Artefact Development Report

Kart Project

Written by

Toby Morgan

Level 6 Games Design
Games Development Project

University of Staffordshire

Contents

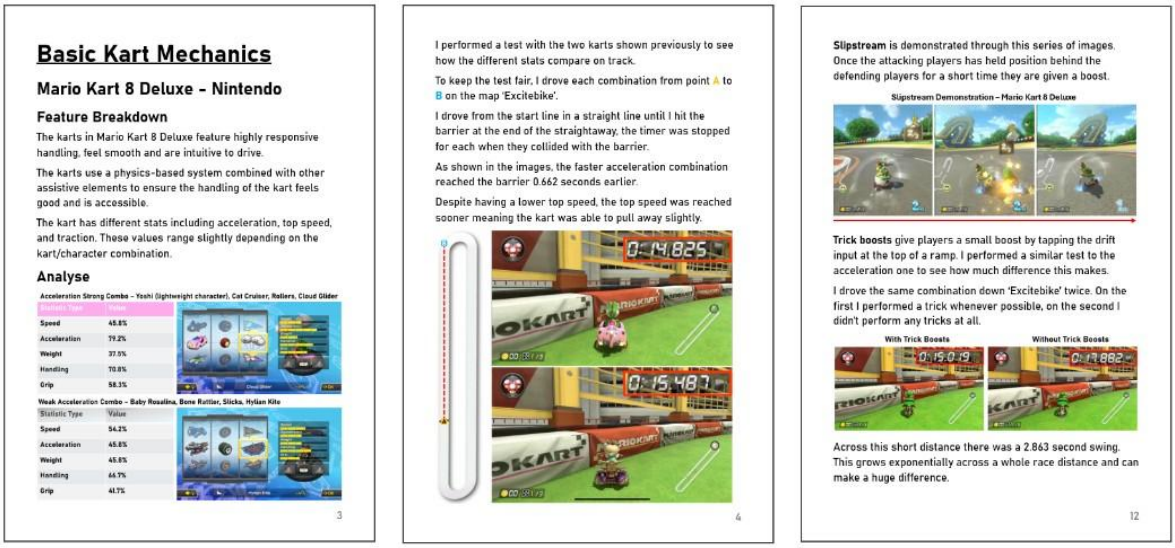
Introduction/Deliverables

Game feel is one of the most important yet least visible elements of game design, shaping how players perceive responsiveness, control and satisfaction (Hicks, 2020). This project's aim was to develop a kart racing game that priorities game feel in order to create an engaging and enjoyable player experience. Within racing games in particular, responsiveness, control and feedback directly are crucial for player satisfaction. To achieve this aim, I created a project in Unreal Engine that implements core gameplay systems typical of the genre, ensuring that considerations of game feel informed design decisions throughout development.

Alongside producing a functional prototype, a key objective of this project was improving my own skill development in preparation for entering the games industry. Target skill areas were identified through analysis of recent industry job listings sourced at the time of development, allowing the project to align both creatively and technically with employers' expectations. As a result, development focused on building an understanding of a vehicle physics, artificial intelligence systems, and efficient system design within Unreal Engine, while also demonstrating applied game design knowledge to an industry-standard level.

Research

Throughout the research phase of this project, I employed multiple techniques to gather useful information that would assist me throughout development. This broad approach ensured that both practical hands-on and theoretical understanding informed design decisions.



Basic Kart Mechanics

Mario Kart 8 Deluxe - Nintendo

Feature Breakdown

The karts in Mario Kart 8 Deluxe feature highly responsive handling, feel smooth and are intuitive to drive.

The karts use a physics-based system combined with other assistive elements to ensure the handling of the kart feels good and is accessible.

The kart has different stats including acceleration, top speed, and traction. These values range slightly depending on the kart/character combination.

Analyse

Acceleration Strong Combo – Yoshi (lightweight character), Cat Cruiser, Rollers, Cloud Glider

Statistic Type	Value
Speed	45.8%
Acceleration	79.2%
Weight	37.5%
Handling	70.8%
Grip	58.3%

Weak Acceleration Combo – Baby Rosalina, Bone Rattler, Slicks, Hylian Kite

Statistic Type	Value
Speed	54.2%
Acceleration	45.8%
Weight	45.8%
Handling	66.7%
Grip	41.7%

3

I performed a test with the two karts shown previously to see how the different stats compare on track.

To keep the test fair, I drove each combination from point A to B on the map 'Excitebike'.

I drove from the start line in a straight line until I hit the barrier at the end of the straightaway, the timer was stopped for each when they collided with the barrier.

As shown in the images, the faster acceleration combination reached the barrier 0.662 seconds earlier.

Despite having a lower top speed, the top speed was reached sooner meaning the kart was able to pull away slightly.

4

Slipstream is demonstrated through this series of images. Once the attacking players has held position behind the defending players for a short time they are given a boost.

Slipstream Demonstration – Mario Kart 8 Deluxe

Trick boosts give players a small boost by tapping the drift input at the top of a ramp. I performed a similar test to the acceleration one to see how much difference this makes.

I drove the same combination down 'Excitebike' twice. On the first I performed a trick whenever possible, on the second I didn't perform any tricks at all.

With Trick Boosts | Without Trick Boosts

Across this short distance there was a 2.863 second swing. This grows exponentially across a whole race distance and can make a huge difference.

12

Figure 1 - Example of Research Document Pages

I created a research document that includes hands on research into existing games in the genre. I also completed video / forum-based research to better understand how existing games implemented the systems needed for my project. This also allowed me to learn how different systems and games have been perceived by the community and why certain design choices were considered successful or unsuccessful.

#	Combination #1	Combination #2	Time Difference
/	1:22.082	1:29.023	+6.941
1	0:12.145	0:13.567	+1.422
2	0:11.322	0:12.663	+1.341
3	0:11.371	0:12.434	+1.063
4	0:11.774	0:12.543	+0.769
5	0:11.614	0:13.032	+1.418
6	0:12.176	0:12.412	+0.236
7	0:11.680	0:12.372	+0.692

Figure 2 - Mario Kart 8 Deluxe, Drifting vs No Drifting Comparison

I focused on key systems that are found in most games in the genre to ensure a point of comparison. I broke down each feature describing how it works in whichever game was the focus, analysing how and why the systems work the way they do. I then compared the different researched focuses and explained how I would apply the understanding I had gained in my own project. This comparative approach helped to identify genre standards and areas that I could innovate.

In the research phase, I explored a range of existing kart racing games, including Mario Kart 8 Deluxe, Sonic Racing: CrossWorlds, Skylanders: SuperChargers, and Rocket Racing (Mario Kart 8 Deluxe, 2017), (Sonic Racing: CrossWorlds, 2025), (Skylanders: SuperChargers, 2015), (Rocket Racing, 2023). Playing Mario Kart 8 Deluxe, I learned about the importance of responsive vehicle handling, ensuring that players feel in control, especially when navigating corners and performing drifts. The drifting mechanics in Mario Kart and Sonic Racing highlight how different approaches can shape the gameplay experience and skill curve. This insight guided my emphasis on making vehicle controls both accessible and rewarding to all players.

Figure 3 - How 'Health' Mechanic Affects Race Position in Skylanders: SuperChargers

Additionally, the research into Skylanders: SuperChargers showed how target audience can impact these systems. The game features simplified vehicle handling and is tailored for younger audiences. This observation showed the importance of balancing and accessibility in my own project. I also completed research into UI design by creating wireframes for existing games. Breaking down existing UI designs made it clear that non-intrusive, readable interfaces are crucial for maintaining player immersion and supporting fast decision-making during gameplay.

