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Where Paradise Ends

An artistic 3D animated documentary about the Madeira Island of the 17th century

MASTER DISSERTATION

Marcelo Luís Soares Mendonça

INTERNATIONAL MASTER OF INTERACTIVE MEDIA DESIGN

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SUPERVISOR
Pau Pascual Galbis

CO-SUPERVISOR
Sergi Bermúdez i Badia

Abstract

Adapting factual historic accounts into modern audiovisual mediums is a crucial practice in cultural preservation, with stylized 3D animation emerging as an innovative approach. 3D animated films have traditionally privileged higher graphical fidelity, resulting in increasingly realistic visuals but a distinct lack of graphical individuality. However, recent projects have challenged realistic rendering trends in favor of artistic expression through stylization and non-photorealistic rendering (NPR).

Where Paradise Ends is a 7-minute artistic documentary which aims to exemplify this shift, by making full use of both the narrative and visual communication possible with the medium, using stylized 3D animation to engage modern audiences with a factual and historic account, in order to preserve an interesting and integral piece of Madeira's history. The narrative of the animation was extracted from a factual account from the book "A Voyage to Suratt in The Year 1689" by English chaplain John Ovington. The documentary recounts Ovington's experiences in Madeira during a period of religious conflict between Catholic and Protestant Christians in the 17th century, highlighting its effect on the island's culture. The film makes use of contemporary NPR techniques to emulate traditional 2D art styles giving the animation the appearance of an old painting in an effort to further immerse viewers in its historic narrative. Additionally, this project analyzes the applications and benefits of stylized 3D in contemporary media, detailing the methods to achieve NPR and exploring techniques to emulate traditional 2D styles in Blender, the free 3D software chosen for its accessible NPR tools and support, with a distinct focus on procedural materials.

Lastly, this report features the full methodology applied to create the documentary, including the decisions made in adapting a written work into an animation with an emphasis on historical accuracy, the ethnographical research on the context of the story, and the merging of art and modern digital technology through procedural materials, following a development timeline including Pre-Production, Production and Post-Production procedures, concluding with the results and considerations of creating an independent stylized 3D animation.

Keywords:

Historical Documentary, 3D Animation, Stylization, Religious Conflict, Madeira Island, 17th Century

Resumo

A adaptação de relatos históricos factuais para meios audiovisuais modernos é uma prática crucial de preservação cultural, com a animação 3D "estilizada" (*stylized 3D*) a emergir como uma abordagem inovadora. Os filmes de animação 3D têm tradicionalmente privilegiado maior fidelidade gráfica, resultando em visuais cada vez mais realistas, mas com uma evidente falta de individualidade gráfica. No entanto, projetos recentes têm desafiado as tendências de renderização realista em favor de expressão artística, através da estilização e renderização não foto-realista (NPR).

Where Paradise Ends é um documentário de carácter artístico com uma duração de 7 minutos que pretende exemplificar esta mudança, tirando partido do potencial narrativo visual possível com este meio, recorrendo à animação 3D estilizada para cativar o público com um relato histórico e factual, de maneira a preservar uma parte cativante e integral da história da Madeira. A narrativa do documentário foi extraída de um relato factual do livro "A Voyage to Suratt in The Year 1689" do capelão inglês John Ovington. O documentário relata o conflito religioso entre cristãos católicos e protestantes na Madeira do século XVII, destacando o seu efeito na cultura da ilha. O filme utiliza técnicas contemporâneas de NPR para emular estilos tradicionais de arte 2D, conferindo à animação o aspeto de uma pintura antiga, com o âmbito de imergir os espectadores na sua narrativa de carácter histórico. Adicionalmente, este projeto analisa as aplicações e os benefícios de 3D estilizado em media contemporâneos, detalhando os métodos para alcançar NPR e explorando as técnicas para emular estilos 2D tradicionais no Blender, o software 3D gratuito escolhido pelas suas ferramentas acessíveis e suporte de NPR, com um foco distinto em *procedural materials*.

Por fim, este relatório apresenta a metodologia aplicada na criação do documentário, incluindo as decisões tomadas na adaptação de uma obra escrita para uma animação com foco em precisão histórica, a pesquisa etnográfica sobre o contexto da narrativa, e a fusão de arte com tecnologia digital moderna, através de *procedural materials*, seguindo um processo de desenvolvimento que inclui procedimentos de pré-produção, produção e pós-produção, concluindo com os resultados e considerações sobre a criação de uma animação 3D estilizada independente.

Palavras-Chave:

Documentário Histórico, Animação 3D, Estilização, Conflito Religioso, Ilha da Madeira, Século 17

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List of Acronyms

3D Three-Dimensional

2D Two-Dimensional

NPR Non-Photorealistic Rendering

CGI Computer Generated Images

VFX Visual Effects

CHAPTER I - INTRODUCTION

1. INTRODUCTION

Factual historical accounts are an important source of knowledge valuable to any culture [1], and adapting them to progressively modern mediums is a crucial practice to preserve the evolution of a civilization [2]. While essential to retain a concise historical view of a culture, the written nature of these accounts complicates their dissemination, making them unappealing to contemporary audiences who are more accustomed to audiovisual mediums [2]. Adapting these works into dynamic formats like animation, enables a new form of engagement with their content, making history more accessible and providing an opportunity for wider audiences to easily consume that information, likewise, preserving and exhibiting that historic work through a more attractive medium.

In parallel, the field of 3D animation has recently seen a shift from a focus on realistic rendering, to an embrace of artistic expression through stylized 3D and non-photorealistic rendering (NPR) [3]. Unlike conventional 3D rendering which aims to recreate reality using real life accuracy as a measure for success, stylization can incur artistic benefits and be more effective in conveying graphical meaning though styles previously exclusive to 2D art or simply incompatible with realism. These new styles and innovative techniques have helped redefine the 3D animation industry, exploring and developing the world of 3D entertainment beyond conventional realistic rendering [4].

Where Paradise Ends aims to explore and apply both of these concepts, through a 7-minute 3D animated documentary, stylized to look like a dated painting at every frame, which adapts an excerpt from a real historical account. The narrative of the documentary was taken from the book “A Voyage to Suratt in the Year 1689” by the English Chaplain, John Ovington [5]. This story and subsequent narration were directly extracted from a chapter where Ovington details the Catholic religious practices of the island concerning foreigners' bodies, placing an emphasis on the handling of British practitioners of Protestantism, where if any Protestant were to die on the island of Madeira, their bodies were thrown into the ocean, as the Portuguese people believed that burying them would desecrate the sanctity of the land [1]. This particular text was chosen for its thought-provoking themes of religious tension, as the short film aims to divulge a key point in the religious history of Europe and showcase the evolution of a conflict that affected the cultural landscape of Madeira Island, intending for viewers to contrast these misguided practices of the past with the welcoming Madeira Island of today, concluding the short-film by mentioning one of the main contributors to the eventual resolution of this conflict, the creation of the English Cemetery of Funchal [6] and the signing of the Westminster Treaty [6].

With this project’s high-fidelity approach specifically, the focus on maintaining a degree of historical accuracy, even adhering to its negative depictions, is essential to further the understanding of a nation and its evolution into present values, allowing modern audiences to engage with the historic source material through an emerging innovative medium. Likewise, this project explores how modern and accessible 3D stylization tools can be used to emulate the aesthetics of traditional 2D art forms to convey graphical meaning [3] and aid in further immersing viewers into a story’s setting [7], by making full use of not only the story’s narrative communication, but also the style’s visual language, a trait which has been increasingly praised in contemporary animation works.

The project takes advantage of the artistic benefits allowed with stylization to create a unique visual style that emulates traditional painting techniques inspired by older artworks from Madeira island. This use of stylization allows the artistic documentary to immerse viewers into the historic account by connecting the 17th century themes with the similarly "dated" art style, achieved through a modern digital medium. Traditional art forms like paintings, sketches and engravings rely on physical mediums and materials, consequently, many of their recognizable features result from "imperfections" characteristic of their real-world applications [3]. Here the challenge lies in digital software producing no such imperfections by default, therefore these must be artificially introduced to recreate these traditional art styles convincingly [3].

The methodology applied is based on research of stylized 3D in contemporary media works and the effects of non-photorealistic rendering on audience perception. In addition to the visual development of the animation and the research on the practical uses for NPR, this project also breaks down the methodological considerations of adapting written works into animated media, including the particularities involved in the handling of a non-fictional resource. Secondly, the project follows a typical 3D animation pipeline [8], detailing the pre-production, production and post-production procedures, with chapters added for the animation's visual development during each stage of the development. Ultimately the artistic documentary was developed almost entirely in Blender, the free 3D program chosen for its accessibility and NPR support, detailing the tools used and the workflow applied in adapting modern stylization techniques, with an emphasis on procedural materials, to create an innovative 3D style unique to this short-film.

Lastly, this document features the results and conclusions of producing an independent stylized 3D animation, using the research and methodology of the documentary to highlight the potential of NPR in multimedia, supported by both the state-of-the-art analysis and the findings from the animation's visual development. Ultimately, *Where Paradise Ends* serves as a relevant example of how stylization can be applied to non-fictional materials and how NPR can continue to evolve as new techniques emerge and the interest in stylized 3D entertainment grows over time.

∘ Dissertation Structure:

This dissertation is structured in seven parts consisting of: **State of the Art**, describing the research topics relevant to the development of artistic documentaries, stylized 3D animation, NPR uses and techniques. Followed by the **Methodology**, detailing the full development pipeline of the final animation, including **Pre-Production** research, visual development and 3D experiments. The full **Production** pipeline with asset creation, style development and animation, and then the **Post-Production** procedures. Concluding with **Limitations and Future Work**, and the **Conclusion**.

CHAPTER II – STATE OF THE ART

2. STATE OF THE ART

2.1. Adapting Written Works to Film and Animation

Each medium has different kinds of affordances, as watching films and animations facilitates different ways of interacting with content than reading books or listening to stories [9], with audiovisual representations proving to be a more suitable choice for an "increasingly cinema-oriented student population" [2]. Effectively, films and animations allow viewers to experience written stories in a comparatively more dynamic medium, as they can elevate a narrative experience through the addition of audiovisual elements such as characters and locations' "real" appearances, actors' convincing performances, music score and sound effects, among the many features that aid in bringing these stories to life [10].

In this field, fidelity to the source material plays a major role in the study of adaptations [2], with low-fidelity and high-fidelity approaches providing different benefits on the audience's perception. Low-fidelity adaptations allow producers to take creative liberties in shaping the original stories to fit modern society's values or a target audience's preferences, as using adaptation to interpret a source material, rather than substitute it, enables a new form of engagement with a literary work and its author [2]. For example, mainstream animation studios like Disney have used books and written works as inspiration for their animated movies since their first feature film, *Snow White and the Seven Dwarfs* (1937) [11], however many of their classic animated adaptations often remove much of their original stories' sensitive content and simplify their narratives to fit their younger demographic, thus enabling newer generations to experience innovative versions of classic stories in their preferred mediums, without their negative depictions.

2.1.1. Historical Animated Documentary

On the other hand, this practice can also be applied to non-fictional materials, which earns them the distinction of "animated documentaries" [12], such as the innovative *The Sinking of the 'Lusitania'* in 1918 by Winsor McCay [13]. For high-fidelity perspectives, adaptation is generally a cultural practice, and adaptations pertaining to historical or sensitive contents need to be approached as "acts of discourse partaking of a particular era's cultural and aesthetic needs and pressures" [2], a process which requires both historical labor and critical acumen [2], meaning that the creative in charge of the adaptation should pay close attention to the historical context surrounding the source material, as well as carefully consider the changes and decisions made outside the original's reach when translating it to another medium, regardless of it being a reproduction, an interpretation, or an extension of the original writing. Documentaries are characterized by their ability to convey the impression of authenticity [14], and are often used to engage in issues that pertain directly to the history of the world [14]. One of the major risks of this approach is that it cannot be assumed that all viewers of a documentary will have read or known about the source material [2], so the film or animation will become their first exposure to the content on display. Consequently, any crucial context present in the original but missing from the audiovisual

version will possibly result in the viewers misinterpreting the story and holding a contrasting opinion or reaction to what the creator originally intended.

Effectively *Where Paradise Ends*' artistic 3D animated documentary nomenclature derives from its stylized medium and its high-fidelity approach. By presenting the narrative through a 3D animation, the film is allowed a degree of abstraction in its visual representation – an unavoidable consequence of translating text to an artistic audiovisual medium [15] – be it in the form of characters, locations, and style, aiming to portray a convincing visual representation, rather than unattainable absolute historical precision. However, its narrative and historic value is essentially devoid of abstraction, as the film maintains its factuality by turning the written source directly into grossly unedited narration, providing contextual evidence to the visuals on display, even adhering to its negative depictions to ensure maximum transparency and lack of bias. This artistic documentary approach allows the film to portray a convincing depiction of the story and its characters while effectively delivering its non-fictional message and themes through narration, allowing for modern audiences to engage with source material through a dynamic medium, and at the same time, preserve an interesting and integral piece of Madeira's history.

2.2. Animated Adaptations and Art Style Emulation

The relevant themes of *Where Paradise Ends* are essentially, the adaptation of historic written materials into animation, and the translation of traditional artworks and styles into contemporary animated mediums. While the focus of this project lies in 3D animation, it is important to acknowledge the influence of 2D animated works, which remain equally relevant in the study of adaptations and stylistic translation. Two exemplary works which highlight the goals of this thesis can be found in *The Tale Of Princess Kaguya* (2013) [16] and *Loving Vincent* (2017) [17].

***The Tale Of Princess* Kaguya** (2013) [16], produced by Studio Ghibli and directed by Isao Takahata, is a 2D animated adaptation of "The Tale of the Bamboo Cutter", a 10th century Japanese literary tale written by an anonymous author. The film adapts the fictional written work into a unique 2D animation style, made to resemble a traditional Japanese watercolor painting at every frame (Figure 1). The stylistic choice of this film was driven by the director's wish to allow viewers to "imagine or recall the reality deep within the drawing" rather than be distracted by a realistic 3D art style [18], as he noted that American 3D animated films of the time (which used realistic rendering) aimed to portray a space, objects and characters as if they were present in that very moment, an unsuitable fit for the film's 10th century literary material [18]. Additionally, Takahata believed that the sketched watercolor style's ability to simplify ordinary human qualities with soft lines and muted hues, allowed viewers to become more emotionally attached to the characters, and appeal to their memory and imagination, "in a more evocative way than through a seemingly real painting" [18].

