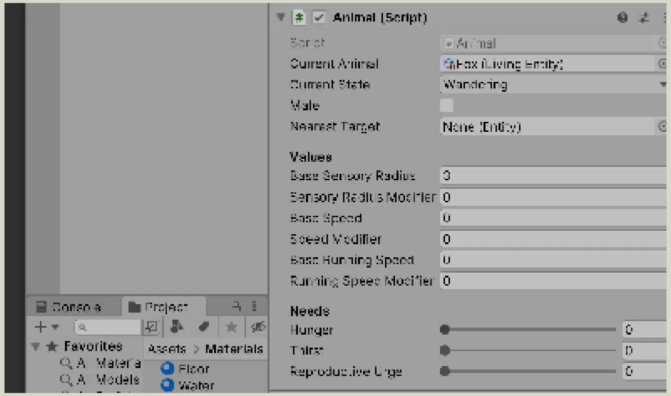
Figure (Appendix 04) //
Proteus is simple; yet effective.
Retrieved from: https://www.rockpapershotgun.com/proteus-screenshots]

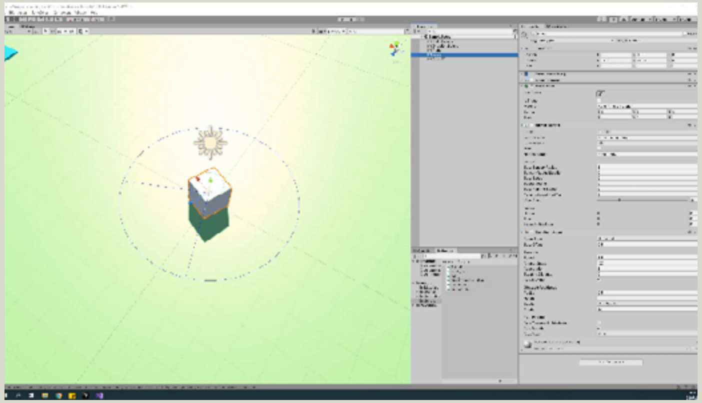
Appendix 05 // Initial Prototype Development

These videos show my standard process for prototype development based off conceptual plans.

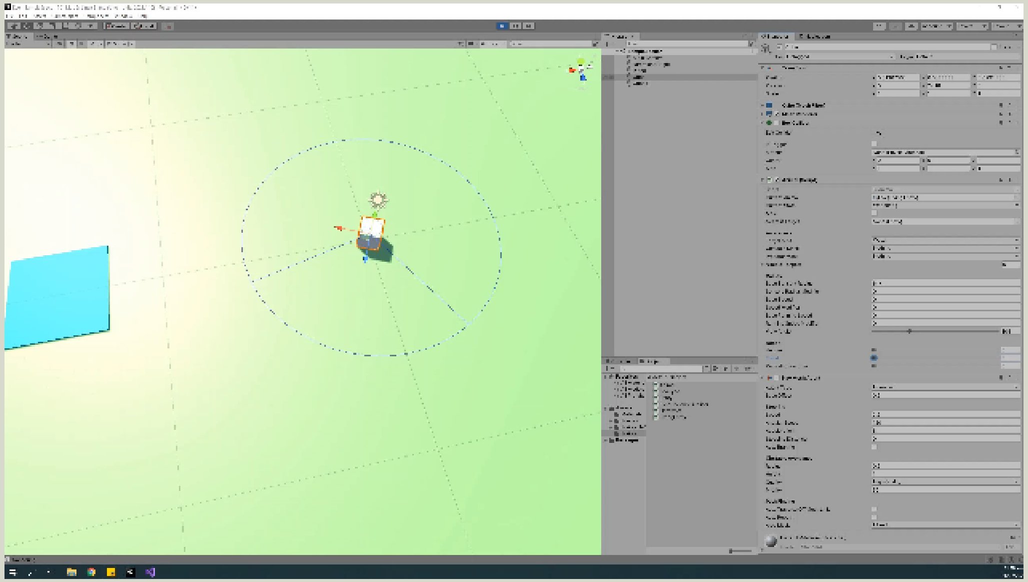
[Go back to page reference]