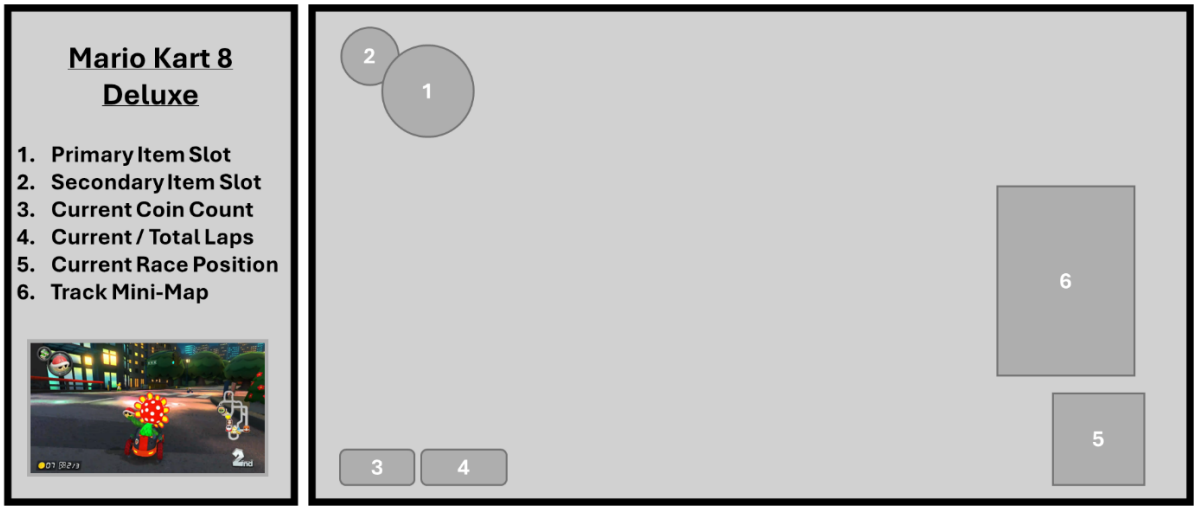


Figure 4 - Mario Kart 8 Deluxe Wireframe

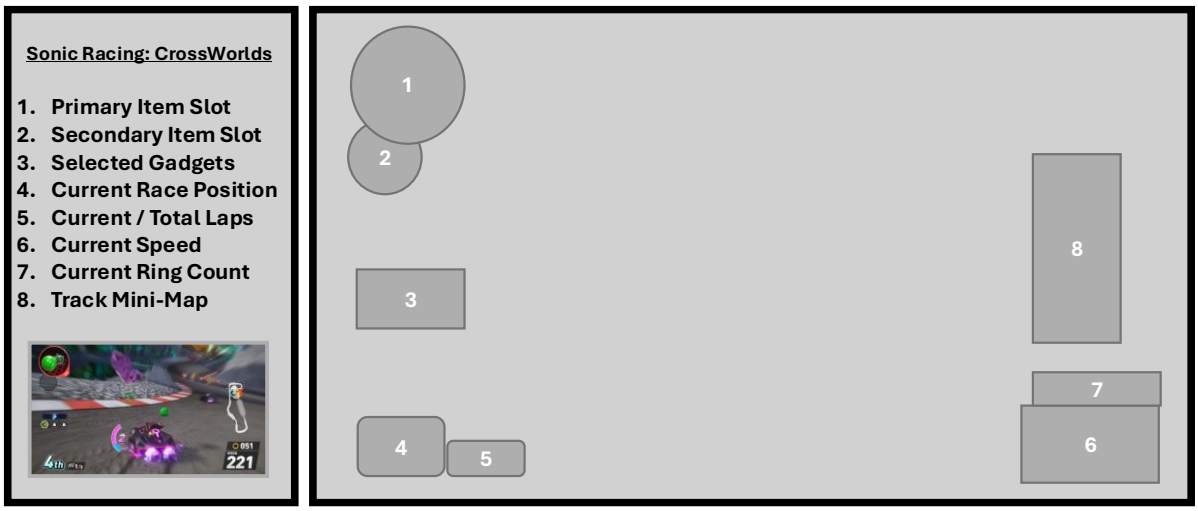


Figure 5 - Sonic Racing: CrossWorlds Wireframe

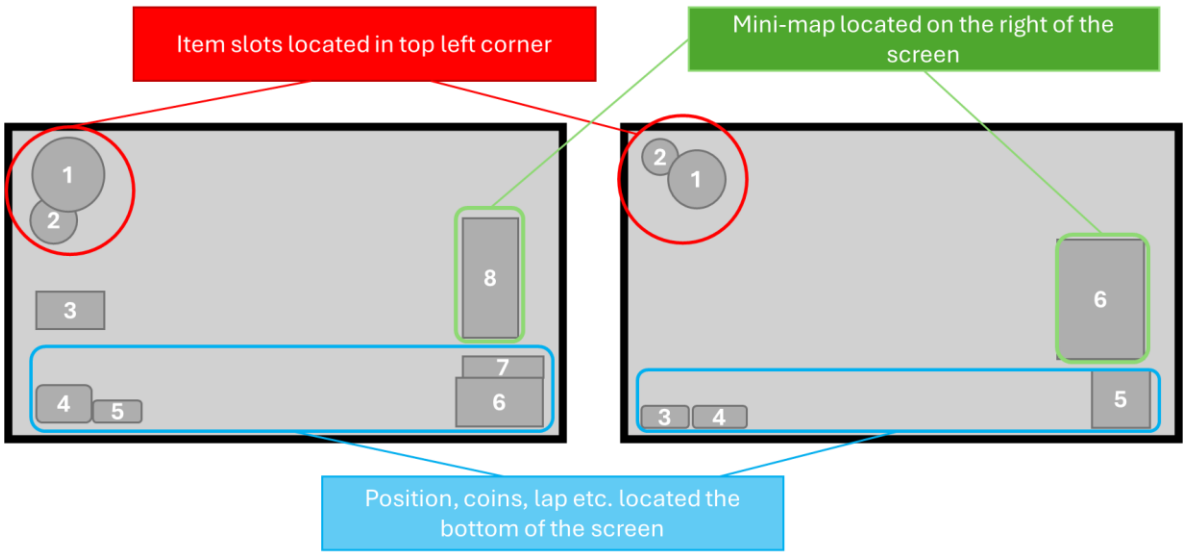


Figure 6 - Sonic Racing (Left) / Mario Kart (Right) Wireframe Comparison

Steel, J et al. presented a GDC talk discussing how vehicle physics work in Skylanders: SuperChargers (Steel & Donnelly , 2016). Watching this expanded my understanding of industry best practices and system related design decisions. I also engaged with online forums and watched various videos to gather insights into community feedback and trends. These resources provided a well-rounded perspective on how different elements in racing games come together to create engaging experiences and reinforced observations made during hands-on testing.

In summary, the research phase highlighted key design principles that shaped the project: responsive vehicle handling, intuitive UI, and AI behaviour that supports dynamic racing. These findings laid the foundation for the development and helped ensure a cohesive and engaging final product by directly informing system priorities and scope decisions.

Methodologies

In the early stages of the project, I explored the core vehicle physics to ensure a tailored experience. Initially, I considered using Unreal Engine's built-in Chaos Vehicle Physics system. However, based on discussions with engine experts and alumni who had worked with similar systems I went with a more custom approach for the project (juliengamedev, 2025), (Quartley, 2025).

Additionally, I conducted a comparative analysis of various kart racing games, including Mario Kart 8 Deluxe and Sonic Racing: Crossworlds. This helped me understand different approaches to acceleration, steering, drifting and power-ups. This comprehensive research guided the development of the game's unique feel and gameplay mechanics.

The best way to discuss the structure / workflow of development I used is "Context Switching". Due to being a solo project and having all kinds of systems to develop I often worked on whatever task I felt like each day. I have made use of lists to help prioritise specific tasks, for example allocating a larger amount of time to key systems such as the vehicle itself and AI enemy racers.

I had meetings with my project mentor weekly which helped me keep on track and ensured I had a clear plan of tasks from week to week. General research came first, followed by the early development of the vehicle system (Toyful Games, 2022), (Laley, 2024). I developed all the other systems being sure to have a strong understanding of how and why systems work the way they do in other projects before implementing my own.

Production

Development

The development phase of the project focused on translating the initial research and design intentions into a playable racing experience, with a strong emphasis on game feel, accessibility, and mechanical depth. This section outlines the key systems developed during the project, including the vehicle controller, user interface, artificial intelligence, track design, and pickups, alongside discussion of iteration, testing, and scope limitations.

Vehicle Development

The vehicle system is the core of the project and occupied a majority of the development time. From my research into Mario Kart 8 Deluxe, I learned that to deliver an experience that feels good to players I needed to create a system that feels responsive, handles well at low and high speeds and overall makes the player feel in control. Initial prototypes explored acceleration, braking, and steering behaviour. These elements are at the core of any vehicle system in games and were important to get right. They all depend on suspension logic, which in my case was calculated using four line traces that check their distance to the ground constantly

and apply upward force when needed. This upward force is calculated through use of a curve, the shorter the distance to a hit object, the stronger the upwards force.

