UFCFHQ-45-3 Comprehensive Creative Technology Project Proposal

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UFCFHQ-45-3 Comprehensive Creative Technologies Project Proposal	
Student Name:	Connor Easterbrook
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Project Title:	Evolving Video Games with Complementary Geometries: Non-Euclidean Level Design

1. Introduction

1.1. Project description

Euclid, the 'founder of geometry', deduced the theorems to current-day Euclidean geometry from a small set of axioms and wrote them in his mathematical treatise consisting of thirteen books 'The Elements' ([1] Artmann, 2020). Euclid's postulates contain the concepts of point, line, angle, and circle but these can only be realized by the reader. Modern Axiom systems do not attempt to define their main concepts but, instead, describe their behaviour ([2] Wolfe, 2013. p.1 - p.21). Non-Euclidean geometries offer alternative postulates for the situations where Euclid's theorems were not adequate. [3]Gowers (2002), discusses how spherical geometry violates three of Euclid's postulates whilst remaining "correct". Another example is in hyperbolic geometry where Euclid's 'parallel' postulate is replaced with a new postulate that states lines both converge and diverge in different locations in the same situation while remaining true to Euclid's remaining four postulates.

This project originated from a curiosity towards the perspective change and the following change in gameplay, that could be implemented through non-Euclidean geometry. The origins of this project came from the initial question of "Could I create large maps in small spaces while catering it to a specific genre, and how would that impact the playability?" The task for this project would be to explore different geometries within multiple game genres to figure out which combination creates the greatest gameplay experience with a compact map design. Or, in plain English, which genres work best with a large map fit into a small space with a different perspective. The idea for creation would be a build consisting of all the attempted genres and map designs in a level-based style with a running explanation as to why a particular combination was or was not selected. This would run similar to an interactive presentation including the cut gameplay aspects.

1.2. Potential deliverables

As of now, the deliverable portfolio appears it will be:

- A range of successful games, each with its own build.
  - These games do not have to be complete, full games.
  - There should be a minimum of two unique games.
    - A "unique game" constitutes different genres and geometries.
  - In total, there should be a minimum of three successful projects.

- A showcase of unsuccessful projects, each being presentable in some way.
  - This could be showcased in a game build where each scene or level is its own failed project.

As of now, the deliverable documentation appears it will be:

- A document dedicated to discussing unsuccessful projects, provided in the deliverable portfolio.
  - This document should include both opinion-based and factual writing to appropriately discuss why a project was deemed unsuccessful.

- A document dedicated to discussing successful projects, provided in the deliverable portfolio.
  - This document should include both opinion-based and factual writing to appropriately discuss why a project was successful.

- A development diary.
  - This diary will become a timeline that showcases my thought process, project development progress, and links together all deliverables quite nicely.

- Both research and production documents.
  - This document would be included as both research and production while later documentation will mostly be focused on production.

- A debriefing document to clearly discuss ownership of any used assets, and authorship of this project.

Figure 1. Outline of deliverables. From 'UFCFHQ-45-3 Comprehensive Creative Technology Project Pre-Production & Research Document'

2. Development plan

2.1. Objectives

There are a number of objectives that are aimed to be achieved by this project. It will be easier to break them down into three sections, each with its own primary focus.

1.4.1. Project objectives

What is this project intending to achieve?

- Develop a video game prototype that could be developed further into commercial release,
- Present possible combinations for non-Euclidean video games that can be used by other game developers,
- Create an important piece for a professional portfolio that covers a wide range of skills.

To summarise, this project is intended to create a foundation for possible future work, whether it be a continuation of the prototype developed, allowing access into better employment opportunities, or a source of inspiration for third-parties to develop their own non-Euclidean video games.

1.4.2. Research objectives

What are the intended discoveries of this project?

- Discover how changes in perspective can affect gameplay based on its genre,
- Explore the history behind non-Euclidean geometry,
- Deepen understanding of non-Euclidean geometry both visually and mathematically,
- Discover the best combinations of geometry and genre.

To summarise, the research objectives of this project prioritise deepening the understanding of both video game development and non-Euclidean geometries, both individually and in tandem.

1.4.3. Learning objectives

What is intended to be learned, personally, from this project?