Figure 1 – Screenshots From The Tale of Princess Kaguya [16]

Loving Vincent (2017) [17], directed by Dorota Kobiela and Hugh Welchman, is an experimental animated historical drama that depicts the life of the painter Vincent van Gogh. The film's story was conceived through studying the artist's letters, and its visuals are uniquely stylized through a multitude of oil-paintings, culminating in a full feature film that effectively resembles a "moving painting" with every shot (Figure 2). Notably, each one of the film's 65000 frames was hand-painted with oils on canvas, creating the aforementioned unique animation style, which was ultimately derived from Van Gogh's actual paintings [19], serving as a prominent example in the study of art style emulation.

Figure 2 - Loving Vincent [17]

2.2.1. Medium Choice

These innovative animated films adapt historical sources, both fictional and factual, as they take advantage of stylization to immerse viewers into their narrative through the emulation of the traditional artistic mediums and artworks of their time, highlighting the strengths of art style choice in visual communication. In the field of art style emulation, 2D animation evidently presents itself as the most pertinent choice, as traditional hand-drawn artworks also belong to the second dimension, with this factor being increasingly obvious the further the art style strays from realism and departs from volumetric 3D shapes. The examples discussed above present extremely good results in their application, however, 2D animation is an extremely labor-intensive endeavor, requiring considerable artistic ability, both to maintain a cohesive style between every frame and to correctly emulate these styles convincingly. This fact is further exacerbated when trying to emulate traditional or complex painting techniques for artistic effect, as for example, Loving Vincent's creators describe its

methodology of painting an oil artwork for every frame as “the slowest form of filmmaking ever devised in 120 years” [19] as the film took a team of 125 artists from around the globe 6 years to complete. Therefore, to create *Where Paradise Ends*, which was estimated to be around 5 minutes long – to correctly portray the extracted text in its entirety – 2D animation was deemed incompatible with both the thesis’ scope and the required artistic ability.

On the other hand, 3D animation allows for asset reusability, as CG (computer generated) characters and sceneries can be infinitely reused and easily modified for different scenes and projects. Additionally, keyframed or motion captured animation removes the laborious process of drawing a new image every frame and ensures uniformity in character and camera movements, in a significantly faster and more accessible manner than hand-drawn 2D animation. These factors made the 3D animated medium stand out as the best choice for the scope of *Where Paradise Ends*. However, 3D animation’s perfect computer-generated geometry and movements come as a stark contrast to traditional artworks and 2D animation’s hand-drawn qualities and imperfections. Here, the field of 3D stylization and Non-Photorealistic Rendering presented innovative techniques and tools capable of overcoming these artistic disparities.

2.3. 3D Animation and Rendering

3D animation has become a mainstay in film, television, and video games [8], and while many industries use this technology, the following will focus mostly on 3D animated films. A 3D animated film is a movie in which all of the visual elements onscreen are created and rendered within a 3D animation software, resulting in a fully computer-generated image (CGI). Unlike drawing, painting and other traditional art forms that have been practiced for centuries, 3D animation is a relatively new medium since its history is closely tied to the evolution of computers [8], with many of the breakthroughs in graphical technology directly driving the 3D animation industry to come up with new techniques and innovative ideas [8], some examples of these breakthroughs (Figure 3) include:

- 1988 - *Pixar’s Tin Toy* [20] became the first 3D animated film to win an Academy Award and established computer animation as a legitimate artistic medium [8], through RenderMan – their in-house photorealistic 3D rendering software – which remains to this day as the main render engine for their studio and many other’s projects .
- 1995 - *Toy Story* [21] became the first fully 3D generated feature-length film [8], with Pixar capitalizing on RenderMan’s advancements in lighting and rendering technology to achieve convincing realistic materials, especially plastic and slightly reflective surfaces, hence the focus on toys and doll-like characters.
- 2001 - *Monsters, Inc.* [22] debuted Pixar’s major breakthroughs in hair and fur simulations, which allowed for the creation of the main character Sully, a monster completely covered in fur, highlighting their new simulation technology’s realistic movements and lighting interactions [22].

Figure 3 - Pixar Animations Using RenderMan [20] , [21] , [22]

Since their inception in the 1960s, computer graphics researchers have focused on improving photorealistic rendering quality [3], and accordingly, most 3D rendering software were optimized to facilitate these reproductions, using real life accuracy as a measure for success. Consequently, striving for realism became a trend in 3D animated movies from studios like Disney or Pixar. With the technology rapidly evolving in its early stages, each year featured impressive advancements in computer graphics, with every project proving to be a step-up from the last. However, in recent years, the previously major leaps in realistic computer graphics have become increasingly minute and undiscernible to an untrained eye, as it can be argued that realistic rendering has reached a plateau to the average consumer [3], and effectively, while modern 3D animations contain impressive graphical fidelity, films featuring the same photorealistic rendering quality, evidently lack graphical individuality (Figure 4).

Figure 4 - Disney Films With Stylized Characters Rendered Realistically, Adapted from [23], [24], [25]

2.4. Non-Photorealistic Rendering

On the other hand, recent projects have shifted the direction of computer graphics to view photorealism as just one of many rendering styles [3]. As evidently, more companies and productions have begun employing stylized 3D and non-photorealistic rendering to previously realistic renditions, revolutionizing the 3D entertainment industry, both in films and games (Figure 5).

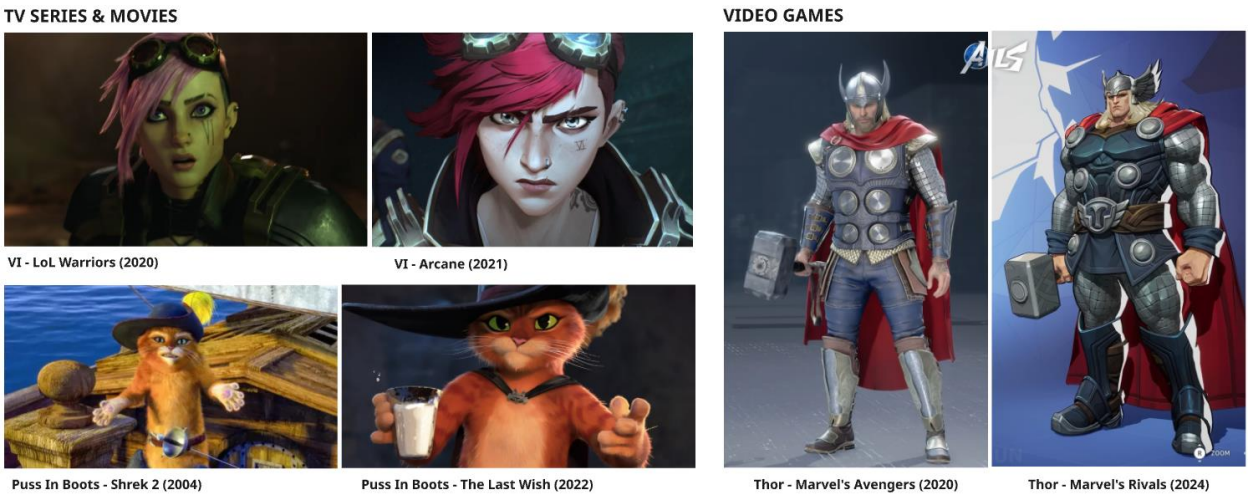


Figure 5 - Previously Realistic Renditions Becoming Stylized, Adapted From [26], [27], [28].

Non-photorealistic rendering (NPR) is an area of computer graphics which deliberately deviates from realism, removing features of photorealistic 3D – such as indirect lighting, reflections and soft shadows. This umbrella term is usually connected with stylization, as the removal of these photorealistic qualities is often followed by replacing or inferring them according to an intended style, often labeling NPR works as stylized 3D. Effectively, while realism aims to replicate reality with perfect visual fidelity, stylization emphasizes artistic expression through abstraction and imperfection. Some of the most influential examples of these works include (Figure 6):

- Disney's *Paperman* (2012) [29], is an innovative short film that used 3D cel-shading in conjunction with hand-drawn elements a groundbreaking integration of 2D and 3D animation techniques for its time.

- Sony Pictures' *Spiderman: Into the Spider-Verse* (2018) [30], is a feature-length animated movie which reproduced traditional 2D comic book aesthetics into an innovative 3D look, further elevated by creative animation techniques which took the industry by storm [31].

- League of Legend's *Arcane* (2021 - 2024) [26], is an animated series which took advantage of impressive digitally hand-painted 3D models and 2D backgrounds to achieve a unique and captivating animation style that earned its own distinction as the "Arcane Style" [32].

- *Flow* (2025) [33] was the first independent film to win the Academy Award for Best Animated Feature, and was made entirely in Blender [34], using the EEVEE render engine [35], which specializes in NPR and stylized 3D, both of which were also used to make *Where Paradise Ends*.

Figure 6 - Innovative Stylized 3D Animations, Adapted from [29], [30], [26], [33]

These projects, and many others discussed in this thesis, challenge realistic rendering trends in favor of innovation and artistic expression through non photorealistic rendering and stylized animation [4], a concept nowadays most commonly known as stylized 3D. All of which provided valuable references and inspiration to develop the style and techniques necessary to bring this project to life.

2.5. Defining Style and Style Analysis:

Style is an important but ambiguous concept present in a multitude of fields, which at its core refers to "the particular manner or technique by which something is done, created, or performed", these may be typical of a particular author, artist, historical period or medium [36], which can all be influenced by a multitude of factors, such as a culture's traditions [37], an individual's preferences [38], societal movements [37], and even advancements in technology [3]. While the concept may come across as abstract, style can also be rationalized as a distinctive manner which permits the grouping of works into related categories [38].

In practice, this notion can be applied to classify trends found within any selected discipline for easier recognition, such as genres of music (e.g. Electronic, Pop, Rock), types of architecture (e.g. Brutalism, Gothic, Modern), or in the case of the disciplines most relevant to this project, traditional art styles (e.g. Engravings, Watercolor, Baroque) and stylized 3D (e.g. cel-shading, hand-painted, stroke-based). For example, to analyze a painting, one might classify an artwork's style as Baroque (because it shares common themes and materials with other paintings of the same time period), while a keener viewer can recognize an artist's signature style within that genre (for it reminds them of the individual's techniques and their previous works).

In this manner, the style of any selected subject matter can be deconstructed systematically into individual features in order to uncover the unique combination of artefacts that make up its distinctive qualities [37]. In visual arts and animation, this same deconstruction can be applied to describe an artwork's style, through the analysis of its visual characteristics, from basic factors like colors, shapes and themes; to more intricate features like stroke density, line weights and framerates. Artworks that share certain common features are considered to have the same style [38]. For this project in particular, this form of art style analysis was crucial to single out the unique attributes of different art styles, both contemporary stylized 3D and traditional 2D art, and attempt the emulation of their techniques into the chosen digital medium.

2.6. Stylization and Realism as a Goal

Stylization means "to represent or design according to a style or stylistic pattern" [39] rather than according to nature, tradition or realism. In other words, it is the act of consciously and purposefully aiming for style instead of conforming to visual fidelity or convention. While the concept of "art style" is prevalent in 2D art, the term "stylized" or "stylization" commonly refers to 3D art which features

overly artistic qualities. Likewise, an important notion to consider is the presence of realism in the discussion of stylized art. Since style is a unique quality made up of individual artifacts or "imperfections", reality's perfect visual fidelity directly contrasts the concept [3]. Effectively, every aspect of a 3D production can be stylized, such as character proportions, textures and animation, but the most impactful feature in creating a "stylized" look is effectively, rendering. Notably, while artworks may exhibit realistic elements, such as accurate proportions or lifelike colors, they are generally still considered stylized if their features lean more towards artistic interpretation than conventional realism, as in these works, the artist's goal is not to replicate the world but to instead interpret and improve it. For example, in *Soul* [40] Disney's signature style features stylized characters, however, their photorealistic rendering attributes them a *realistic* appearance. On the other hand, *Nimona* [41] also features stylized characters but renders them in a non-photorealistic manner, resulting in a distinctly *stylized* look (Figure 7).

Figure 7 - Disney's Soul [40] - Realistic | Netflix's Nimona [41] - Stylized

In conclusion, it is possible to affirm that any artwork produced with realism as a goal cannot be considered stylized, and that the closer one gets to realism, the further they are from stylization.

2.7. Uses for Stylization and Non-Photorealistic Rendering

While realism aims to replicate reality with perfect visual fidelity, stylization emphasizes abstraction and imperfection, as straying away from photorealism allows for a multitude of benefits previously restricted to 2D art and animation or incompatible with realistic depictions.

2.7.1. Conveying Meaning:

Effectively, 3D stylization can be more effective in communicating specific information than photorealistic renditions [3], and though this project mostly pertains to 3D animated films, the following concepts are also prevalent in video games and other forms of visual entertainment [8]. This use of stylization allows viewers to ascertain the "intended meaning of a graphical message" [3]. In other words, it allows for the visual language of the style to infer further context for viewers to interpret without having to explicitly exposit it, which may also enable audiences to feel more immersed in a story [7]. For example, if a project were stylized to emulate a popular 2D visual entertainment medium, like comic books, children's cartoons or anime; then the viewer can

intuitively ascertain that it will follow some of those world's principles and be more willing to accept their themes and generic tropes – like impossible movements, exaggerated poses, onscreen onomatopoeia – all of which would look out of place and break viewers' immersion in realistic renditions.

Shifting an animation's style can also be used to indicate tonal shifts and emotional states through visual language alone. In *Arcane* [26] for example, in a scene where two friends fight violently against each other, the style switches from semi-realistic digital hand-painting, to a considerably more illustrative one, using sketched silhouettes, solid colors and textured shading to emulate a child's drawing, toning the dramatic conflict with a style that purposefully undermines the violence of their encounter to add emotional weight and remind the audience of their childhood bond.

2.7.2. Artistic Vision:

The main advantage of stylization and NPR is the ability to "free oneself from physical constraints of reality" [3]. This allows 3D artists to convey an impression, rather than just the details of a scene's appearance, empowering animators to create new worlds and visual experiences not limited by the constraints of the real world and its graphical fidelity. This freedom also allows for expressive and unique animation choices, as animation flaws and inconsistencies tend to be less accepted on realistic characters than stylized ones [42]. Additionally, unlike realistic 3D, which focuses on meticulous detail, stylized 3D emphasizes abstraction and imperfection, which can prove to be more powerful in conveying feelings than photorealistic animations [4], as, for example, reducing details in the features of a character allows a wider audience to easily relate to said character [7].