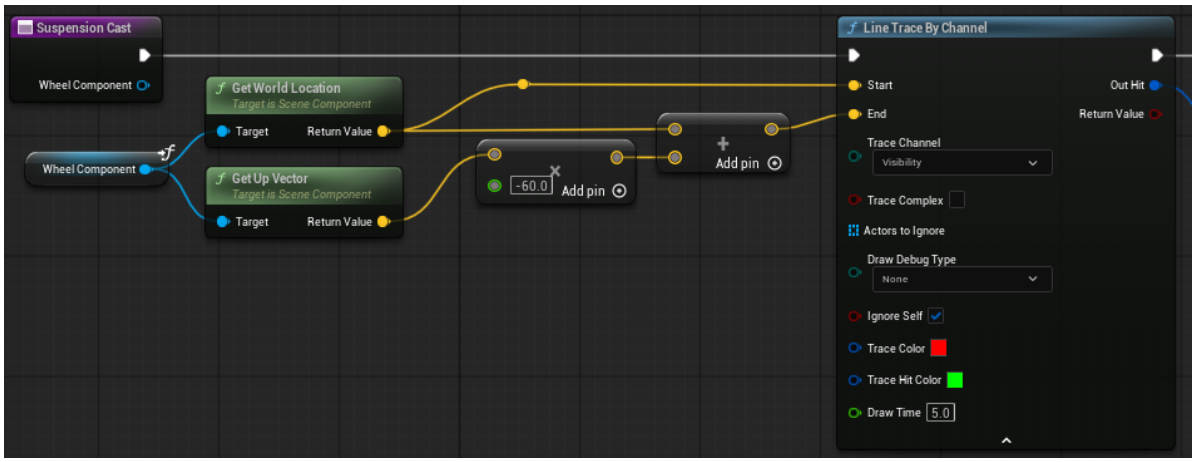


Figure 7 - "Suspension Cast" in "BP_Kart", Line Trace Downward Check

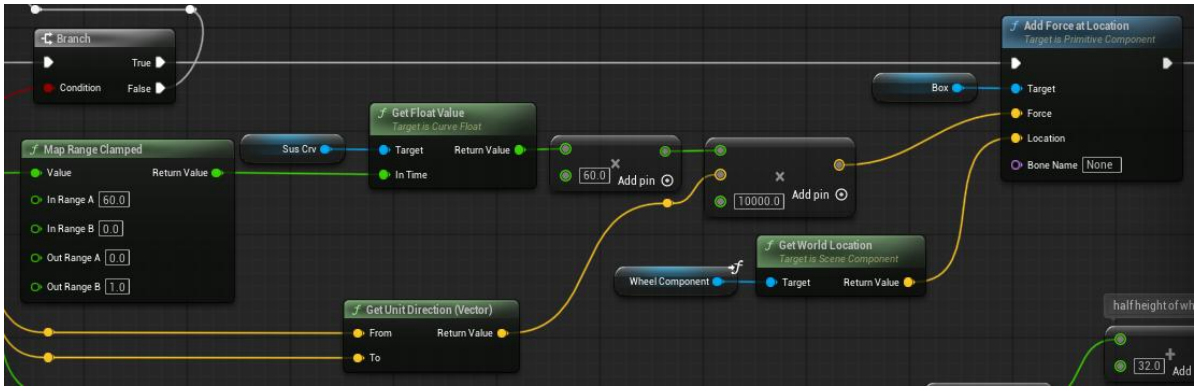


Figure 8 - "Suspension Cast" in "BP_Kart" Upward Force Calculated using Curve

These systems were informed by research into other games in the genre and community discussion on the topic. As development progressed, the vehicle handling changed significantly through repeated iteration and testing. During testing, people stated that at low speeds the vehicle felt stiff and unresponsive. Iterating from this feedback, I made changes to how steering is calculated at lower

speeds tying acceleration directly into steering.

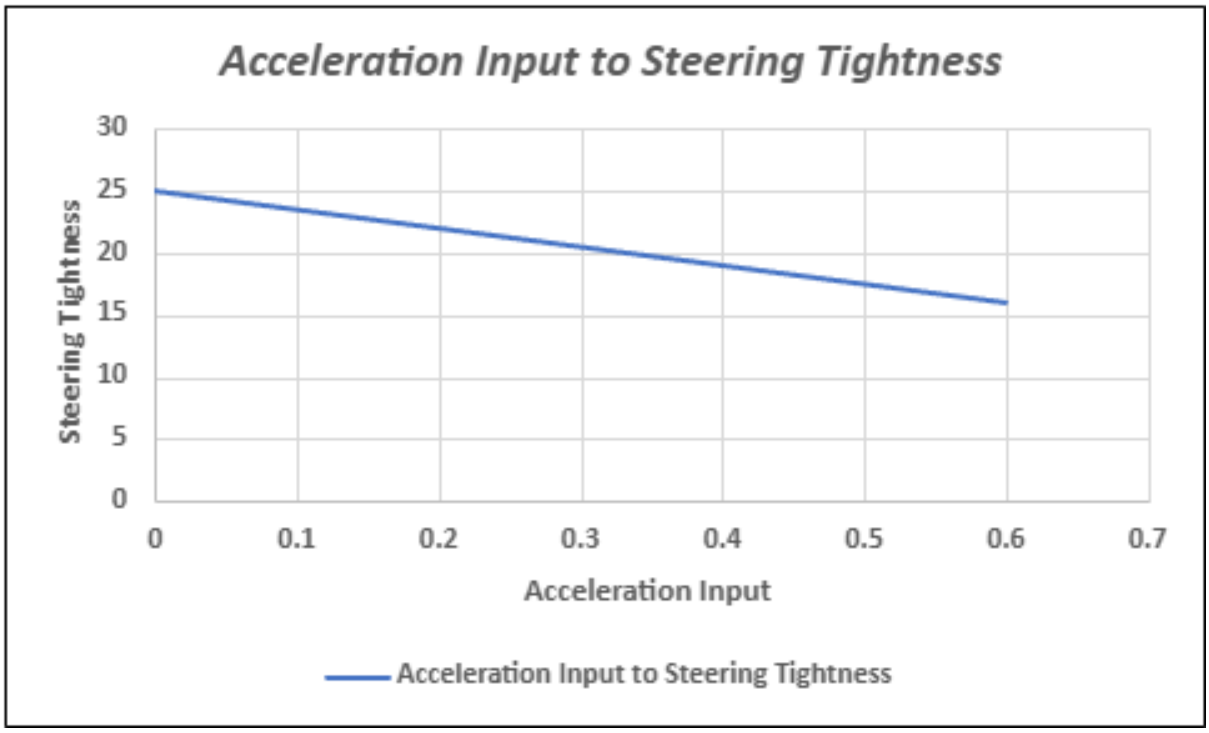


Figure 9 - Relationship between Acceleration Input & Steering Tightness

The aim here was to make the vehicle feel stable at high speeds while being easy to manoeuvre at a lower speed. This change helped to create a skill curve where less experienced players were still able to comfortably navigate the track, while experienced players can take advantage of different racing lines and advanced mechanics.

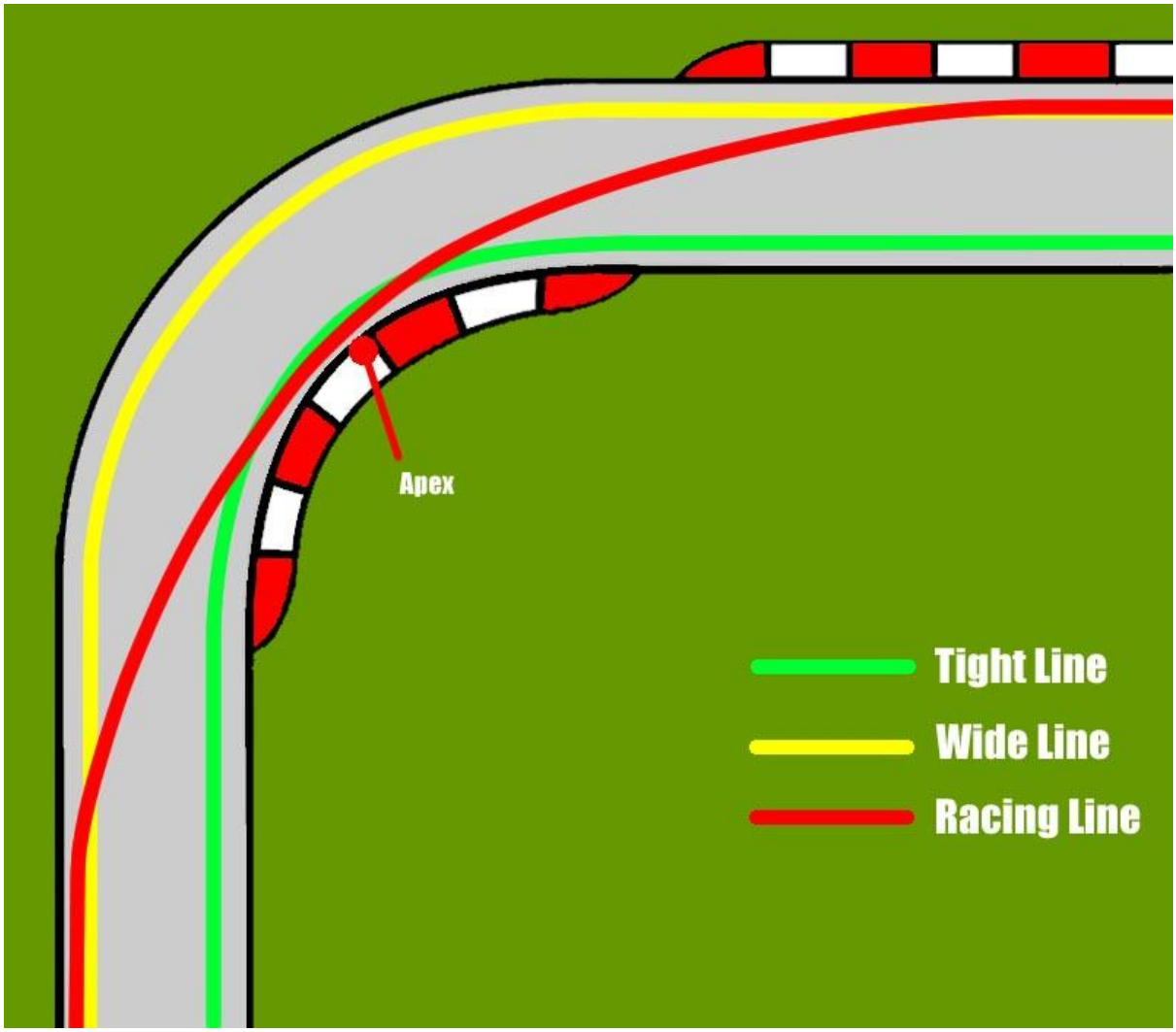


Figure 10 - Graphic Demonstrating the Concept of Different Race Lines

A drifting mechanic was later implemented; this system is at the core of the vehicle's design and is a big component of the game's mastery. Balancing the drift system required careful tuning to ensure it was neither too punishing nor overly forgiving. Extensive playtesting was used to adjust drifting angles, control during a drift and visual cues. These iterations ensured that players could gradually improve their skills through practice.