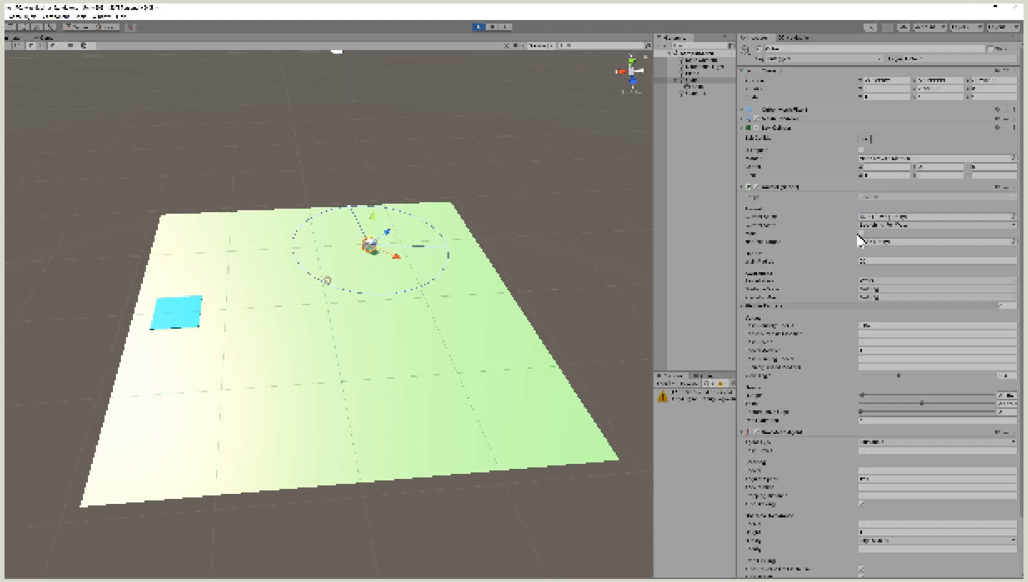
Video (Appendix 05):1 //
First step involved having the animal's needs decide their state.



Video (Appendix 05):2 //
The second step gave them a radius and cone in which to sense and see targets.



Video (Appendix 05):3 //
The third step allowed the creature to sense what they need once it came within range.

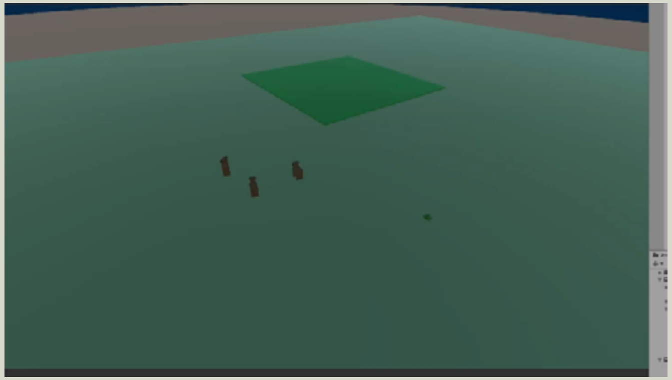


Video (Appendix 05):4 //
The fourth step involved them being able to move around to retrieve their target.

Appendix 06 // Continuing to try Herd behaviour

Herd behaviour prototypes were continously attempted throughout *Apis's* development. This video documents the prototype in which they graze as a group. It was rejected due to being too mechanical, and too time-consuming to fix.

Go back to page reference



Video (Appendix 06) //
Grazing as a group felt too mechanical.

Appendix 07 // Systemic Design in the System

Part of a modular system I developed, with the lighting and sky colours being affected by the weather and time of day. This shows that systemic design is essential even in development, and if a designer wants to implement it, it needs to be thoroughly thought about in unexpected avenues of the game.