- Further develop game development skills in a commonly-used engine,
- Advance ability to manage a project efficiently when working as an individual.

To summarise, the personal learning objectives from this project intend to establish a foundation of skills that would be helpful both inside and outside the games development industry.

Figure 2. Outline of objectives. From 'UFCFHQ-45-3 Comprehensive Creative Technology Project Pre-Production & Research Document'

2.2. Development

2.2.1. Methods, techniques, tools and processes

The project would be developed via ‘C# scripts’, ‘HLSL shaders’, and map design that accommodates a shift in geometric controls. All of which have been covered by skills provided through certain modules during the studies of Games Technology. The development within Unity also allows for experience in a highly regarded engine within the games development industry. External libraries do not seem necessary as Unity provides all that is believed to be required.

A brief plan would be written up with discussions for each subproject on implementations, as a game design document. Then an ‘alpha development’ version of the subproject would be developed. This would offer a view into whether the chosen combination would be compatible at a level that allows it to become the primary development.

2.2.2. Risks and issues

Risk	Mitigation	Contingency
Incompatibility between geometry and engine.	Avoiding the use of more complex methods of non-Euclidean implementation could mitigate this risk.	A contingency for this risk would be to prepare designs to offer the illusion of the targeted non-Euclidean geometry.
Comprehension of research material at more than just a superficial level.	I should mitigate the risk by avoiding the technicalities of non-Euclidean geometry and focus on the design aspects.	To avoid the technicalities of geometries, I should limit myself from writing code beyond my skill level.

Figure 3. Table of risks.

2.2.3. Specialist resources and support

No specialist resources and/or support are required throughout the development of this project as it’s focused on self-study within accessible means.

2.3. Project Timeline

Month	Task	Estimated Duration
October 2021	Write a project proposal to be submitted by 04/11/2021.	11 days (24/10/2021 - 04/11/2021).
November 2021	Finish 'CCTP Pre-Production & Research Document', Develop one sub-project* (artefact & documentation),	20 days (24/10/2021 - 12/11/2021), 15 days (13/11/2021 - 28/11/2021),
December 2021	Research documentation ready for submission by 16/12/2021, Develop one sub-project* (artefact & documentation), Create a roadmap for project development in 2022, including the previous work completed.	N/A, 15 days (01/12/2021 - 16/12/2021), 3 days (17/12/2021 - 20/12/2021).
January 2022	Prototype demonstration as 2-min video ready for submission by 24/01/2021 (exact date tbd), Develop one sub-project* (artefact & documentation).	N/A, 15 days (01/01/2022 - 16/01/2022).
February 2022	Develop one sub-project* (artefact & documentation), Develop one sub-project* (artefact & documentation).	15 days (01/02/2022 - 16/02/2022). 15 days (17/02/2022 - 04/03/2022).
March 2022	Write a project post-production document, Work on final hand-in.	20 days (05/03/2022 - 25/03/2022), N/A.
April 2022	Artefact, final report, and final video to be completed for hand-in by 28/04/2022 via Blackboard and Github.	N/A.
May 2022	Viva submission completed for hand-in by 16/05/2022 (exact date tbd).	N/A.

*One sub-project will be selected to be developed further into the primary deliverable.

Figure 4. Estimate project timeline. From 'UFCFHQ-45-3 Comprehensive Creative Technology Project Pre-Production & Research Document'

3. Research

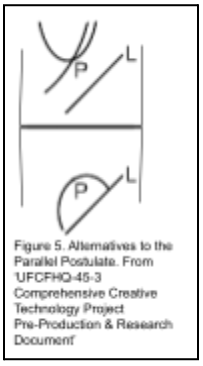


Figure 5. Alternatives to the Parallel Postulate. From 'UFCFHQ-45-3 Comprehensive Creative Technology Project Pre-Production & Research Document'

3.1. Hyperbolic Geometry

There are multiple ways to present hyperbolic geometry but if we were to visualise it, we'd have to first completely negate the parallel postulate. To do this, avoid making every line intersect with every other line because this would be spherical geometry and the interior angles of triangles would become more than one-hundred and eighty degrees. The correct option contains infinite lines that intersect the other line while never intersecting with the original line; this would be hyperbolic geometry as it leads to the interior angles of triangles summing up to less than one-hundred and eighty degrees ([4] Comment, 2016).