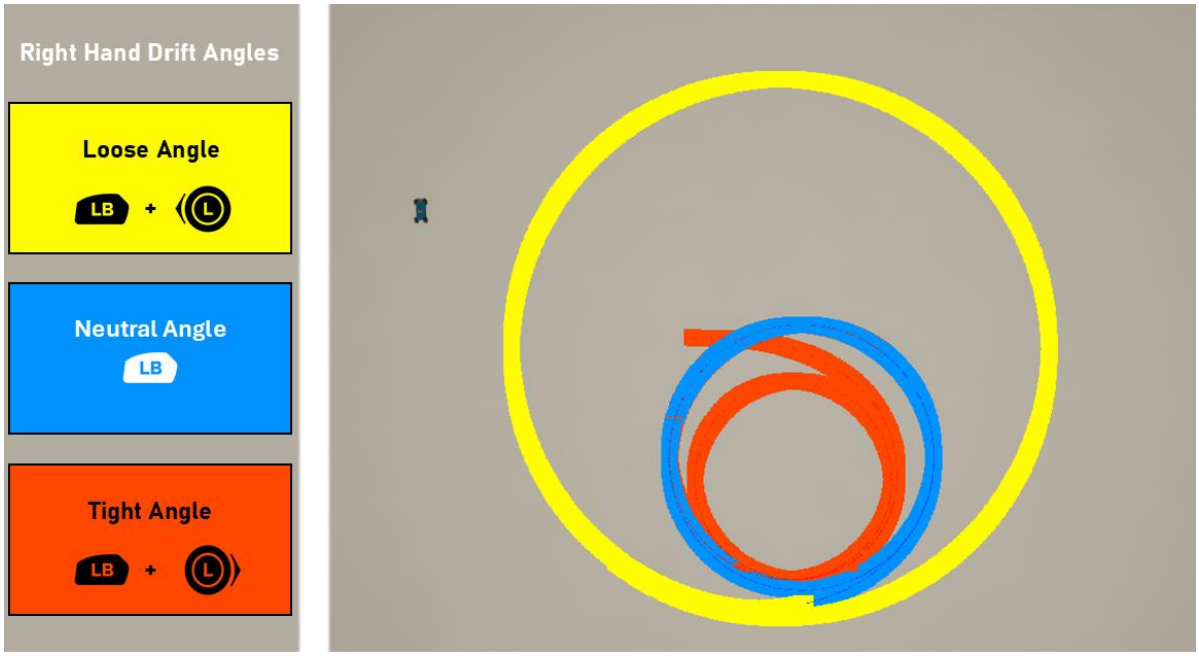


Figure 11 - Unreal Engine Example, Drifting Angles Depending on Input

Figure 12 - Drifting Angle Adjusting Depending on Input

User Interface (UI)

The user interface was developed iteratively, beginning with placeholder elements designed to communicate core gameplay information during development.

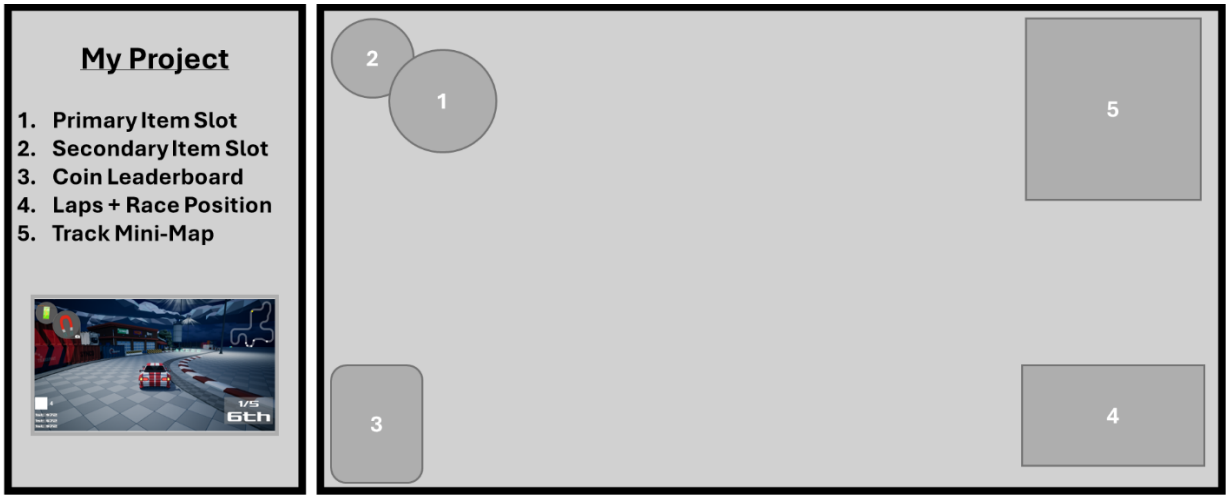


Figure 13 - UI Wireframe of my Unreal Engine Project

The coin leaderboard is directly supportive of the project's unique selling point where players can collect coins to gain points, lowering the skill curve and enabling less experienced players to still feel competitive.

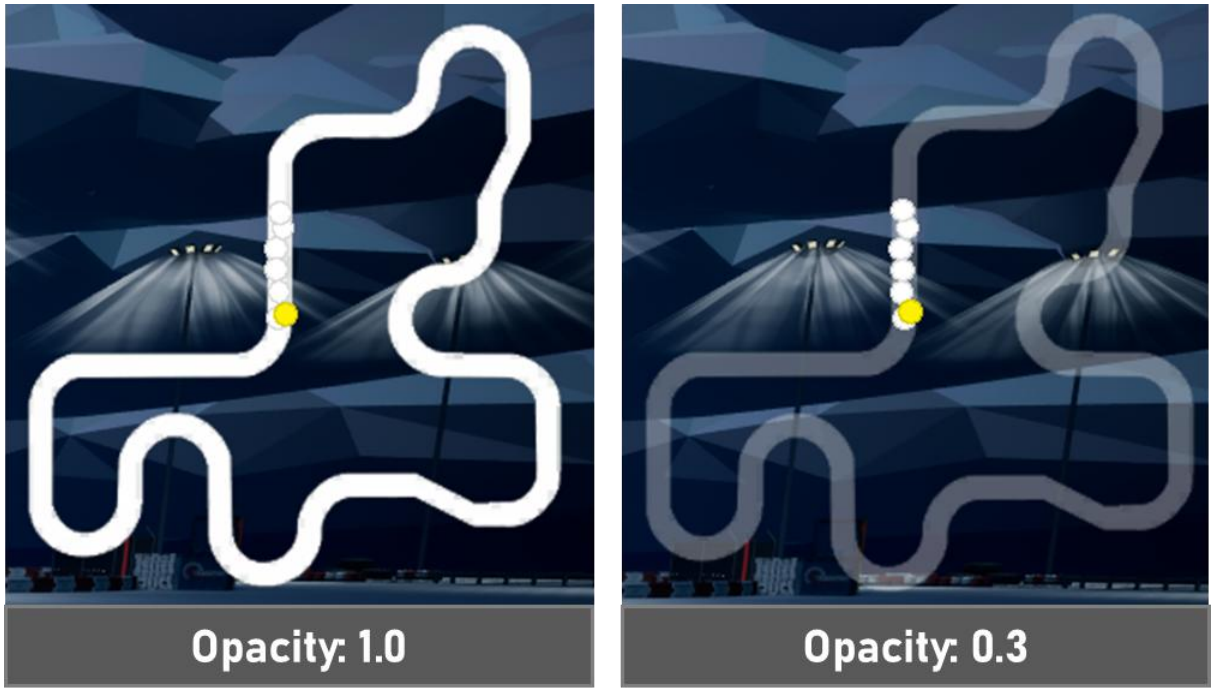


Figure 14 - Mini-Map Opacity Comparison

Research into existing games within the arcade racing genre informed the UI layout, with the primary design goal being clarity without visual clutter. Players should be able to check key information at a glance. Throughout development, UI elements were created to occupy minimal screen space and avoid obstructing the player's view during gameplay. Iterating from the prototyping solid-colour UI designs I lowered their opacity allowing for players to see gameplay elements beneath the HUD.