Another benefit of NPR lies in its hand-crafted nature, since stylized projects' visual aesthetics aren't reliant on real world graphical fidelity, it attributes them a "timeless" look [32], as opposed to photorealistic rendering in animation, which may look increasingly outdated as its technology evolves (Figure 8). This allows stylized works to remain indefinitely prevalent, while an outdated realistic rendition can negatively affect an audience's perspective and viewing experience.

Puss In Boots - Shrek 2 (2004) Puss In Boots - The Last Wish (2022)

Figure 8 - Realistic Puss In Boots (Shrek 2, 2004) vs Stylized Puss In Boots (Puss In Boots: The Last Wish, 2022) [27].

Moreover, stylized 3D has allowed projects to stand out within the animation industry. For example, Disney signature style of cartoon characters rendered in a realistic manner has been a trend in the industry for many years. Conversely, their oldest competitor, DreamWorks Animation,

has recently set itself apart by leaning into stylized animation, with films like *Puss in Boots: The Last Wish* (2022) [27] and *The Bad Guys* (2022) [43] making use of non-photorealistic rendering, choppy animation and 2D effects to attain new and original styles (Figure 9).

Figure 9 - Disney's Zootopia [44] – Realistic | DreamWorks' Bad Guys [43] – Stylized

2.7.3. Style Emulation:

Stylization and NPR can be used to emulate traditional animation styles or specific drawing techniques, as this application resulted from artists' desire to move away from photorealism, creating a trend for NPR to generally "mimic images made by hand" [3], this style emulation is a common feature in the uses discussed until now, and thus provides the same benefits. In this application, a casual way to rate an NPR rendition's "hand-drawn" quality, is to pause the animation at any point, and assess if the resulting frame resembles a 2D image, rather than a 3D render. Some examples of style emulation including the following:

- 2D Cartoons: Featuring solid outlines, flat colors and cell-shading, like The Iron Giant [45];
- Comic books: Complete with solid colors, strong outlines, printing artifacts and 2D effects, like Spider-Verse [30];
- Hand Painted: Animations that emulate concept art techniques with visible brush strokes and digitally painted backgrounds, like Arcane [32];
- Anime: Colorful cell-shaded 3D with light outlines and variable framerates like Cowboi [46] and many other NPR experiments featured in Blender's website [34].

2.7.3.1. The Illusion of 2D within 3D:

In 2D emulation specifically, the NPR techniques employed must follow the intended style's individualities to accurately depict them, and multiple factors must be taken into account to maintain this two-dimensional illusion within a 3D render. The goal in these cases is to mask the fact that the 2D images on screen are actually three-dimensional, a pertinent factor for this project in particular, with most of these illusion-breaking factors involving motion:

- *Camera Movement*: 3D camera motion which shifts the 3D models from a flat view automatically highlights the assets' "perfect" computer generated geometry and perspective, a feature uncanny of hand-drawn 2D animation. To maintain this illusion, the 3D camera should

preferably be left static and rely on mostly orthographic perspectives [46]. In shots where movement is required, the camera should translate flatly across two axes of a plane to avoid any rotation or parallax between the character and the background.

- *Character Movement*: Likewise, any character animated through a 3D rig will perfectly retain their geometry at any angle. To combat this, animators can make use of stepped interpolation to emulate traditional 2D animation's framerates or make use of exaggerated poses and clever camera tricks to create inconsistencies in more dynamic movements. Additionally, animators can add animated textures or modifiers that deform a character's mesh, making their silhouettes shift and distort at every frame to emulate the inconsistencies of frame-by-frame animation.

- *Dynamic Shading*: While cel-shading is commonly used to emulate traditional 2D animation, this illusion is immediately broken once the shadows contour complex character models in a perfect fashion during movement or various lighting situations. This automatic shading approach can also result in unwanted artifacts being visible in the model. Some productions make use of cel-shading in mixture with hand painted shadows, these are baked directly into the model's textures to ensure they are permanently visible and unchangeable regardless of their lighting.

- *Paint-overs*: Stylized productions can use of "paint-overs" to solidify a 2D style's features. This process involves manually adding 2D shapes, lines and other artistic effects on top of the 3D render during compositing to artificially introduce features like shading, extra outlines or artistic effects unique to that intended style, similarly to hybrid animation.

2.7.4. Hybrid Animation:

Taking advantage of NPR's ability to emulate 2D styles in 3D allows for clever use of computer-generated elements within primarily 2D animated mediums. This combination of two-dimensional (2D) and three-dimensional (3D) animation media is called hybrid animation [47]. NPR usage in hybrid animation includes fully 3D generated characters and objects within traditional animation, as well as the complete replacement of complex elements [47]. In these situations, 2D elements that would be "difficult to animate believably using traditional methods" [47] as they would take an insurmountable amount of effort to hand-draw and paint every single frame, are instead replaced by their convincing stylized 3D counterpart, which has the additional benefit of being infinitely reusable.

Examples of these complex elements include crowds of people, props and backgrounds, and especially, solid geometric shapes such as vehicles, buildings or mechanical parts which would be difficult to redraw in multiple perspectives. For example, *The Iron Giant* (1999) [45], was an innovative 2D animated film that included a fully computer-generated character who convincingly blended in and interacted with the 2D elements present in the film despite belonging to the third dimension (Figure 10).

Figure 10 - Fully computer-generated character interacting with a 2D character [45].

To achieve this, the character's rendering style features solid colors and dark outlines in and around the model, with cell-shading being the main contributor to the character's stylization, though often deliberately containing no shading at all to achieve a convincing application of NPR that perfectly matches the traditional flat 2D character style, which are also devoid of shading. In hybrid animation the NPR and stylization must replicate the 2D animation's style convincingly enough to not break the visual cohesion of a scene, as doing so would make the 3D look out of place by looking "computer generated" and distract the viewers from the main hand-drawn 2D characters/elements [47]. These include the same immersion breaking factors discussed above in "Style Emulation".

2.7.5. Optimization:

Photorealistic rendering incurs high performance costs, as factors like light bounces, indirect lighting and reflections require strenuous amounts of processing power to correctly calculate through a render engine. On the other hand, non-photorealistic rendering, as the name implies, removes many of these visual effects, significantly speeding up rendering times and improving real-time rending capabilities for a multitude of uses. In 3D films, this means that an animation can be rendered extremely fast or even viewed in its final form directly through the software's viewport, allowing the animator to visualize the final result without having to render, export and composite the animation elsewhere. This real-time rendering capability proved especially useful to develop *Where Paradise Ends*, allowing the style of the animation to be previewed and iterated directly through the viewport optimizing the visual development phase of the production.

2.7.5.1. NPR And Stylization For Optimization In Games:

On the topic of real-time 3D rendering, NPR and stylization has also seen great success in video games. While the study of video game graphics and optimization is an immense field of its own, the following will focus on how advancements in non-photorealistic rendering and stylization impacts this medium. Since their inception, video games have strived for increasingly realistic visuals, however, before the technology was as developed as it is today, many photorealistic effects proved impossible to recreate with the available technology at the time and the taxing demands of real-time rendering. As these technologies became increasingly developed and accessible – for example, with the release of the free game development software, Unreal-Engine 5 – modern software are now capable of achieving high-quality realistic graphics "with the push of a button". This accessibility and removal of the need to develop unique solutions for low system

specs, has resulted in many modern video-games retaining the same “quality of realism”, stripping them of graphical individuality. And while realism does have its place in video games, incorrect optimization negatively impacts their performance, accessibility, and consequently, their enjoyment.

In conclusion, games as an entertainment medium can make use of stylization to create memorable experiences at a fraction of the performance cost, while significantly elevating their artistic quality to reap the benefits of non-photorealistic rendering described in this chapter, as well as comply with the high-performance demands of real-time rendering, without the diminishing returns of easily replicable and replaceable realistic graphics.

2.8. How to Stylize 3D Images

Most 3D software and rendering engines were primarily designed to create photorealistic images [3], and consequently, the industry-standard 3D animation pipeline caters to their reproduction. NPR and stylization techniques vary greatly between programs as they are most often achieved through the addition of specialized NPR tools, a combination of 2D and 3D software, or the exploitation of each individual program’s “workarounds”. These techniques and styles feature infinite combinations and variations, specific to each software’s tools, as well as the project’s needs and goals, however, research into the state-of-the art can reveal several recurring trends and features, represented in the following categories:

2.8.1. Cartoon/Cel-Shading:

Cartoon characters are intentionally two-dimensional, as the animator deliberately reduces the amount of visual detail in their design to draw the audience into the story and add emotional appeal [7]. With cel-shading, rather than shading the character to represent a 3D appearance, the software removes the smooth transition between the lit and unlit parts of a 3D model, creating a hard cutoff between the two values [7]. In stylized animations, reducing shading to two values, or removing shading entirely, is the single-most important factor to make a 3D model look two dimensional, as it infers an illustrative image rather than a volumetric object (Figure 11).

Figure 11 - Cel-Shading Applied to 3D Characters, Adapted from [48], [29]

2.8.2. Outlines:

Cel shading is often accompanied by outlines, as these are also a common feature in traditional cartoon characters. These are outlines which automatically delineate a 3D model's silhouette when viewed from certain angles, ignoring the smoothest or roundest edges inside of the shape. There are multiple methods to outline characters dependent on the 3D software being used and the desired outcome, with some of the most common being:

The **Inverted**-hull method duplicates the 3D mesh into a slightly thicker version painted solid black. This duplicated mesh is then "inverted" so it renders behind the original 3D model, making this slightly thicker version show up as outlines around the silhouette of the model. This technique is prevalent in 3D software like Autodesk Maya and Blender, as well as game engines like Unity and Unreal.

Automatic outlines are assets present in a 3D scene which add a physical outline to any objects in view of the camera, this physical outline can then contain custom properties such as line weights, textures and curvatures. For example, in Maya this can be achieved through a "Toon Outline" object, while in Blender this is achieved through a "Grease Pencil Outline" object.

Additionally, artists can add **Manual** lines to a model akin to hand painting to infer important details within the design which would otherwise not be automatically displayed by the software. These can be painted directly on the character's textures, applied to select edges in the mesh to create exceptions, or added on top of the 3D render during compositing [7]. Outlines can be modified with properties, such as line weights, colors, textures and curvatures to recreate a multitude of traditional line-art styles specific to the medium being emulated or the intended style for that project. (Figure 12).

Figure 12 –Characters With Different Styles of Outlines and Linework [29], [45]

2.8.3. No Outlines:

On the other hand, artists can also remove outlines from cell-shaded styles. This absence of drawn silhouettes emphasizes the characters and environments through strong use of shape language, forms and color, with the visual style resembling a digital graphic illustration (Figure 13) rather than a traditional cartoon or artwork (Figure 12).

Figure 13 - Cel-Shaded Characters Without Outlines [49], [50].

2.8.4. Stroke-Based Illustrations / Filters:

In this style of NPR, select algorithms are used to calculate the edges and the dark and light values of an image to automatically overlay heavily textured effects onto the 3D render, emulating illustrative images akin to hand-drawn sketches, pen drawings and paintings among many other stroke-based art forms. In these works, the strokes' applications simultaneously depict tone and texture [3], as different-sized strokes and outlines provide varying senses of shapes and lighting conditions, as well as depth and focal points. While being at the forefront of NPR research, this technique's applications vary greatly between projects, recurring to highly complex algorithms specifically developed for that style's replication. Similarly to an image filter, these are usually applied to a full 3D render (Figure 14) or picture (Figure 15), instead of behaving as individual parameters on each one of the objects present in a scene. When animated, this can create a distracting flickering or flashing image, or result in the "glass door effect", a visual phenomenon which will be described further in the next chapter titled "How to Stylize 3D Animation".

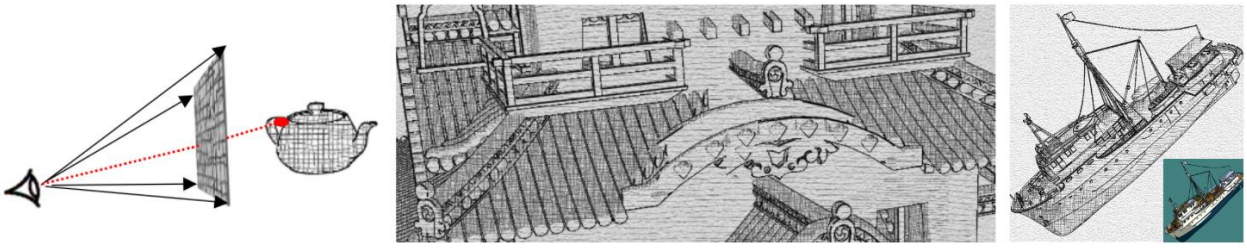


Figure 14 - Stroke Based Rendering To Resemble a Pencil Illustration, Adapted from [7]

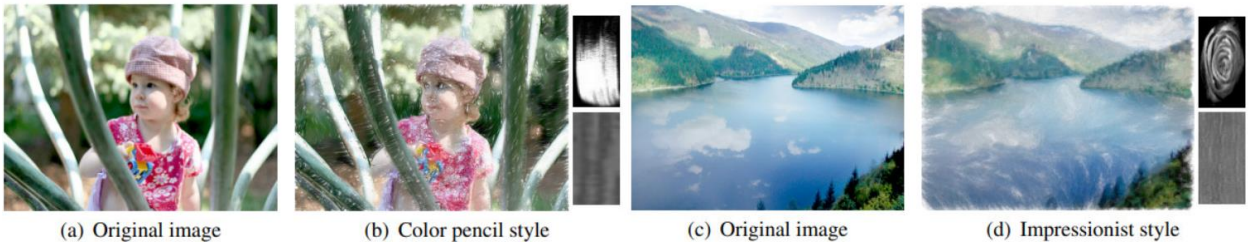


Figure 15 - Stroke Based Rendering Applied to Real Photographs, Adapted from [51].

2.8.5. Hand Painting:

Hand painting as a technique in and of itself can encompass a multitude of art styles, however its application within a 3D software can be reduced to the following methods. In this technique, 2D artists paint directly onto the 3D models, often leaving visible brushstrokes and digital painting artifacts. This "manual" application ensures complete artistic expression within the texturing process, as it can achieve the closest resemblance to a project's concept art [32], regardless of the style being reproduced, as long as it is also possible through 2D art. This style can also be usually named "2D 3D", though not to be mistaken with hybrid animation, although they can and usually do coexist, for example, making use of digitally painted 2D backgrounds and foreground props. With hand-painted 3D textures this practice can include adding permanent shading and lighting effects directly onto the models – painting shadows under or around characters' noses, ears and eyes, or manually placing highlights on characters' pupils and hair [32]. All of these features are then baked into the 3D model's textures, making these details show up in any lighting situation. On the other hand, this method is extremely labor intensive and requires a team of highly skilled digital artists to maintain visual coherence and achieve high quality results [32] (Figure 16).