Go back to page reference

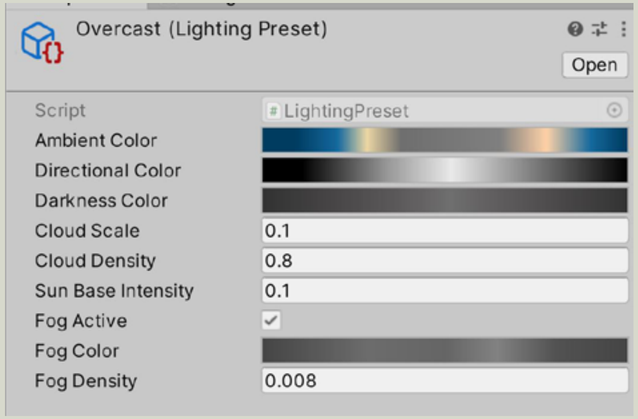
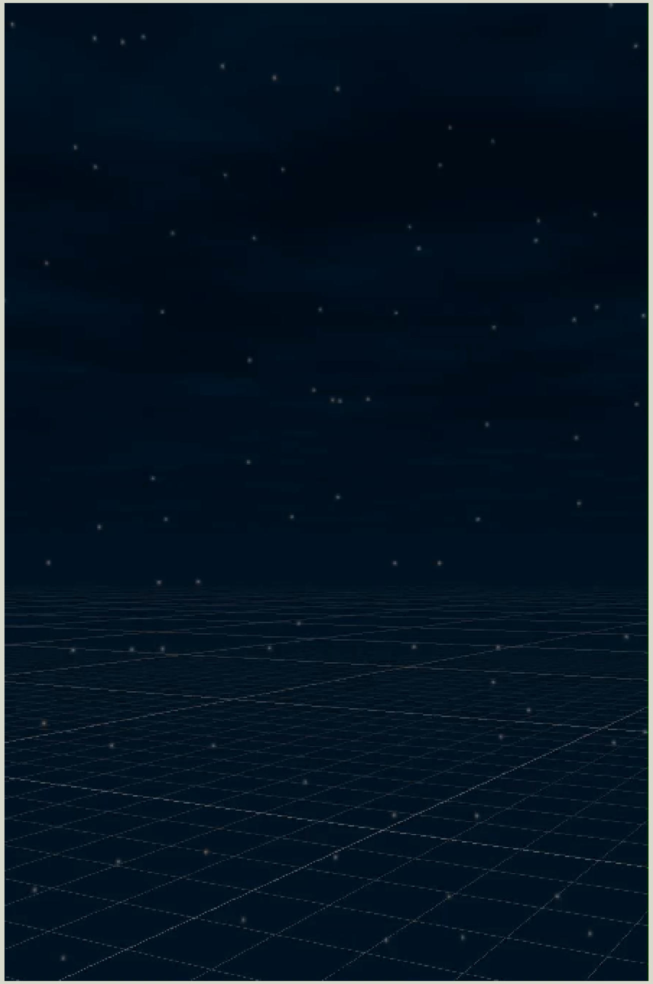


Figure (Appendix 07) //
Every part of the weather state can be adjusted.

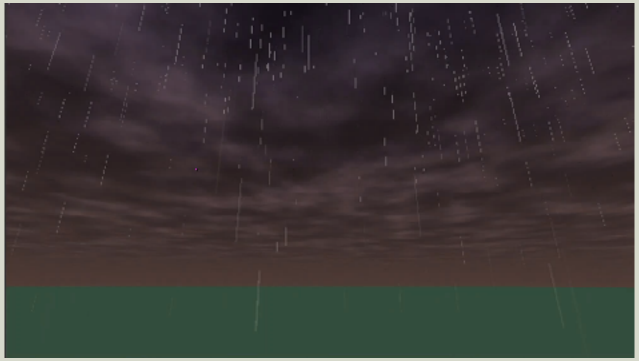


Video (Appendix 08:1) //
Lightning particles.

Appendix 08 // Lightning!

Lightning particles developed in Unity, to help communicate the prescence of a storm to the player and wildlife. Lighting was going to be able to set fire to plants, and be doused by rain, but time constraints meant this would be implemented in future.

Go back to page reference

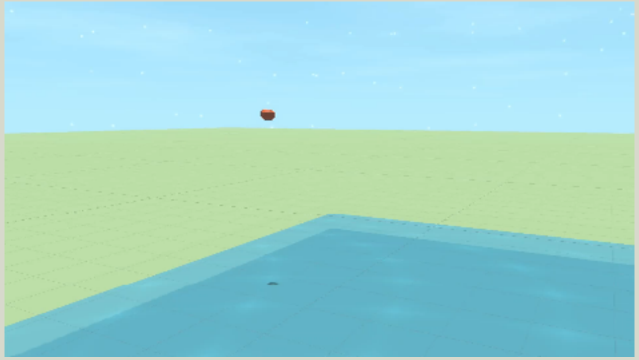


Video (Appendix 08:2) //
Lightning in a storm erupts into sparks off the ground.

Appendix 09 // Floating Fruit

The ability to throw fruit and have it land in water and float, to feed fish, was part of the conceptualised ideas to remove player destruction. However, this was not implemented in the final prototype as the hands were removed entirely.

Go back to page reference



Video (Appendix 09) //
Buoyant fruit.