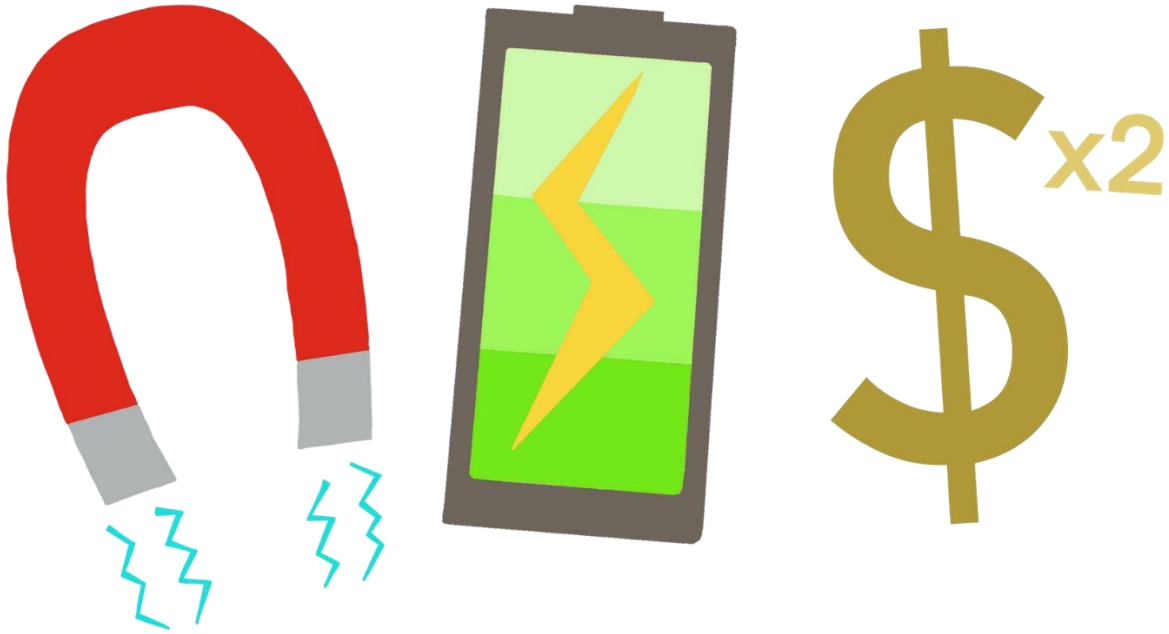


Figure 15 - Pickup Icons, Magnetic! Turbo! & Jackpot!

Visual feedback was implemented through the addition of animations and recognisable icons. During the prototyping phase, items were simply displayed using a text blocks; these were later replaced with visually distinct icons This allows players to identify their current pickup at a glance. This change was driven by user feedback during testing, where players reported difficulty recognising items quickly during races. Testers also reported being unsure of certain inputs, to iterate on this I added a visual indicator displaying the input button to use an item right beside the slots improving accessibility and clarity.

Figure 16 - Mario Kart 8 Deluxe (2017), Sonic Racing: CrossWorlds (2025)

A timer element was also implemented to show the remaining duration of active items. This feature was inspired by genre conventions and helped players make informed decisions during races. Font selection was guided by thematic consistency, with a stylised font chosen to match the game's tone while remaining legible during fast-paced gameplay (Sronstudio, 2025).

Figure 17 - Blueprint Components used for Pickups

Track Design

The game features a single track; it was created using a custom tool I developed in an earlier module. This tool provided a flexible framework for quickly prototyping various layouts, this allowed for rapid iteration during early development. Initial track designs were created and tested repeatedly using the current vehicle setup, ensuring that layout decisions complemented the vehicle handling and drift mechanics.

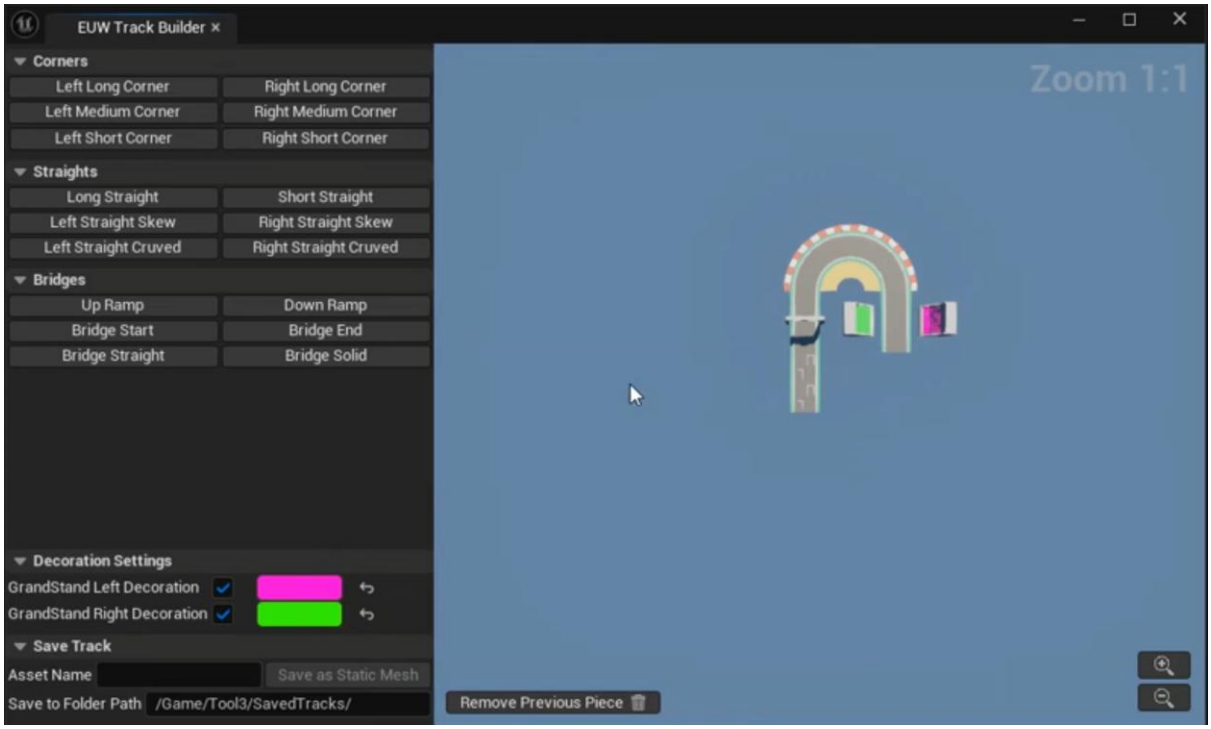


Figure 18 - Track Builder Tool Developed in Tools Module

The final track was designed with a balance of fast corners and straights, supporting the game's emphasis on the drifting mechanic. Care was taken to ensure the track was approachable for new players while retaining a level of mastery that players could achieve by learning optimal racing lines.

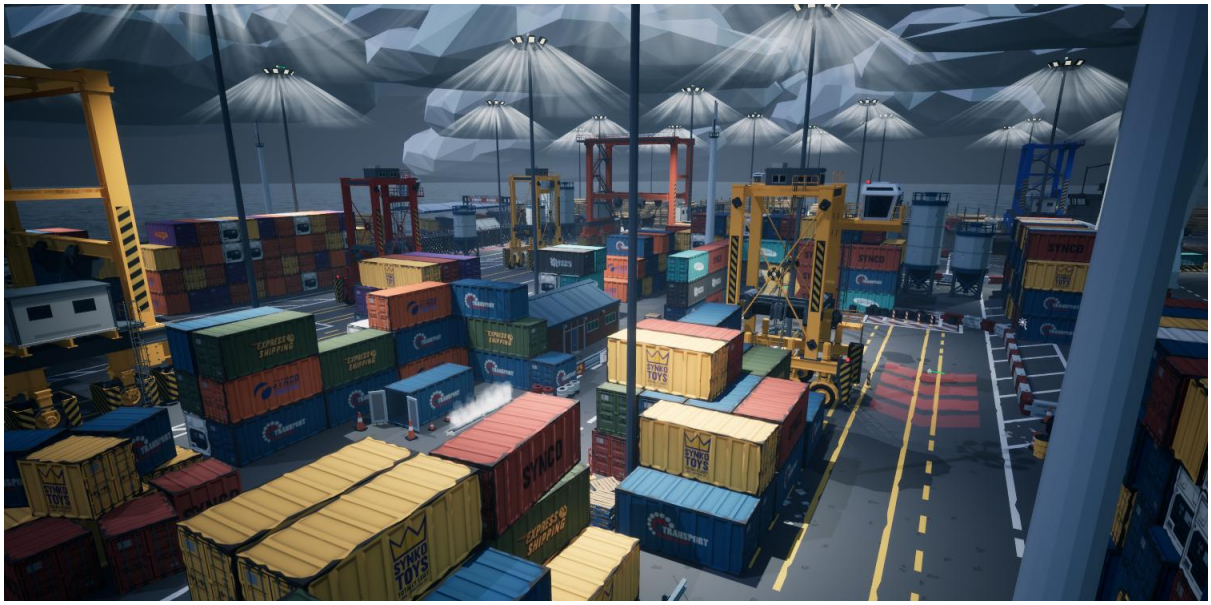


Figure 19 - Screenshot of Asset Pack in Unreal Engine

Thematically, the track aligns with the game's setting, inspired by a shipping dock environment (Synty, 2025). This influenced the track's winding layout and high-

speed corner design, reinforcing a gritty, underground street-racing atmosphere. Testing involved both solo iteration and feedback from testers of varying skill levels. This helped to refine the overall flow and readability of the track.