Figure 16 - Hand-painted 3D characters in front of 2D painted backgrounds, Adapted from [26]

2.8.6. Procedural Materials/Shaders:

Procedural materials vary greatly between digital programs and rendering engines, in both their functionality and creation process, as these are programmable materials that can "automatically" recreate many surfaces and styles. These materials are created through a combination of highly customizable parameters which define their appearance and shading behavior. These parameters can come in the form of algorithms, lines of code, or in their most accessible form, as visual nodes in a 3D software's shader editor, in Maya these are edited through "Hypershade", while in Blender, these are edited in the "Shader Editor". Their procedural nature makes them ideal for quickly texturing a multitude of objects, allowing for infinite iterations of the same surface, however, multiple objects containing the same procedural material will lack individual attention, prioritizing quantity over quality similarly to stroke-based illustrations. Additionally, one of the most common uses of procedural materials in contemporary stylized animation is the emulation of hand painted textures or painterly 3D visuals without having to actually paint these features by hand onto the textures of each asset (Figure 17), which was in fact, the focal point of this project.

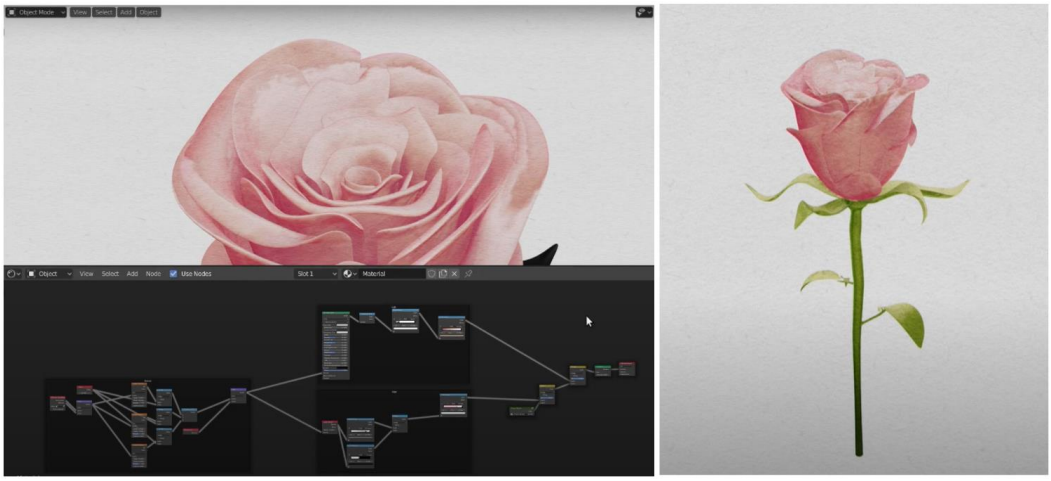


Figure 17 - "Painterly" Visuals Achieved With Procedural Materials in The Shader Editor, Adapted from [52]

2.8.7. Stylization Method Choice:

Some styles and contemporary works proved more prevalent than others in consideration of *Where Paradise Ends*' scope and artistic goals. Arcane's hand painted texturing would evidently be the most relevant stylization method to recreate traditional art styles in 3D [17], as it has effectively the closest resemblance to traditional art within 3D stylization, as one artist said when asked how the studio achieved its style, they simply answered, "We paint!" [32]. However, this technique is extremely labor intensive and requires a high degree of artistic ability, risking style inconsistencies between the multiple characters and sceneries in the 7-minute-long animation, all of which would prove incompatible with the project's timeline and required artistic ability.

To comply with the thesis' scope, the most applicable option was in fact, procedural materials. With this method, a singular procedural material can be used to "automatically" emulate the intended traditional painting artifacts and styles, replicating them infinitely across every surface and character, without having to paint them individually. This application ensures a cohesive look, proving useful in quickly texturing multiple scenes, objects and characters for every shot of the animation. Additionally, automatic line art tools such as Blender's *Grease Pencil* prove to be especially useful in the emulation of line art focused styles such as sketches or engravings, adding great artistic effect to an image with minimal manual input, cementing this method of outlining as the most pertinent for the project.

2.9. How to Stylize 3D Animation

Going from static stylized images to 3D animations adds further layers to the style expression possible with the medium. On the other hand, it also adds new challenges with the added complexity.

2.9.1. Stylized Character Animation:

- **Stylized Keyframed Animation:** Keyframed animation offers a high degree of artistic expression through exaggerated poses and dynamic movements unrestrained by the limits of the physical world, as opposed to motion capture, which replicates actors' real movements and is therefore restricted to purely realistic animation [32]. However, within the confines of keyframed animation, artists can convey more than physical realism by stylizing character movements beyond conventional motions. Keyframed animation can be used to emulate existing forms of 2D animation, such as anime and cartoons, in which characters can be seen stretching and bending in "unnatural" ways, holding poses for prolonged periods, skipping multiple sequences of frames, or even breaking traditionally established principles of animation [8], all of which would look out of place if performed by realistic characters. A great example of stylized animation to emulate a specific style can be found in Cowboi [46], an NPR project using Blender and EEVEE, where the creator details the methods to recreate 2D anime-like movements, highlighting in the following example the use of keyframed animation to hold the character's head in the same position through multiple movements and actions to break the 3D smoothness of the rotation (Figure 18).

Figure 18 - Holding Character's Head Direction To Create A 2D Feel, Adapted from [46]

- **"Choppy"/Stepped Animation:** Framerate or frames per second (FPS) is the number of times each frame is displayed onscreen for each second of video [8], usually both 2D and 3D animated movies operate at 24 fps [8]. Traditional 2D animations make use of lower framerates like 12fps or 8fps on slow, irrelevant, or non-dynamic movements, as it is optimal to only draw the minimum amount of frames on actions that can be convincingly portrayed at lower FPS without breaking immersion, considerably shortening production time, and instead allocating that time saved into shots that require higher frame counts, like fast paced actions or emotional scenes. Though 3D animation can be rendered at a multitude of framerates above the standard 24fps [8], contemporary stylized animations have recently established a trend of limiting their framerate to 12 frames or lower to make their motions resemble classic hand-drawn productions like cartoons and anime [47]. This technique also allows for variable framerates between characters, backgrounds and camera

movements, resembling the "choppy" animation that can be seen in a multitude of modern animated films, like *Puss In Boots* [27], *Arcane* [32] and *Spider-Verse* [30] among many others.

2.9.2. Stylized Speed Effects:

- **Smear Frames:** While realistic motion blur makes fast-moving objects seem out of focus through directional blurring, stylized motion blur takes inspiration from "Smear Frames" and other visual tricks used in traditional cartoons to convey rapid movements and adapts them to the computer-generated medium. Some 3D rigs feature bones that can be bent, extended and distorted to create a smear frame effect in which the character or object is stretched to span multiple points in space. This technique can include multiple versions of a character's features superimposed onto itself or motion lines with the character's silhouette to improve the effect (Figure 19).

Figure 19 - Realistic VS Stylized Motion Blur, Adapted from [23], [53], [30]

- **Motion Lines:** Stylized animation can also use 2D elements in conjunction with 3D animation to add "Motion Lines" and "Impact Frames" in front and around fast-moving objects or strong actions to indicate their speed, direction and force [32] (Figure 20). These may be created within the 3D software through 2D planes or specialized effects, or digitally added on top of the renders during video editing in post-production [32].

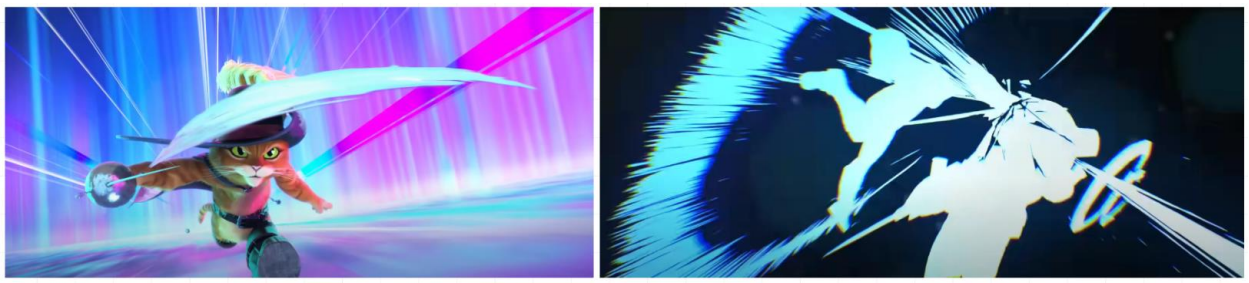


Figure 20 - 2D Motion Lines and Impact Frames in Stylized Animation, Adapted from [27], [26]

2.9.3. 2D Visual Effects And "Fluid" Simulations:

Visual effects in 3D animated movies range from massive explosions to simple rain drops. In fully 3D animated productions, these are traditionally simulated within the software to facilitate their interaction with the characters and objects present in the scene. In 3D animation, fluids are

traditionally represented with particle simulations that use complex equations to realistically emulate the movement of liquids, however this designation is not restricted to waterlike materials, as it also includes smoke, fire and other plasma-like substances [8]. Some stylized animations have resorted to replacing these realistic simulations with 2D elements animated frame by frame on top of their 3D animation, an effect which is commonly present in Arcane [32] (Figure 21).

Figure 21 - 2D Hand-Drawn Smoke in Arcane [32]

2.9.4. Animated Textures:

In painting-like stylization, keyframing a mixture of hand painted textures to change shape every frame within a procedural material creates a "moving painting" effect, looking as if the objects and subjects in the scene are being painted by different brush strokes multiple times every second. In stroke-based 3D animation, for example, adding noise to the object's outline so it jitters or displaces itself slightly in every frame, akin to traditional animation, is an effective method to break up the even nature of computer-generated models and textures. Efffectively using animated textures can provide artistic benefits as a "lack of frame coherence can be harnessed to achieve special effects" [3]. For example, keyframing textures to alternate every frame or every few frames is one of the best ways to avoid the shower door effect in heavily textured animations, as their inconsistencies evolve with the models, as opposed to being dependent on the camera. This technique is used effectively by the 3D artist Bozo Balov [54] (Figure 22). Interestingly, this digitally created "moving painting" effect is also present in a physical form, in the previously mentioned "*Loving Vincent*" [19].

Figure 22 - Bozo Balov & Alexander Tullo Stylized 3D Animations, Adapted from [54]

2.9.5. Shower Door Effect:

Some stylization methods are easier to accomplish when applied to a whole frame [7] rather than on each 3D object in the scene, akin to applying a filter over an image. Conversely, when any of these objects move behind that filter it becomes noticeable that it is not the objects themselves that are stylized, but rather the static image in front of them. This phenomenon is a common pitfall in stylized 3D animation, known as the “shower-door effect” [3]. To visualize it, one might imagine a person walking behind a glass shower door filled with a square pattern, here, it becomes obvious that it is not the person themselves who is "squared" but rather their image as seen through the pattern.

2.9.6. Stylized Animation Method Choice:

Stylized 3D in motion features many effects which are often reserved for fast paced and dynamic movements, both of which come as a stark contrast to the pacing of *Where Paradise Ends*, as the documentary’s slow and dramatic approach is devoid of fast actions and as such is incompatible with most of these techniques. However, stepped animation and animated textures were tested during the later stages of production during the documentary’s visual development and animation stage to resemble a moving painting, however it was ultimately let go for reasons explained in that section. Additionally, the glass door effect was definitely taken into consideration, as it was especially prevalent when overlaying 2D images on top of the 3D animation incorrectly during compositing or post-production, as when turned to high values, this effect made it obvious that the animation was just playing behind a 2D paper texture instead of belonging to it.

CHAPTER III - METHODOLOGY

3. PRE-PRODUCTION

The following chapters detail the methodology used in the development of *Where Paradise Ends*, further developing the concepts from the state of the art and detailing the stages of the animation, categorized into **Pre-Production**, **Production** and **Post-Production** procedures.

Pre-production is the planning, designing, and research phase of the entire 3D project [10]. This first stage is crucial in generating ideas and creating credible production plans to manage the animation's development, taking into account the project's goals, scope and timeline, before moving onto the production. This phase of the project was divided into five components – idea/story, storyboards, animatic, concept art and visual development, with the latter being a crucial chapter in producing stylized 3D animations and experimenting with non-photorealistic rendering, to define a direction and workflow for the style before moving onto the production.

3.1. Goals and Concept

The concept of this project was to adapt a text concerning Madeira Island into a more dynamic and modern medium, as this adaptation would serve to promote the island's culture or disseminate any important events in history and their effect on the cultural landscape of the island. Additionally, this project would serve to explore modern and accessible 3D stylization methods in order to further immerse viewers into a selected story's date and setting, reinforcing the narrative weight of the adaptation through a unique style of visual communication. Finally, one of the focal points in this adaptation was to maintain the essence of a factual source material and ensure a certain degree of historical accuracy in its visual adaptation, rather than modify a fictional story to reflect modern values or trends, accordingly, designating this type of film as an "animated documentary" [12]. Effectively, these goals and concept culminated in the creation of *Where Paradise Ends*, an artistic 3D animated documentary, adapting a factual account from a foreigner's experiences in 17th century Madeira island, stylized to emulate paintings from that time.

- **Target Audience:**

The target audience for *Where Paradise Ends* is Portuguese and English citizens alike, as the film pertains to both nations' culture, including any foreigners researching the island's history. Though the sensitive themes of death and desecration might restrict its viewing to teens and up, this type of documentary is important to showcase the reality and evolution of Madeira's history and the Christian religion, connecting it to an important location which still stands in Funchal as of the writing of this thesis, the British Cemetery of Funchal [6].

This engagement will be accomplished by submitting the documentary to film and animation festivals, and possibly disseminating it through regional and national museums. Notably as the film features animation techniques relevant to 2D and 3D artists interested in stylization and non-photorealistic rendering, it will eventually be published online and shared in forums concerning NPR

and Blender animations, after its promotional run. Additionally, the son of António Aragão, who has given explicit permission to include his book [1] in the credits, which served as a great inspiration for the project, can also be sent the film to showcase an opportunity to preserve Aragão's legacy.