3.2. Spherical Geometry

[5]Papadopoulous (2014), states that spherical geometry, "as the study of the figures made by intersections of planes with the sphere", was developed by Theodosius. A sphere is defined as a closed surface in three-dimensional space, formed by a set of points an equal distance from the centre of the sphere and its radius is calculated as the distance between its centre and the surface. A straight line within a three-dimensional space with the sphere could lead to one of three outcomes.

- An intersection at two points when the line passes through the sphere.
- An intersection at one point on the sphere when the line is tangent to the sphere at the intersection point.
- No intersection occurs.

In a case where a line passes through the centre of the sphere, the first outcome, the points of intersection form the antipodes of the sphere. Like lines and spheres, a plane and sphere in three-dimensional space can have the outcomes of:

- No intersection
- An intersection at one point on the sphere when the plane is tangent to the sphere at the intersection point.
- An infinite number of intersection points when the plane cuts through the sphere and forms a circle of intersection.

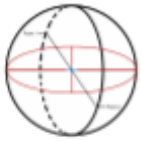
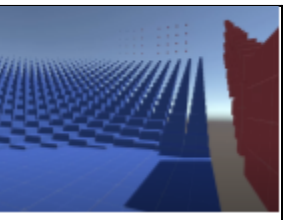


Figure 6. Example of antipodal points. From 'UFCFHQ-45-3 Comprehensive Creative Technology Project Pre-Production & Research Document'

We would then focus not on the line in the figure but instead on the great circle with the plain and dashed lines. A great circle is defined as the circle of intersection which shares the same radius and centre as the intersected sphere. A small circle is a title for plane intersections where the plane is not intersecting with the sphere at a central location ([6] Szecsei, 2004).

3.3. “Mostly Euclidean” Geometry

Like [7]Henderson (2020) discusses, ‘non-Euclidean’ geometry is simply a geometry that differs from Euclidean geometry. Though some differ much more than others, it was decided to describe the geometries that are very similar as “mostly Euclidean.” An example of what can be considered “mostly Euclidean” would be [8]Doucette’s (2017) provided image. The image shows the player walking on Euclidean geometry that shrinks and disappears based on distance. Even though the gameplay is Euclidean and the local geometry is Euclidean, when perceived from a global perspective, it can be said that this is a non-Euclidean game.



[8] Figure 7. “Mostly Euclidean” game (Doucette, 2017. Used with permission)

4. Bibliography

[1] Artmann, B. (2020) Euclidean Geometry [online]. *Encyclopedia Britannica*. Available from: https://www.britannica.com/science/Euclidean-geometry. [Accessed 30 October 2021].

[2] Wolfe, H. (2013) *Introduction to Non-Euclidean Geometry.* Newburyport: Dover Publications.

[3] Gowers, T. (2002) *Mathematics: A Very Short Introduction*. Oxford University Press.

[4] Comment, S. (2016) The Geometric Viewpoint [online]. *History of Hyperbolic Geometry*. Available from: https://web.colby.edu/thegeometricviewpoint/2016/12/08/history-of-hyperbolic-geometry/ [Accessed 30 October 2021].

[5] Papadopoulos, A. (2014) *On the works of Euler and his followers on spherical geometry* [online]. HAL Archives-Ouvertes. Available from: https://hal.archives-ouvertes.fr/hal-01064269/document .

[6] Szecsei, D. (2004) *The Complete Idiot's Guide to Geometry.* Alpha Books.

[7] Henderson, D.W. (2020) Non-Euclidean Geometry [online]. *Encyclopedia Britannica.* Available from: https://www.britannica.com/science/non-Euclidean-geometry. [Accessed 30 October 2021].

[8] Doucette, M. (2017) *Unity - Non-Euclidean Geometry - Test 1.03*. YouTube.com [online]. Available from: https://www.youtube.com/watch?v=ExpFTbJE6Yg [Accessed 30 October 2021].

Appendix A: 'UFCFHQ-45-3 Comprehensive Creative Technology Project Pre-Production & Research Document'

https://docs.google.com/document/d/10XsEr6aNCmh6YeVFqMFQSdVdJT6rvR-61TTznkQoS7s/edit?usp=sharing