Artificial Intelligence (AI)

Artificial Intelligence (AI) opponents were initially implemented using a spline-based system that defined a line around the track that they should follow.

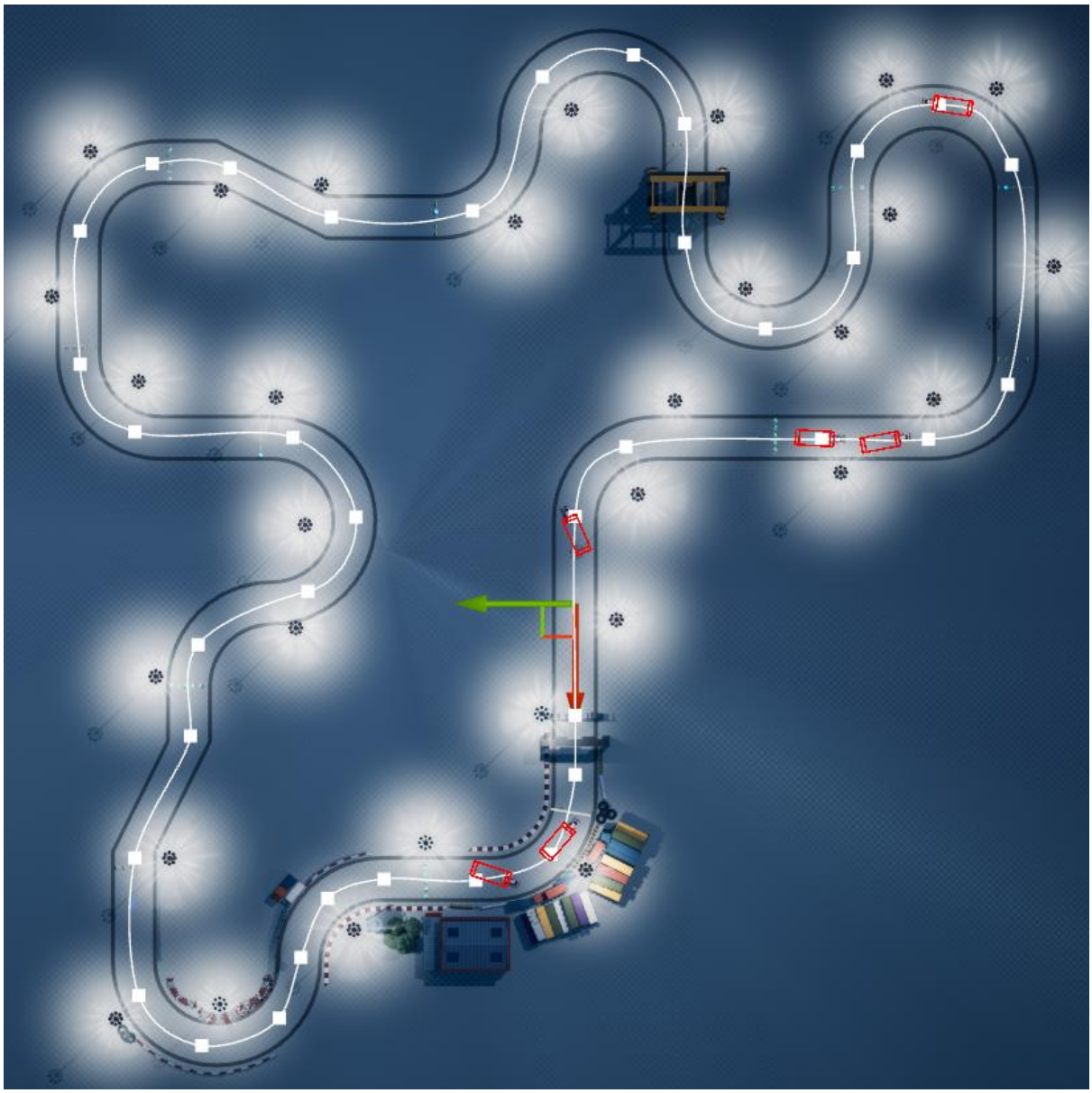


Figure 20 - Track Spline in Level

Significant development time was spent ensuring AI vehicles followed the spline smoothly and turned at the correct times so they would correctly navigate every

corner. Once functional, the system was expanded to include varying aggression levels, affecting how tightly AI cars took corners and how aggressively they maintained speed.

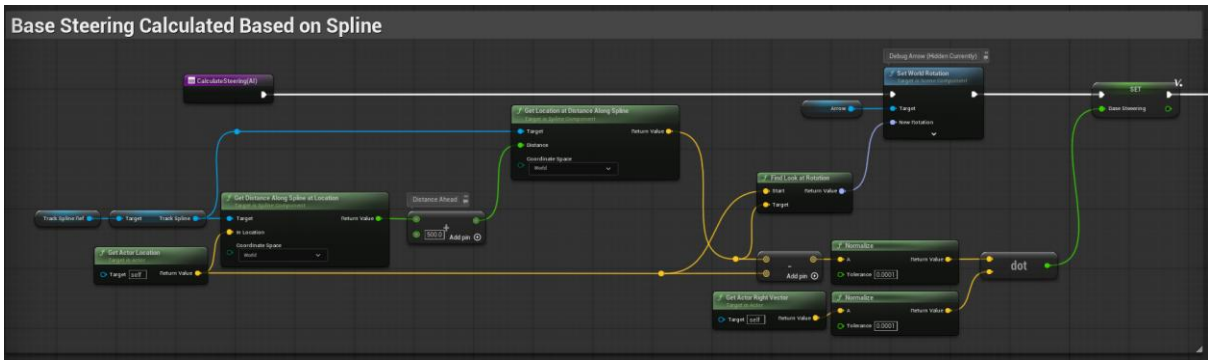


Figure 21 - "Calculate Steering (AI) Function, Base Steering Calculation Calculated using Spline

These different aggression levels created natural separation between AI racers, simulating varying skill levels and improving race dynamics. Less aggressive AI provided overtaking opportunities for new players, while more aggressive AI offered greater challenge and unpredictability.

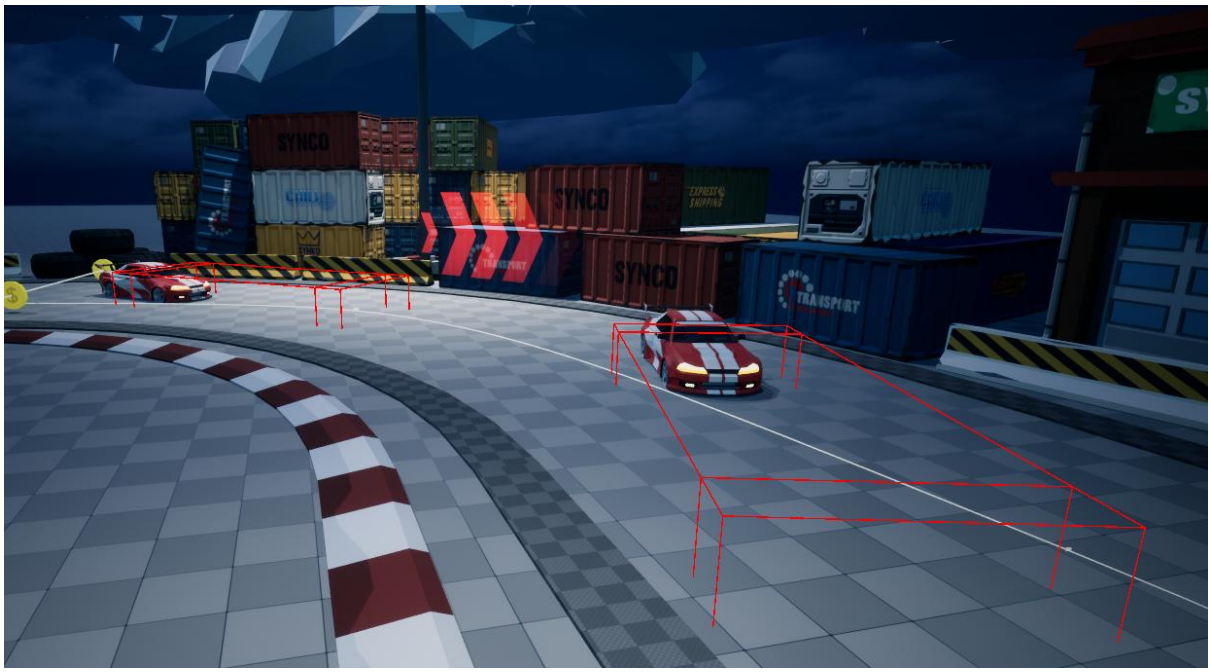


Figure 22 - Box Trace Checking for Vehicle Ahead

I also implemented basic obstacle avoidance; AI racers check for vehicles ahead or alongside them and adjust their steering to avoid a crash. Although an overtaking system was considered, it was ultimately excluded due to scope constraints. Pickups are collected by AI opponents but not actively used. This decision was made to prioritise core systems within the project timeline. However, future development

could involve contextual item usage, such as using turbo boosts on straights or magnetic / jackpot pickups when coins are detected nearby.