3.2. Choosing a Story

○ A Madeira Vista Por Estrangeiros – Madeira Through A Foreigner's Eyes:

There is a plethora of written accounts of Madeira's history from both national and foreign document centers [1]. These provide valuable knowledge concerning the island's culture, such as the evolution of trends, the origin of modern customs, and, in the case of international works, valuable insight into Madeira's history through the eyes of another nation's beliefs and philosophies. To this end, the book "*A Madeira Vista Por Estrangeiros 1455 - 1700*" by António Aragão [1] stood out as the most relevant resource for nonfictional content concerning the history of Madeira Island.

The book features a compilation of texts written by multiple foreigners who visited or lived on the island from the 15th to the 18th century. From personal letters to published volumes, each chapter is dedicated to a different visitor's written account, including the texts written in both the foreigners' original languages and their Portuguese translation, as well as additional notes and corrections on relevant topics added on by the compiler António Aragão. This publication was used as the primary source for the stories and accounts deemed eligible for adaptation, as the author performed a careful selection of the written works for each chapter, filtering them to comprise only of the content considered fundamental to achieve a "concise historical view" of the island [1].

○ Selection Process:

The first phase of choosing a story to adapt was to analyze the multiple written accounts the book compiled. This process involved a thorough reading and summarization process of each part, breaking down each chapter into extracts of relevant quotes, chronological events in bullet points, and any stories told written in full. The content extracted was filtered through a lens of cultural relevancy, focusing only on information pertaining to the island's inhabitants and its culture, including both visual and behavioral descriptions, while excluding some sections concerning overly technical descriptors such as nautical coordinates, complex trade routes, monetary values or any extensive trade records, all of which proved common among the descriptions.

With this main analysis complete, the next step was to isolate the moments from each chapter that could be turned into an animation. The criteria for these inclusions were that they fit within the thesis' scope and goals, considering the project's contextual and technical limitations.

As for the **contextual considerations** of the narrative, for the sake of cultural relevancy, the content isolated featured a focus on human interaction. These requirements were meant to prioritize interesting events like the meeting of important historical figures (e.g. An Italian merchant meets Infante D. Henrique [1 , p.27], insight on the foreigners' perspective of the island's inhabitants and

culture, interesting facts and customs, important historical events (e.g. the mistreatment of foreigner's bodies [1 , p.175], and any generally entertaining stories and accounts (e.g. Foreigner is repulsed by the face of the Portuguese woman he slept with after she removed her makeup [1 , p.91].

On the topic of **technical considerations**, the adapted story should fit within the short film's estimated runtime of around 5 minutes, to not omit important context relevant to the plot and risk misinterpretation by the viewers [2]. This length of animation requires a considerable amount of manhours to complete to a high-quality standard, so time-saving production factors had to be considered as early as possible in the pre-production process. These considerations include factors like: the number of narrative relevant characters shouldn't exceed 3 or more visually distinct designs, while still affording slight variations of each to populate scenes as deemed fit (e.g. One 3D model of a character can be reused with interchangeable colors and props, such as hats and capes, to simulate a small crowd without the need to create a new character altogether); the animation shouldn't contain more than 3 plot relevant locations, as each distinct scenery type and subsequent prop list would considerably impact the workload (e.g. A nature setting can reuse the same tree to efficiently populate a shot and fill the frame, while an indoor setting must feature a variety of props to convincingly portray a plausible living space).

3.3. The Chosen Story

○ A Voyage to Suratt in The Year 1689 – Chapter 1 "The Island of Madeira":

The chosen story was taken from the first chapter of "A Voyage to Suratt in The Year 1689" by John Ovington [5], a book which details the English priest's trip to the city of Surat in India, including personal reflections and in-depth descriptions of his experiences in the many countries he visited as chaplain of the East India Company's vessel the Benjamin. The very first stop on Ovington's voyage was Madeira Island. In this first chapter of the book, like the many other accounts compiled in the Aragão's book, the author provides valuable information on the Madeira of the past, including: the history of its discovery, settlement and origin of the name; ample descriptions of the atmosphere and complements to the beauty of island; highlights on the quality of the wine and food products; visual descriptors of Funchal and its people; and lastly, valuable information on the customs and interesting behaviors of the Portuguese inhabitants.

Where this chapter stood out from the rest is in the interesting events Ovington witnessed while on the island. Among these are experiences like: the act of murder gaining impunity and even reputation among the Portuguese nobility; the mistreatment of English bodies being thrown into the sea, including a deceased English child being dug up, baptized, and reburied; as well as a lengthy conflict in which several sailors from his crew were held captive by the Portuguese authorities, resulting in the captain of the ship kidnapping some Madeiran priests and citizens in a tense hostage situation. Of all these fascinating events, the chosen was an excerpt concerning the mistreatment of English bodies, as it fit within the animation's production scope and also created an opportunity to bring awareness to an integral part of the history of Madeira and the Christian religion, connecting it

to an important location which still stands in the city as of the writing of this thesis, the British Cemetery of Funchal.

∘ Story Summary:

***1º Exposition*:** Before telling the story, Ovington exposits that English foreigner's bodies are forbidden from being buried on the island, as the Portuguese people believed a Protestant's body would desecrate the sanctity of the land.

***2º English Merchant*:** He then recounts a case where an English merchant died on the island from a disease, so his compatriots held a secret funeral as they knew Madeira's catholic inhabitants would not allow their foreign ritual. However, the people eventually found the hastily buried body among the rocks, they dug and dragged it up and down the island, presenting it to the populace, until they threw him into the ocean.

***3º English Child*:** Ovington then recounts a case in which the Madeiran priests showed some "mercy". Here a few members of the Clergy were alerted that an English child had been buried in secret, but as they were swayed by a generous monetary bribe, instead of throwing it into the ocean as they had done so with the previous cases, they decided to dig up the child's body and baptize it in their Catholic manner. This way, having made the child one with their religion, they buried it once again as it was now allowed to rest in their land.

This factual description has an evident element of shock factor, which made it stand out as a thought-provoking piece for adaptation, as the inhumane practices of the island's inhabitants seem straight out of fiction. Moreover, this late 17th-century account is a stark contrast to the world-renowned tourist attraction that is the Madeira Island of today. While Ovington provides valuable information on Madeira's culture, his clerical background led him to focus on the religious practices of the island, and his personal reflections contain hints of disdain towards the Portuguese priests, as during the 17th century, his country's Protestant beliefs were actively challenged by the Catholic populace of Madeira [5].

∘ Catholic-Protestant relations:

The Protestant Reformation started in 1517 when Marin Luther, an Augustinian monk and university professor in Germany, publicly posted a list of academic arguments against the Catholic Church's practices, which eventually split the Western Christianity into Protestant and Catholic variants, leading to more than a century of religious warfare across Europe [55]. The Protestant church's most consequential doctrines were "scripture alone" (in Latin, sola scriptura), a belief that the Bible was the only ultimate source of authority for Christians, renouncing the Catholic church's popes and councils; another was "faith alone" (sola fide), which held that salvation couldn't be earned through good deeds or purchased through indulgences, rather freely granted by God to those who have faith in Jesus Christ; and lastly "grace alone" (sola gratia), that salvation comes directly from God to each person, without any intermediaries such as priests or popes. In response to the

spread of Protestantism, the Catholic church condemned Protestant teachings as heresies, and in an era when religion was interwoven with all aspects of life, these reforms set off religious violence across all of Europe, culminating in the Thirty Years' War, which lasted from 1618 to 1648, with many religiously based wars continuing until the early 18th century [55], alas, Madeira Island and its populace were no exception to this conflict.

- **Protestantism in Madeira & The English Cemetery:**

After the Restoration, and the end of the Hispanic union between the Portuguese and Spanish crowns [56], including its colonial possessions under the control of the Spanish king, Philip III of the Habsburg dynasty, Portugal's difficult situation, economically defeated and still under threat from the Spanish crown, led the kingdom to form alliances and sign treaties, especially with England, on which Portugal became increasingly dependent, and at times compromising its sovereignty [57].

One of these treaties was The Treaty of Westminster of 1652 [6], signed between the Kingdom of Portugal and the Kingdom of Great Britain. Besides being a commercial and diplomatic accord between both nations, it also guaranteed religious freedom for English subjects, mostly Anglican reformers, residing in Portuguese lands [6]. Conversely, even after the treaty's signature, protestant foreigners who lived and died in Madeira were prohibited from burying their dead, as they were instead thrown into the sea near the coast of Garajau [6]. However, it can be said that the history of the public practice of Protestantism in Madeira began in 1761, when, after petitions from consuls and British residents of Madeira, the Marquis of Pombal granted permission for them to possess their own cemetery, on the condition that it be placed outside of city's limits. In 1808 the English Cemetery of Funchal was constructed and still stands to this day on Rua da Carreira.

3.4. Script and Storyboard

3.4.1. Narration Extraction:

A decision was made to use narration all throughout the documentary to provide contextual evidence to the visuals on display. This narration uses the text Ovington wrote in his book as a script, leaving it mostly unchanged and often uninterrupted. This literal use of the original writing solidifies the story as factual and ensures the narrative remains faithful to the author's experience, as can be seen in the following table (Table 1). On the left is the excerpt directly extracted from the book in full, with the parts which were used in the narration in blue. On the right is the script created from the excerpt to be used as narration, and in red, are the words which were added to correctly introduce the phrases and adjust for timings in the animated adaptation. Evidently, the narration was directly extracted from the written work in full chronological order, adding only phrase connectors to adjust for cuts and timing differences during editing.

Table 1 - Written Account To Script

Full Excerpt [1 , p.188]	**Narration Script**
"But as their Church allows no Charitable Thoughts to the Souls of Heretics, so does it forbid all kindness to their dead Bodies, and prosecutes the English that die there, with more inexorable hatred, than what they shew to the Carcasses of Beasts and Birds, which may find a resting place on shoar, and quietly remain upon common ground; **both which are strictly forbid the English, who are cast into the Sea, and committed to the waves.**"	○ Their church allows no charitable thoughts to the souls of heretics. ○ As it forbids all kindness to their dead bodies. ○ And prosecutes the English that die there. ○ They do so with more inexorable hatred than what they show to the carcasses of beasts and birds. ○ Which may find a resting place on shore and quietly remain upon common ground. ○ **Both which are strictly forbid the English, who are cast into the sea, and committed to the waves.**
"And accordingly an English Merchant falling sick of a sudden Distemper at Madeira, was unfortunately carried off by it; which mov'd the rest of our Nation that were there, to contrive for his decent Interment. And therefore, lest a publick Burial might expose him to the Rage of the People, or the Clergy's Indignation, they concluded to deposit him among the Rocks, in order to his better concealment."	○ And accordingly, an English merchant. Falling sick of a sudden distemper at Madeira, was, unfortunately, carried off by it. ○ Which moved the rest of our nation, that were there, to contrive for his decent interment. ○ Lest a public burial might expose him to the rage of the people, or the clergy's indignation. ○ They concluded to deposit him among the rocks, in order to his better concealment.
"But the Rocks were unable to shelter him from their Tyranny, which was exercis'd upon him in this barbarous manner, **they dragg'd him from the place where he lay, up and down the Island, and expos'd him to the contempt of the Inhabitants, till they threw him into the Ocean.**"	○ But the rocks were unable to shelter him. From "their", tyranny. ○ Which was exercised upon him in this barbarous manner. ○ **They dragged him from the place where he lay, up and down the island.** ○ **And exposed him to the contempt of the inhabitants.** ○ **Till they threw him into the ocean.**
"This Inhumanity, which is carried even beyond the Grave, is propagated as far as their Plantations in the East; where if any Protestant chance to die among the Nation of the Portuguese, no place is allowed for his Reception, nor vile enough for his Sepulchre, but the very Corps of a rank Heretic annoys the Dominions of a Catholick Country, tho' it were buried under ground."	○ Here, this inhumanity, is carried even beyond the grave. ○ Where if any Protestant chance to die among the nation of the Portuguese. ○ No place is allowed for his reception, nor vile enough for his sepulcher. ○ As the very corps of a rank heretic, annoys the dominions of a catholic country, though it were buried underground.
"And yet a powerful Summ of Mony, which is said to blind the world, prevail'd to open the Eyes of the Priests Intellectuals in this very case; for thus they stated the difficulty concerning an English Child, which had been clandestinely Interred there, that if it were immediately taken up, and then Baptized after their manner, and so made a Member of their Church, it might be admitted among their Dead."	○ And yet… a powerful sum of money, which is said to blind the world. ○ Prevailed to open the eyes of the priests' intellectuals. ○ In this very case… ○ Concerning an English child. ○ Which had been clandestinely interred there. ○ The clergy decided that if it were immediately taken up. ○ And then baptized after their manner. ○ It might be admitted, among their dead.
"This Conclusion was approv'd of as Canonical, **for the Child was Baptiz'd, Buried after their manner, and deposited where it was taken up.**"	○ This conclusion was approved of as Canonical. ○ **For the child was baptized, buried after their manner, and deposited where it was taken up.**

3.4.2. Storyboard:

With the story and script defined, the next step in the pre-production pipeline was storyboarding [8]. In this phase, the excerpt from the book was broken down into story beats, creating the first visual representation of the narrative (Figure 129).

∘ **Storyboard Highlights:** The “highlights” of the selected story are the deceased English merchant being thrown into the ocean and the English child’s body being dug up, baptized and reburied. Apart from their narrative relevancy and sensitive content, these moments were highlighted as they are the passages most intricately described in the source material, leaving little room for interpretation. Therefore, these were given priority on their storyboard appearance.

The actions preceding and proceeding these moments aren’t as detailed in the source material’s descriptions, which provided more creative liberties in their visual representation. However, these fabricated moments are also subject to a higher degree of scrutiny as their contents are crucial to set the mood and build up to the key events and their aftermath. The storyboard’s pacing features a pattern repeated on both key events of the documentary, using slow uneventful scenes during buildups of narrated exposition, followed by concise actions of climax moments that serve as a visual aid to what is being literally described in the narration. In the later stages of production, the storyboard was updated to contain 3D renders of each shot, creating the first previsualization of the completed 3D animation Figure 132.

3.4.3. Storyboard Breakdown:

The following small storyboard strips provide an overall visual to the characters, actions and compositions being described. The complete and higher resolution storyboard can be seen in full in the annex starting with Figure 129.