Pickups and Game Balance

Three primary pickups were developed: a turbo boost, a magnetic pickup that attracts coins, and a jackpot item that temporarily multiplies coin collection. These items were designed to reinforce the game's scoring system and provide alternative ways for players to remain competitive, particularly those less skilled with drifting. The turbo boost functions similarly to genre-standard speed boosts, offering a sudden boost of speed to the player upon use. The magnetic pickup was inspired by similar mechanics in existing games, allowing players to collect coins that they'd otherwise have to disrupt their driving lines to collect. The jackpot pickup directly supports the unique selling point by rewarding strategic coin collection and item usage times. This enables players to gain points even if they finish lower in race position.

Throughout development I received feedback and testing from my peers and lecturers. One major piece of feedback I received following my midpoint review was that lack of a unique selling point (USP). This led to the design and implementation of the coin scoring system alongside the race scoring system, by implementing this I was able to form a USP that also considers the accessibility of this type of game as discussed in the research section. Players of all skill levels are now able to remain competitive and feel like they are part of the action.

Additional Development (Sound Design & Multiplayer)

During the planning phase of the project, I decided that as a contingency for AI enemies not being able to be developed, I would instead implement multiplayer capability. As discussed, I did ultimately implement AI systems successfully however I did also start to implement multiplayer functionality. This is something that will be developed further in the future.

Figure 23 - Split Screen Multiplayer, Contingency (Not Fully Implemented with bugs relating to UI)

Similarly for future development I would like to develop the implemented sound design. A bespoke music track was created for the project which was based on my vision for the project. I wanted an upbeat, fast paced synthy track with a strong beat. I learned during my research that having catchy, thematic music can enrich gameplay and it was crucial for me to implement that (Morgan, 2026). Upon reaching the final lap the songs pitch is shifted up creating a sense of urgency, this is found throughout games in the genre. For future development I would like to implement other aspects of sound design enhancing immersion and giving players another medium which they are able to interact with the project through.

Figure 24 - Leaderboard Showing Points for Race & Coin Position

I also conducted a testing session on my project towards the end of development where nine testers played and gave feedback on the project. Testers would read through the information sheet and sign the consent form before playing through the Unreal Engine level until they are happy to stop. After testers were done with the project I asked them to fill out a form of questions related to their experience.

I asked three different questions relating to specific mechanic feel in the project, vehicle, track and drifting. Overall, they were all perceived positively with the drift being specifically mentioned by testers who said they were experienced with games in the genre.

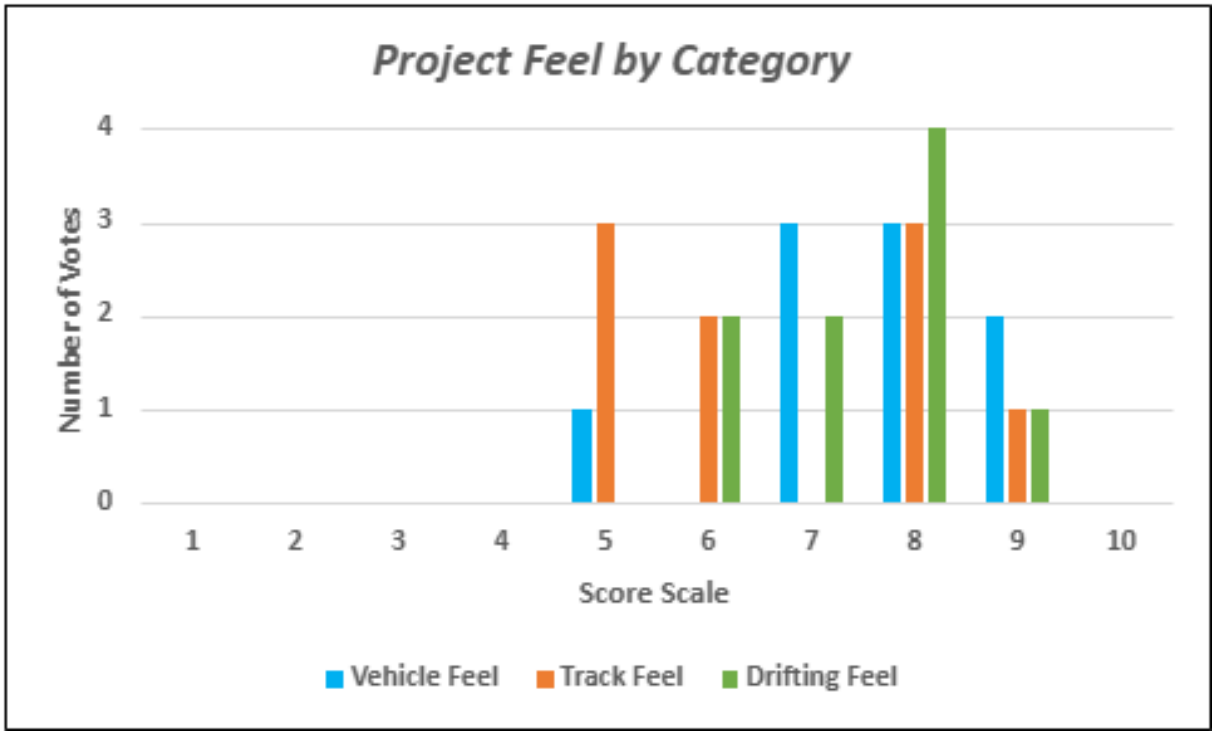


Figure 25 - Tester Ratings on Mechanic Feel

I asked testers if they felt boost pads and power-ups added to gameplay in their experience. For testers who said “no” or “somewhat” I asked a follow up question asking if they had any suggestions that they felt would improve their experience. Testers mentioned the need for visual elements which would bring clarity to the use of these systems. Adding an FOV shift on use of the boost pad was also suggested and implemented.

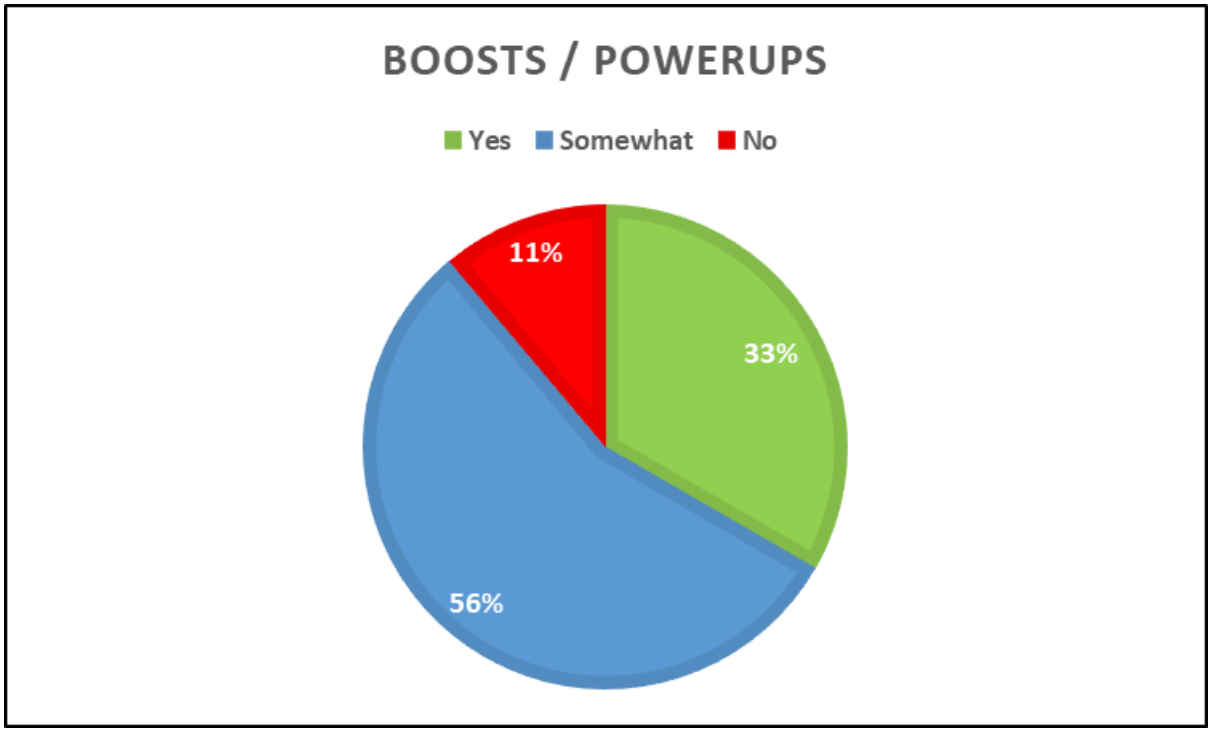


Figure 26 - Tester Feedback on Boosts / Power-ups

During the research phase of the project, I concluded that HUD elements should be clear, readable and effective. I asked testers if they felt crucial pieces of information were effectively communicated to them during gameplay. None of the testers said "no", for the testers who chose "somewhat" I asked how they felt this could be improved. Testers suggested hiding UI elements when they aren't relevant (item slots when empty for example). Icons to improve readability was also suggested, both suggestions were later implemented.