1º Exposition: The animation begins with written exposition to provide the viewers with context on the themes of the documentary. As the start of the extracted text pertains to Ovington’s explanation on the handling of Protestant bodies by the Catholic populace, the storyboard uses simple motions of two English men walking through the woods of Madeira, to not distract the viewers to the narrator’s spoken context. When the narrator mentions bodies, the camera then closes in on the two men and shows that one is carrying a shovel and the other a large object covered in cloth, which serves as foreshadowing for their secret burial soon after (Figure 23).

Figure 23 - Storyboard pt1 - Merchants Walk Uphill Carrying Tools

In the next scene (Figure 24), the English merchants collide with a Portuguese gentleman carrying a sword. At first glance it alludes to a possible confrontation as the previous exposition recently mentioned their conflict with foreigners, but conversely the Portuguese man kindly apologizes. This

shot was added to show that despite the extremist practices of the Catholic populace, foreigners and English citizens were usually accepted and well regarded within Madeira. Additionally, this scene is also meant to highlight the visual features and differences between the gentlemen of both nations at the time, highlighting the dark hair and costumes of the Portuguese against the light hair of the English.

Figure 24 - Storyboard pt2 - English Man & Portuguese Man Collide

2º Deceased English Merchant: Ovington then begins narrating the first key moment in the story, in which two English merchants secretly buried one of their deceased companions amongst the rocks to hide him from the populace. The visuals in these key moments are more literal in their representation of the events being described in the narration. In this case, showcasing the two English merchants actively burying their deceased comrade (Figure 25).

Figure 25 - Storyboard pt3 - Merchants Burry Their Comrade

Next, Ovington recounts how the citizens of Madeira found and dug up the body, parading it around the island before throwing him into the ocean. Here, the body falls into the camera, using the fast motion to cut and transition into the next act of the animation, using sound design to imply the body's contact with the water, instead of actually showing the gruesome event (Figure 26). As for the populace that discovered and degraded the body, a choice was made to never show their faces and use a variety of clothing items as to not isolate a specific group like the clergy or the common folk as the main perpetrators, instead portraying them as a misguided collective of citizens.

Figure 26 - Storyboard pt4 - Madeiran Citizens Find The Body And Throw It Into The Ocean

3º Act Transition: The Portuguese man seen in the previous shots makes a re-appearance as the story transitions from the forest to the city and moves on to the next act. Here, Ovington gives further context to how foreigner's bodies are handled and highlights the Portuguese populace's disdain towards them (Figure 27). This stretch of spoken exposition is accompanied by simple walking motions to highlight the narration until the animation picks up again in the next scenes, in a similar pattern to the exposition given at the start.

Figure 27 - Storyboard pt5 - Portuguese Man Walks To The City

4º Deceased English Child: In this scene the narrator recounts the next key event of the story. Here, the narrator describes a situation in which a priest was paid a generous amount of money to handle a case concerning an English child which had been buried in secret. The sequence of these shots highlights the priest's reluctancy, until he receives said compensation, quickly springing to action (Figure 28).

Figure 28 - Storyboard pt6 - Priest Is Paid

Ovington then recounts the clergy's decision, of digging up, baptizing and reburying the child's body. In this sequence of events, the storyboard makes a point to never show the infant's body in full, as the sensitive content might restrict the documentary's reach, instead hinting at the contents of the grave through narration and small clothing items alone (Figure 29).

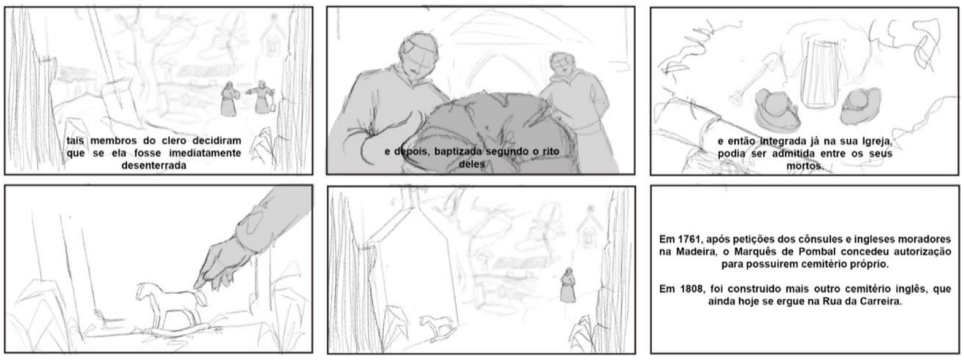


Figure 29 - Storyboard pt7 - Child Is Dug Up, Baptized and Reburied

At the end of the animation, to bring a resolution to the story and inform the viewers of the outcome of this religious conflict, the storyboard adds a mention of the British Cemetery of Funchal, as its creation contributed greatly to subside this religious antagonism and stopping the kinds of misguided practices included in the documentary.

3.5. Animatic

With the storyboard reviewed, the next step in the preproduction pipeline was the animatic, which serves to set the pacing of the shots for the final animation, using the storyboard images as placeholders to dictate the time each shot is held and get a preview of post-production visuals like subtitles or visual effects [8], this process allows the viewing of the whole short film and narrative before animating a single shot. The 5-minute animatic uses English narration and Portuguese subtitles to allow both languages to understand the narrative, ensuring the translation is as accurate as possible to remove any risk of misinterpretation. Some of the vocabulary and complex words in the original text were swapped for their modern counterparts, and a few introductory words and expressions were added in between the extracted quotes to match the pacing of the animation.

As for audio, the short film places a focus on complementing the written source material with the animated visuals, as a decision was made that the sound effects should not overwhelm the viewer with audible information atop the narration. The sound design in the animatic, though basic, created precedent to highlight the narrator's voice, accompanying it by foley that immerses the viewers in the visible actions, such as the footsteps of the Englishmen walking through the forest or the shovel hitting the ground as they dig. Alongside these diegetic sounds, the animatic also includes non-diegetic effects that imply the actions or locations not distinctly shown on screen, for example, using the sound of splashing water to imply the Englishman's body hitting the ocean offscreen instead of

actually showing the gruesome event, or the bells ringing in the distance to signify that the current scene takes place in close proximity to a church.

The narrator's voice used for the animatic was attained through an AI voice generator from ElevenLabs [58] while the script and pacing of the animation were still in development. This AI voice was used until the later stages of post-production, where it was eventually replaced by a real voice actor hired to be the narrator for the final animation.

The full animatic can be viewed in the following link: https://tinyurl.com/ParadiseEndsAnimatic

3.6. Late 17th Century Character Designs

Visual development is the process in which visual representation brings characters, worlds, and stories to life [10]. This process is used to explore and establish the look of a film, using the story and its culture as a guide [10], and in the case of this project, the ethnographical research of Madeira Island [56] and art styles of 17th century Europe.

The story chosen for the documentary takes place in 1689, late 17th century, and features figures like English foreigners, Portuguese people, and Madeiran Priests. To comply with the scope of the project, these characters were simplified and broken down into three distinct designs: the Madeiran Priest, the Portuguese Gentlemen and the English Merchant (Figure 30).

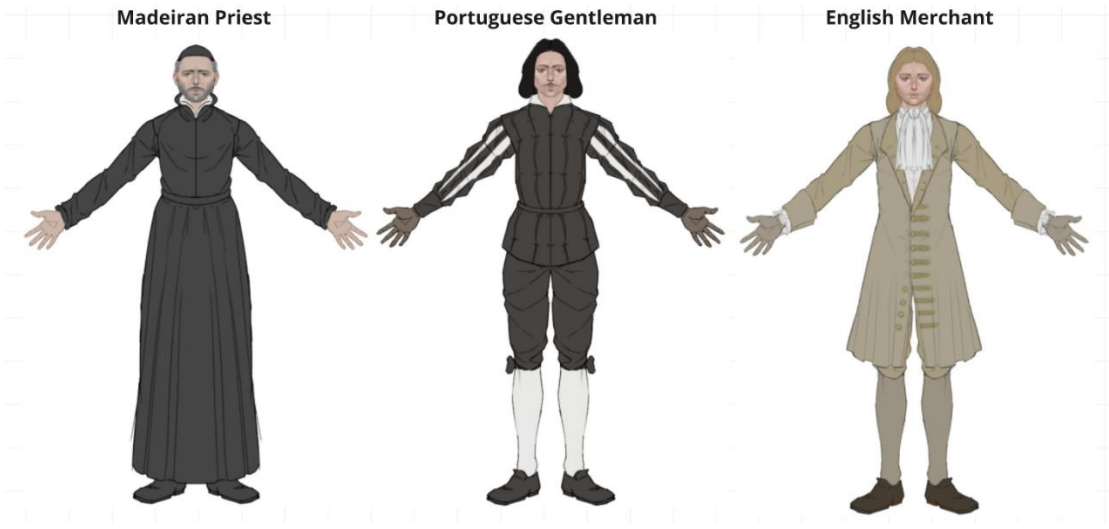


Figure 30 - Late 17th Century Character Designs

The character's concept art was hand drawn in Photoshop, parting from the same body proportions, as they were designed to be compatible with interchangeable clothes and accessories between each other, such as hats and capes, to simulate small crowds with minimal animation. Additionally, the Priest and Merchant's faces are variations of the Portuguese Gentleman's, having only been distorted and recolored to achieve their variants, a technique which was also applied in 3D during Production to reuse the same head model across each character (Figure 31).

Figure 31 - Character Face Variations

The visual design of these characters was based on ethnographic research of late 17th century people, using descriptions taken from intertextual sources, such as other texts from the same time frame included in Aragão's book [1], as well as documents on the history of 17th century fashion trends [59] (Table 2).

Table 2 - Late 17th Century Main Clothing Items

Portuguese Man & Priest Clothing	**English Merchants** Clothing
Source: *"A MADEIRA VISTA POR ESTRANGEIROS 1455 - 1700" António Aragão [1]* **1687** – *"A VOYAGE TO THE ISLANDS MADEIRA (…)"* – *Hans Sloane* ∘ "(…) some People living here to an hundred years of age." - "Every Tradesman wears his short Doublet, and for the most part a black Cloak, under it a long big hilted Dagger (…)" ∘ "(…) I have not seen any where more accomplished Gentlemen than here (…)" **1689** – *"A VOYAGE TO SURATT IN THE YEAR 1689"* – *John Ovington* ∘ "The People (…) are cloathed all in Black, in complaisance (as I imagin) to the Sacerdotal Function (…)"	***Source:*** *17th Century "Fashion History Timeline"* ***[59]*** **1670-1679** - "(…) the doublet had been thoroughly displaced by the justacorps, a long collarless coat, typically worn open with a vest and breeches (…)" - "The cravat was now the dominant form of neckwear, displacing the lace collar." **1680-1689** ∘ "Most men gave up facial hair preferring to appear clean-shaven" ∘ "Older children of age 5 or 6 would be dressed in a similar fashion to their parents." **1690-1699** ∘ "There was less braid, embroidery and trimming than in previous decades with ribbons finally passing out of favor(…)" ∘ "Coats and waistcoats were often left open from the waist up, which revealed much of the shirt and cravat (…)"

Additionally, multiple artworks and paintings [60] which depicted the 17th century and its people were used as visual aids for these written descriptions (Figure 32). The artworks used to aid in the designs of the Madeiran priest and gentleman come from depictions of Lisbon and in some cases Spain [60], for a lack of 17th century artworks which specifically pertained to Madeira Island. However, as the intertextual sources confirm [1], Madeira was largely populated by denizens from the mainland and maintained their costumes for a few centuries before evolving into the traditional Madeiran "Vilhão" and "Vilhoa" clothing visible in early 19th century artworks of the island [1]. Additionally, these artworks of 17th century Lisbon were also used to approximate the building

materials and architecture of Madeira complemented by the intertextual descriptions of Funchal found in the same book [1].

Figure 32 - Portuguese Man and Reference Painting, Adapted from [61]

As the goal of the documentary is to disseminate a factual account and preserve its source material, likewise the characters in the animation should also uphold a certain degree of historical accuracy as portraying 17th-century religious conflicts, with, for example, 19th century traditional Madeiran clothing would cause the viewers to misinterpret the conflict as having continued for many more centuries afterward. To this end, the characters in the short film were designed to portray a convincing summary of the costumes worn by both cultures at the time, rather than unattainable absolute historical precision.

3.7. 17th Century Paintings and Art Styles:

As the goal of project is to make an animation that resembles an old painting, a traditional art style had to be chosen as inspiration, and preferably, one prevalent around the 17th century and cohesive with the thesis' artistic goals. The choice of art style was dependent on three major factors:

- ***Relevancy to the themes of the animation*:** The art style must convey a serious, historic feel, appropriate for a documentary and the period of its themes, while avoiding overly colorful or cartoonish depictions.

- ***How far it strays from realism*:** An art style which doesn't simply aim to recreate reality, rather interpret it, to comply with the NPR focus of the project, allow for a degree of abstraction in Madeira's representation, and avoid the animation looking like an old photograph, and more of a flat painting.

- ***How well it can be replicated with contemporary NPR tools*:** Taking into account the stylization methods and tools currently trending or available, their accessibility, ability to comply with the scope of this project and the time and skill required to replicate them.

The most predominant art style of the 17th century was the Baroque [62], and in parallel to the documentary's theme, this art movement "occurred during an era of deep religious, cultural and social unrest" [62]. Baroque painters often focused on expressing movement, emotion and drama, using highly contrasting lighting to direct attention to the central actions or figures in their artworks. This use of lighting and strong contrast to highlight subjects and actions was taken into consideration for *Where Paradise End*'s compositions. However, the highly realistic depictions of Baroque paintings directly contrast with the thesis' goal of incorporating non-photorealistic rendering techniques, as it would risk the animation looking like an old photograph rather than a flat painting, while requiring much higher quality models, assets and textures, removing any room for visual abstraction and demanding considerably higher artistic ability to achieve a pleasing result.

Therefore, the project's possible reliance on these kinds of intricate paintings was discarded in favor of more abstract art styles like sketches, engravings and watercolor paintings, all of which were equally prevalent from the 17th century onwards. While these styles comply with the first two requirements of proving relevant to the time period and allowing for a degree of abstraction, they had to be experimented with to evaluate their ability to be translated into 3D through non-photorealistic rendering and deduce how these styles could evolve as the animation's production progressed.

3.8. 3D Stylization Experiments

The standout of this project is its visual development phase, a crucial chapter in producing stylized 3D animations and experimenting with procedural materials in the context of non-photorealistic rendering, as there is no master method for stylization, and NPR is a relatively recent trend in the animation industry, these workflows vary greatly depending on each project's artistic vision and creative goals. Traditional art forms like paintings, sketches and engravings rely on physical mediums and materials. Consequently, many of their recognizable features result from "imperfections" characteristic of their real-world applications (e.g. Watercolor drying at different rates resulting in light uneven coats of paint, or graphite pencils creating noisy and heavily textured lines) [3]. The challenge lies in digital software reproducing no such imperfections, so these must be artificially introduced to recreate these traditional art styles convincingly [3]. Before settling on the animation's final style, multiple experiments were necessary to understand the possibilities and limits of non-photorealistic rendering and procedural materials in emulating the traditional art styles previously mentioned, in order to set a stylistic goal, develop an optimized workflow and create a solid baseline for the final animation's visuals.

3.8.1. Program Choice - Blender

To optimize the workflow and simplify the production pipeline, a decision was made for the animation to use the least amount of software, resorting to a single program for modeling, texturing, animating and rendering [4]. The program selected for the final animation was Blender [34], a free open-source 3D software which was chosen for its accessibility, available learning materials and ease of use. It features a multitude of convenient tools applicable for every step of the 3D animation

pipeline, and especially non-photorealistic rendering capabilities, exemplified by the recent award-winning stylized animated film, Flow (2024) [33], which was completely created and rendered in Blender.

As Blender is a free 3D software, there is a plethora of accessible materials and tutorials made by independent artists [36], as its accessibility allows casual users to engage in more creative projects that go beyond the traditional 3D pipeline. On the other hand, a software like Autodesk Maya, which is considered the industry standard [63], is thought of as majorly inaccessible for its subscription-based business model, resulting in a lack of a casual userbase and, consequently, a distinct shortage of independent tutorials and materials that actually go beyond the "industry standard".

○ Techniques and Tools:

Blender features two tools that make it stand out as the best choice for this type of project: Blender's ***Shader Editor*** is used to edit materials and textures which are used for rendering, these materials are defined using a combination of connected nodes which define its appearance and behavior [64]. This type of node-based material editing is a common feature in many 3D software such as Maya's "Hypershade" or Unreal Engine's "Blueprints", however, Blender's version stood out for its plethora of customizable nodes, intuitive user interface, and especially the amount of available free learning materials on procedural materials.

Blender's ***Grease Pencil*** is a multi-use tool that can be used to make traditional 2D animations, cut-out animations, motion graphics or outline objects [65]. The highlight of this tool is its ease of use, as it can be added to any 3D scene to automatically outline every 3D object within the camera frame, this outline can also be customized to apply a multitude of line art techniques, changing its shape, length, and texture among many other additions useful in recreating traditional stroke-based art styles (Figure 33).

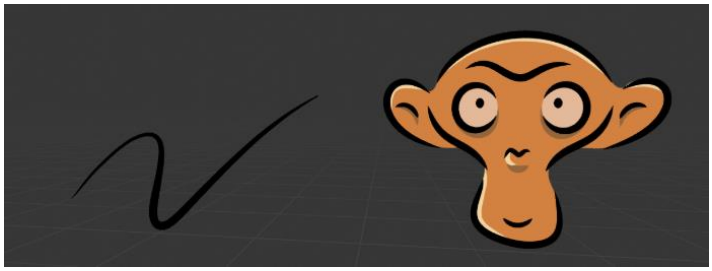


Figure 33 - Grease Pencil Outlining A 3D Model With A Custom Line Shape, Adapted from [65]

The biggest advantage of developing a 3D project in Blender is its popularity and accessibility amongst indie creators, which have created a plethora of online tutorials, communities, and guides, detailing their methods of recreating all manner of styles and techniques, from unique personal projects to trending works in the animation industry, with some even sharing their project files for in depth analysis. All of these accessible learning materials, can be studied and adapted to fit a specific project's needs and goals, which was a crucial step in developing *Where Paradise Ends* and the NPR experiments preformed during its pre-production.

3.8.2. Creating And Understanding Procedural Materials (Donut)

To test these tools, the experimentation methodology was to create basic scenes and models using a traditional 3D production pipeline and then test different forms of stylization on the same subjects to become familiar with the limits and capabilities of NPR within Blender, comparing the effects and results between them to deduce which techniques would be best suited during the later stages of style selection.

3.8.2.1. Realistic Donut:

The first step was to model a basic scene, here, the test subject was a donut and a plate, inspired by the renown "Donut Tutorial" [66], a series of YouTube Blender lessons made by Blender Guru, which were taken to learn Blender's functionalities. Here, the subject was modeled, textured and rendered using a conventional 3D pipeline, complete with realistic materials and rendering (Figure 34).

∘ Creating a Material in the Shader Editor:

In Blender's shader editor, a material is comprised of a shader node and an "output" node. Any additional nodes connected to and from the shader, which ultimately enter the output, will affect the final appearance of that material. To create a conventional realistic material, in the shader editor, the output is assigned a "*Principled BSDF*" shader by default, as it contains inputs for every property that a realistic material can portray and affect. **Base color** defines the surface's main color. A simple material can be created by connecting either a solid color or an image texture to this input. To create a more realistic and interesting looking surface, a **normal map** – which is a texture which simulates a high-resolution surface with details and depth, altering the manner in which light interacts with the material, without actually adding or changing the 3D model's geometry – is connected to the shader to emulate an intended surface texture. Additional inputs like "Metallic" and "Roughness" do exactly as advertised, increasing those properties in the lighting behaviors of the material evenly from a set value, or in specific spots defined by a 2D image. The more nodes and textures are input into a material, the more complex it becomes.

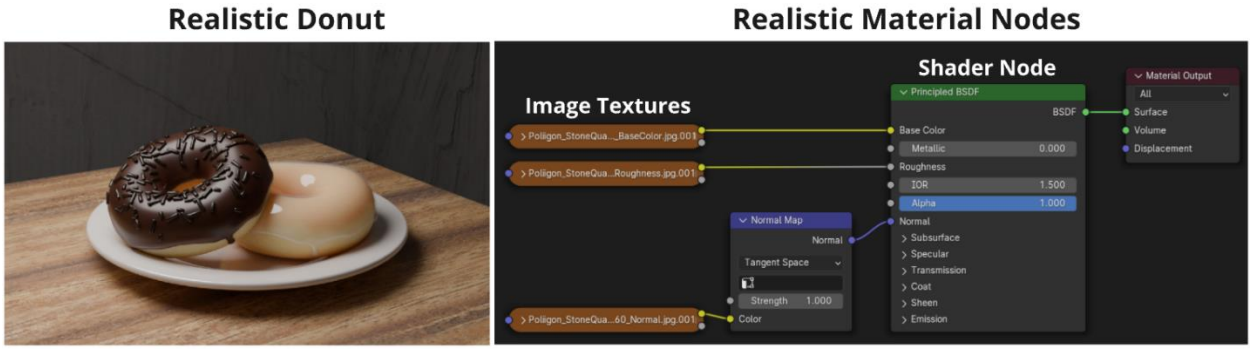


Figure 34 - Realistic Donut Modeled Textured And Rendered In Blender

3.8.2.2. Cel-Shading:

Having learnt Blender's tools and experimented with the shader editor, the next techniques tested were cel-shading and an initial version of the "painted" procedural material, as these are the most prominent and relevant styles in the contemporary NPR works studied in the state of the art.

- **NPR Render Settings:**

To set up a Blender scene for stylization and NPR, the renderer and project settings must first be changed from their default realistic options. EEVEE is one of the two default renderers included in Blender. While its counterpart Cycles specializes in photorealistic rendering using physically based path tracing, EEVEE uses rasterization, meaning it estimates light interactions through algorithms rather than individual light rays [35]. This results in considerably faster rendering but produces less realistic results than Cycles, and while this "flaw" would be considered a downside in conventional 3D renders, this quality makes EEVEE the ideal choice for NPR and stylized projects. Evidently EEVEE is the standard engine used in essentially every stylized 3D rendering Blender tutorial, and most recently showcased in the award-winning stylized 3D animated film, Flow [33].

- **Cel-Shading:**

To create cel-shading, a "Shader to RGB" node restricts the shader's light values to inputs defined by a color-ramp. Here, the ramp's transitions are changed from "Ease" to "Constant", breaking down the object's shading into hard values rather than smooth gradients (Figure 35).

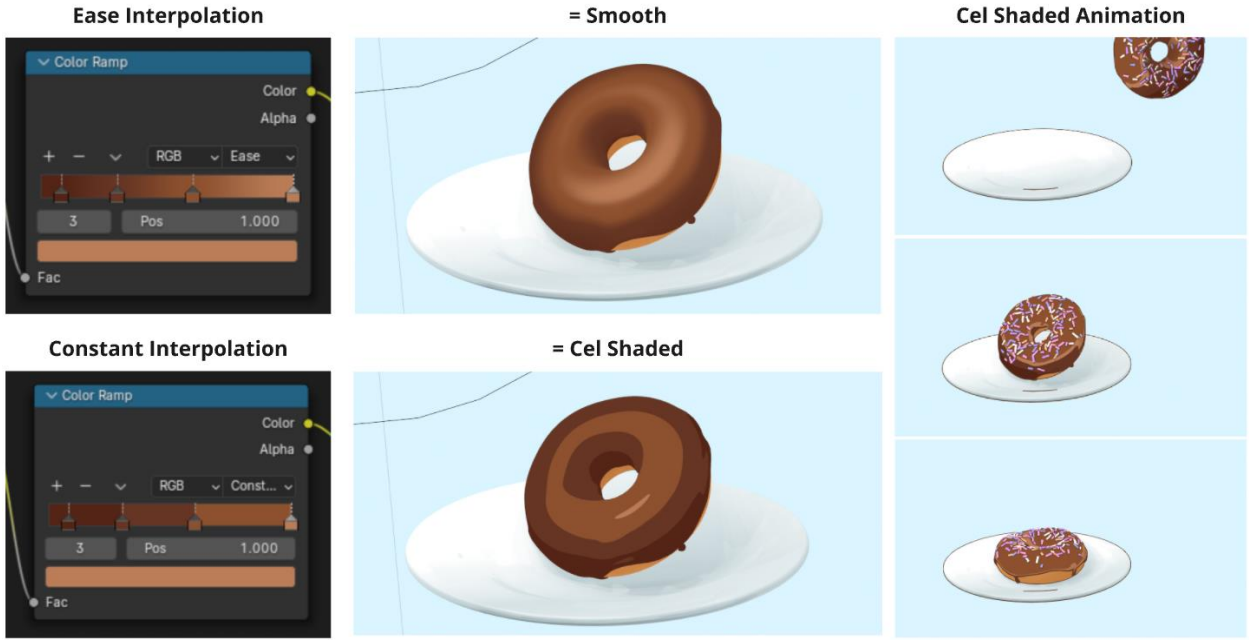


Figure 35 - Effect of Shading Interpolation in Cel-Shading

With the cel-shader created, the Grease Pencil Outline was then added to the scene, this was done by adding a "Collection Line Art" object in the scene and selecting the group which the donut is in to automatically outline it from the camera's point of view (Figure 36).

Figure 36 - Grease Pencil Addition Process

3.8.2.3. Painterly Material:

This technique was based on a tutorial for a "Watercolor-Like Shader" by Kevandram [67]. With this technique, using the previously developed color ramp for cel-shader, the interpolation is switched from "Constant" to "B-Line". The highlight of this shader is the use of a Voronoi texture, which resembles a randomly "cracked" surface, which is affected by a Noise texture to make the "cracked" surface more organic. The resulting texture is then applied to the normal map of the object, which effectively breaks up the surface of the material into randomly generated organic "flakes". This restricts the transition between the light and dark values of the shading into solid blotches of color, resembling brush strokes. In this material, scaling and rotating the Voronoi texture defines the "brush's" size and dynamics, while the color ramp in front, similarly to the cel-shaded material, defines its colors and values (Figure 37).

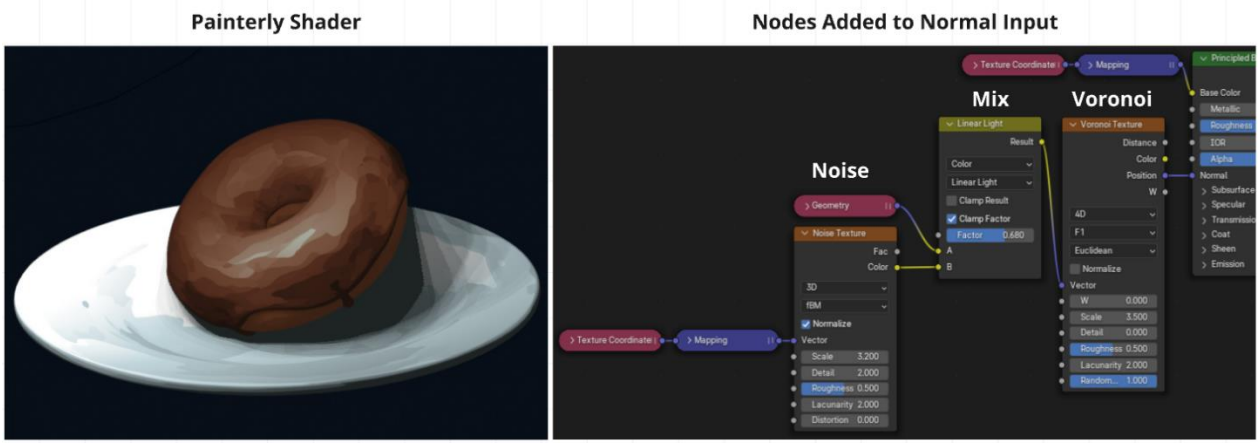


Figure 37 – Donut Painterly Procedural Material and Nodes

Having experimented with the common stylization techniques it was clear that the "Painterly" material would be the most applicable for this project as it has the closest resemblance to a traditional artwork (Figure 38).

Figure 38 - Stylization Techniques Applied to 3D Donut

3.8.3 Customizing Procedural Materials (Still-Life Composition)

Here, the next step was to adapt and customize the procedural materials to recreate select traditional art styles like oil paintings, engravings and pencil sketches, to create a baseline for the final animation's style and material. A still life painting "Red in Front" by Qiang Huang (Figure 40) was used to experiment and define a stylization workflow on smaller props and compositions before moving onto the larger scenes required for the final animation. The props in the painting were modeled accordingly, then the stylized materials were applied to the scene. The styles experimented with this subject were the painterly material used on the donut, altering its parameters attempting to emulate the original artist's style, as well as a new cross hatching and etching based technique inspired by the artworks included in Aragão's book [1].