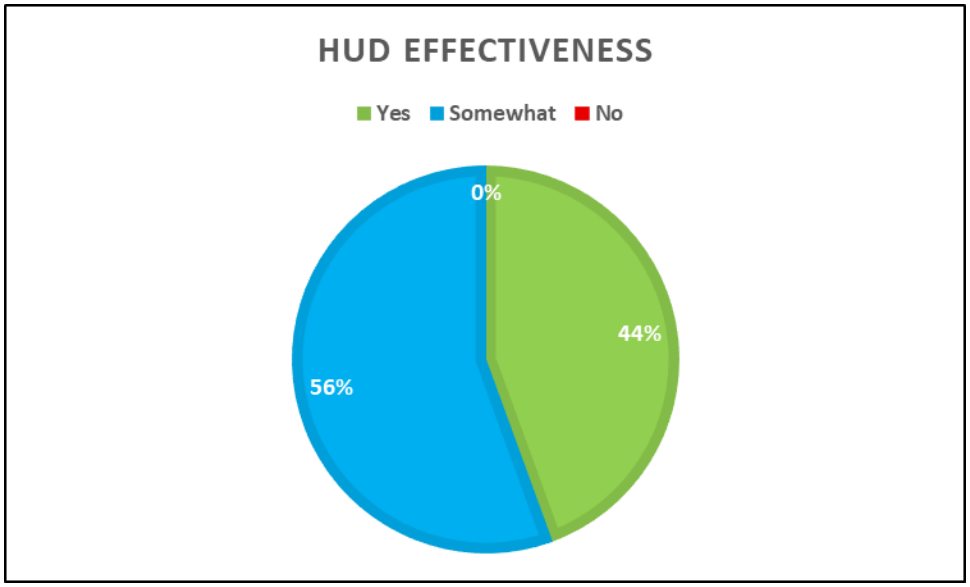


Figure 27 - Tester Feedback on HUD Effectiveness

Finally, I asked testers how well game feel elements added to their experience. These elements include vibrations, particles etc. Overall, these elements were rated highly which links back to my original goal for the project. Some testers suggested that a fully meshed out and lit level would help to improve the feel of the project going forward which I intend to implement in future development but was ultimately out of scope for submission.

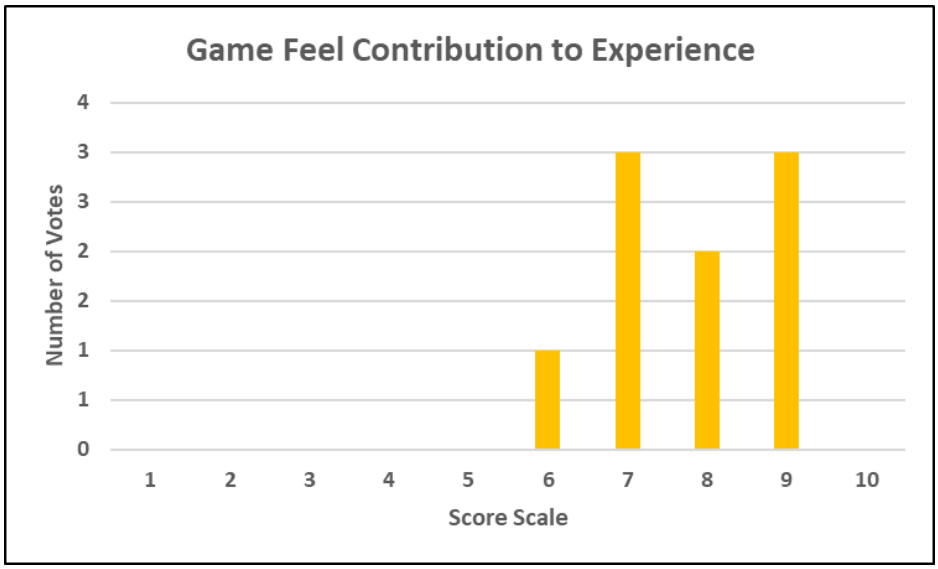


Figure 28 - Tester Ratings of Game Feel Contribution

Conclusion

This project's primary aim was to develop a kart racing game that prioritises game feel to create an engaging and satisfying player experience. Throughout development, I successfully designed and implemented a functional prototype that demonstrates core systems that are typical of the genre, including vehicle mechanics, drifting, artificial intelligence behaviour, track design, UI design and a pickup system. Through iterative testing and refinement, these systems were adjusted to improve responsiveness, clarity and player control. This ensured that the overall experience aligned with the original design goal.

Tester feedback indicates that key mechanics—particularly drifting and vehicle handling—were perceived positively, suggesting that the project achieved its primary objective of delivering satisfying, dynamic gameplay. The introduction of a coin-based scoring system also addressed earlier feedback regarding the lack of a unique selling point, improving accessibility and allowing players of all skill levels to remain competitive.

Despite these successes, certain features were limited by time and scope constraints. More advanced artificial intelligence behaviours, meshing of and additional tracks, further iteration of UI designs, added power-ups and further visual polish are areas that would enhance the experience but were not feasible within the project timeline. Systems made in Unreal Engine have had consideration for future development and are expandable going forward. Developments to the overall gameplay loop and track meshing will be areas of focus for future development ahead of GradEx. These limitations highlight opportunities for future development and demonstrate an awareness of production prioritisation.

I achieved almost all the deliverables I set out in the project proposal with only the GDD (Game Design Document) not completed. Ultimately after discussion with my project mentor, I decided the GDD would not bring as much value as I had initially thought. Instead, I will be working on a TDD (Technical Design Document) moving forward with future development.

Overall, the project fulfilled its intended goals and provided valuable insight into both technical implementation and design decision-making. It has also strengthened my proficiency with Unreal Engine and expanded my knowledge into

areas that I previously had very little experience with including vehicle physics and AI systems. The project has resulted in a prototype that functions both as a playable experience and as evidence of professional-level development capability. Game feel has been considered throughout and learning through user-testing players enjoyed their experience because of considering them and their experience at every stage of the development process.

Bibliography

Davies, M. (2014). *Space Dust Racing UE4 Arcade Vehicle Physics Tour*. Retrieved from YouTube: https://www.youtube.com/watch?v=LG1CtlFRmpU

Hicks, K. (2020). *Juicy game design : explorting the impact of 'juiciness'.* University of Lincoln.

juliengamedev. (2025). *Kart Racing Drifting Physics*. Retrieved from FAB: https://www.fab.com/listings/d5dd4e92-ba35-43db-befe-24378e3f5810

Laley, R. (2024). *Unreal Engine 5 Tutorial - Kart Racing Game Part Part 1: Suspension*. Retrieved from YouTube: https://www.youtube.com/watch?v=2EqFzRNxNLM&list=PL3VMlf7ELrhGVxd_6tjfkaoBkAcJnY1jB

Mario Kart 8 Deluxe. (2017). Nintendo.

Morgan, S. (2026). Miniland Vaffel (Instrumental).

Quartley, A. (2025). *Food Rush*. Retrieved from Andrew Quartley Portfolio: https://www.andrewquartleygamedesign.com/foodrushpage

Rocket Racing. (2023). Epic Games.

Skylanders: SuperChargers. (2015). Activision.

Sonic Racing: CrossWorlds. (2025). SEGA.

Sronstudio. (2025). *Pro Racing*. Retrieved from dafont: https://www.dafont.com/pro-racing.font

Steel, J. E., & Donnelly , P. (2016). *Supercharged! Vehicle Physics in Skylanders*. Retrieved from GDC Vault: https://www.gdcvault.com/play/1023219/Supercharged-Vehicle-Physics-in-Skylanders

Synty. (2025). *POLYGON - Street Racer*. Retrieved from Synty Store: https://syntystore.com/en-gb/products/polygon-street-racer?gad_campaignid=22923935236&gad_source=1&gbraid=0AAAAAB_9YiBwj9KPab8IEbnnnJcSgvtwX&gclid=CjwKCAiAncvMBhBEEiwA9GU_flGud2SpL3gDBzxe9gaZKOQbGePf74KTpVa0QQ-4GfGGinXsxGopVRoCQ1AQAvD_BwE

Toyful Games. (2022). *Making Custom Car Physics in Unity (for Very Very Valet)*. Retrieved from YouTube: https://www.youtube.com/watch?v=CdPYlj5uZeI