3.8.3.1. Painterly Material:

The painterly material developed on the donut was edited to allow for stronger highlights, colors, and textures, this was achieved by inputting a "Paint Brush" texture in between and after the "Noise" and "Voronoi" textures added previously. This paint brush texture changes the previously blotched pattern into highly textured brushed ones. It is at this point that procedural materials highlight their versatility, iterative process and complexity, as they become more convoluted with each added node and parameter, highlighting the importance of understanding each node's behavior and how to manage them (Figure 39).

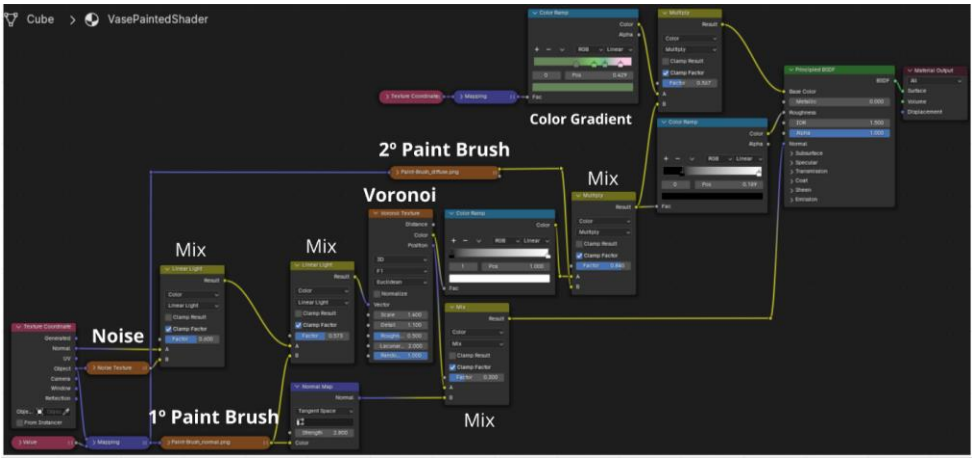


Figure 39 - Vase Painterly Material Nodes

The material was also assigned a vertical color gradient to add color variation within the objects themselves. For example, making the apple fade from red to yellow as it approaches the stem, or the grapes fade from pink to purple to make them more interesting. Additionally, the outlines in this phase were created with the inverted-hull method (Figure 40), based on a tutorial by SouthernShotty [68], instead of the Grease Pencil used on the previous experiments (Figure 36).

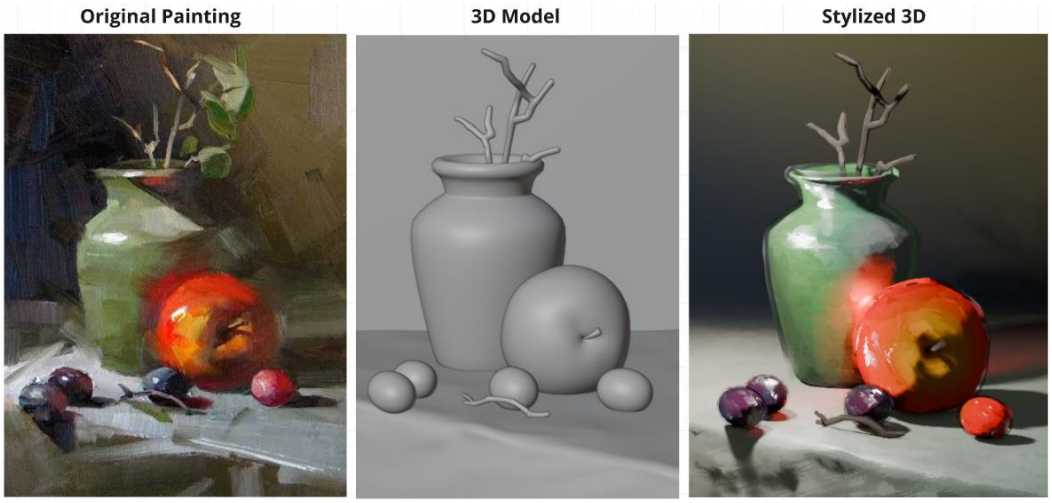


Figure 40 – Original Painting to Stylized 3D Version

3.8.3.2. Hatched/Graphite Drawing:

This technique was based on a tutorial by Toni Mortero [69], here a texture node applies a noise pattern to the shading creating randomly generated blank spaces. These gaps are then stretched infinitely in a singular direction to create thin and long breaks, reducing the shadowed areas to a collection of straight lines (Figure 41). These lines can then be scaled and rotated to achieve multiple hatching styles, or even overlayed on top of each other with multiple rotations to create cross hatching.

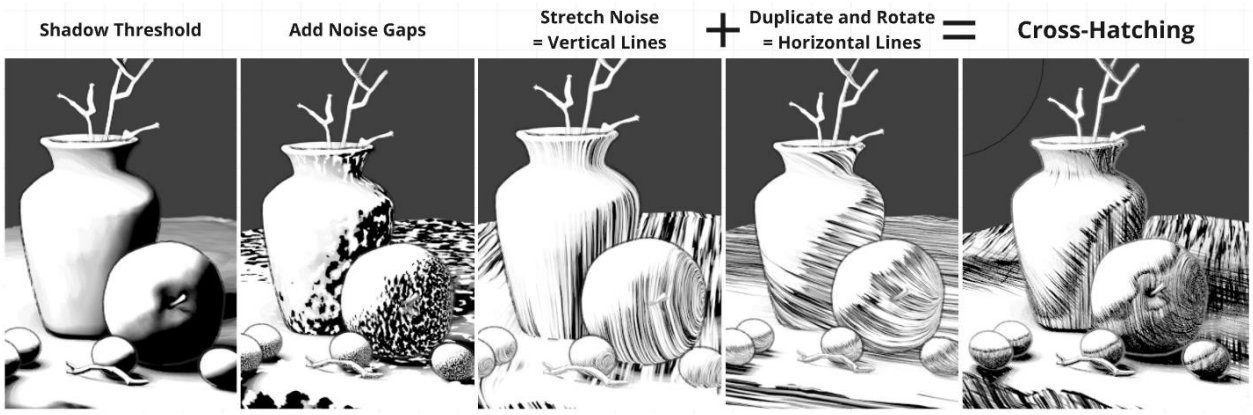


Figure 41 - Cross-Hatching Procedural Material Sequence

Thick and long lines dependent on the object's curvature emulate a strongly engraved image. Conversely, thinner, closer, and shorter lines emulate a sketch, graphite-like appearance (Figure 42).

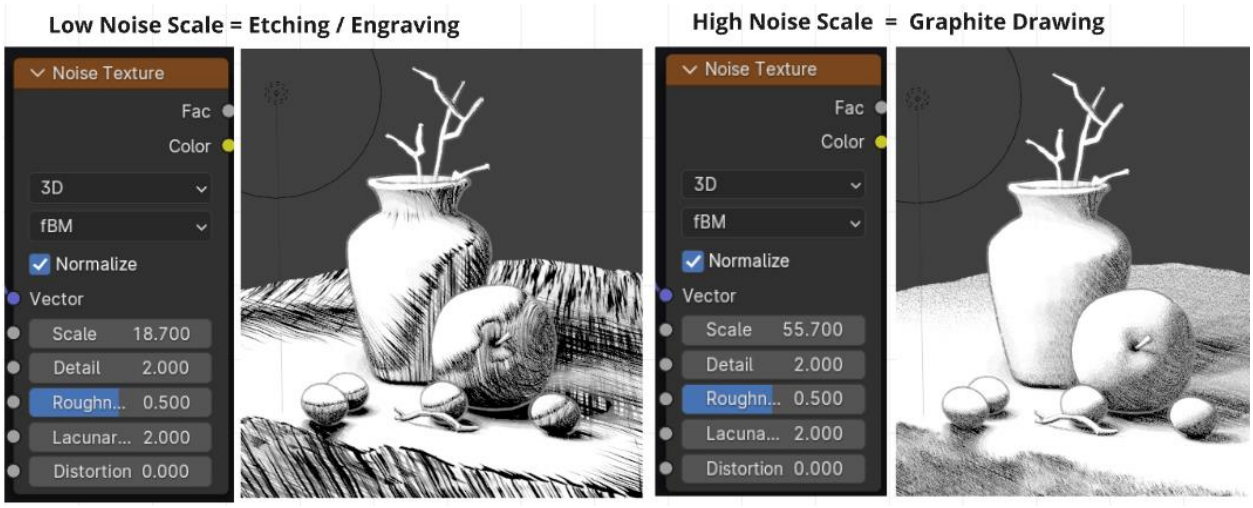


Figure 42 - Changing Line Thickness to Create An Etched Drawing or a Graphite Drawing

Effectively, both experiments preformed with this still-life composition proved successful in their implementation (Figure 43), emulating traditional painting and drawing techniques within stylized 3D, and proving that procedural materials are capable of emulating multiple styles by changing their select parameters (Figure 42).

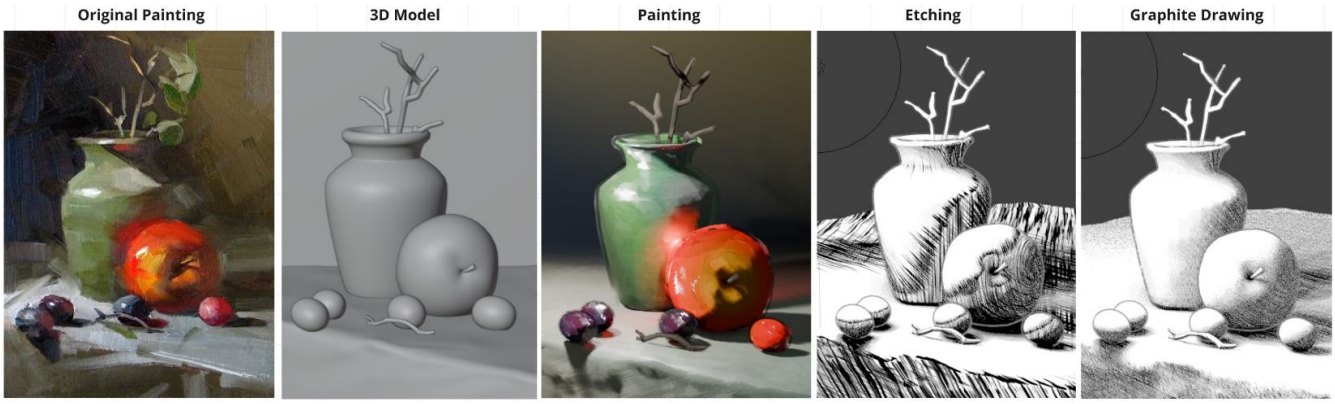


Figure 43 - Traditional Techniques Emulated in 3D

The etching and graphite materials have the closest resemblance to a hand-drawn image, as their focus on linework and two-toned approach strongly emulates a 2D appearance. Therefore, at this stage in the process, the visual development swayed towards etchings and line-work focused styles. However, during the later stages of production, the style eventually circled back to the painterly material after discovering the downsides of the etching approach, all of which will be further developed in the following chapters. The painterly material relies on strong use of colors and shape language to portray a scene correctly, and while it generates a more colorful image, it struggles to maintain a 2D appearance when compared to the other two methods, requiring more procedures to achieve a truly foolproof result, such as compositing and stylization image filters, both of which were experimented with and applied in the final documentary.

3.8.3.3. Initial Procedural Material Results:

After the experiments on the smaller compositions with different styles and varying results, workflow optimization stood out as the project's main concern, especially considering the bigger compositions required for the final animation. The workflow devised and applied for this stage of NPR experimentation was the following:

> 1º Block out the scene and match the camera perspective;
>
> 2º Model the prop/subject;
>
> 3º Assign the custom material;
>
> A) Ideally, use only 1 material per object/scene;
>
> B) Avoid secondary materials or modifiers for effects;
>
> C) Use custom object properties when applicable;
>
> 4º Adjust and customize the material according to the style desired;
>
> 5º Add and adjust the "grease pencil" outline;
>
> 6º Light the scene and render;
>
> 7º Import the render into Photoshop/Premiere and color correct/blend;
>
> 8º Repeat steps 4 to 6 until satisfactory.

Some important considerations and discoveries on procedural materials and the 3º step:

A) Procedural materials require a multitude of shader nodes resulting in a web of complex connections, and changing the attributes of a single node makes the altered material look out of place in the scene. Instead of copying that new node and replacing it on every single object, ideally the scene and props should rely on a single “master” material which can be adjusted freely and affects every model equally.

B) Some Blender stylization techniques require multiple modifiers on a single object (e.g. Displace modifier to warp an object’s surface). While this might produce satisfying results, any alterations to an object’s modifiers must be reproduced on every single other object present in the scene. Scenes with a lot of 3D models quickly become unmanageable, and depending on the modifiers used, extremely unoptimized.

C) Following the thought process of the first step, there are a few techniques applicable to optimize the project’s material list, one of the most promising was “Custom Object Properties”, a programmable attribute that can be used to alter the material’s behavior solely on the selected object. For example, this allows multiple objects using the same material to each have a different color, this property is assigned directly to the selected object and is unaffected by the others.

3.8.4. Compositing Procedural Materials (Replacing 2D Buildings With 3D Equivalents)

With an optimized workflow developed, the next step in the style development phase was to experiment with recreating traditional artworks that pertained to Madeira Island specifically, and most importantly, experiment with compositing techniques. The goal of these recreations was to replace one major building in a selected artwork with its stylized 3D model equivalent and then composite the computer-generated structure into the original image. This "hybrid" image would then be used to perform a casual test to see if individuals could notice which subject had been replaced by a 3D model. These experiments were meant to prove a satisfying replication of traditional art styles in 3D and achieve a convincing implementation of the research and tools acquired throughout the pre-production.

3.8.4.1. Black And White Etching:

The first experiment used "Santa Cruz" by Rev. James Bulwer [70] (Figure 48) as a base. This artist's etching style features a prominent cross-hatching technique, as well as noticeable vertical lines that denote the facade of buildings, including some lightly sketched outlines and high contrasting shadows. The building was modeled accordingly, and these features were promptly added and adjusted in the engraving material developed for the previous vase.

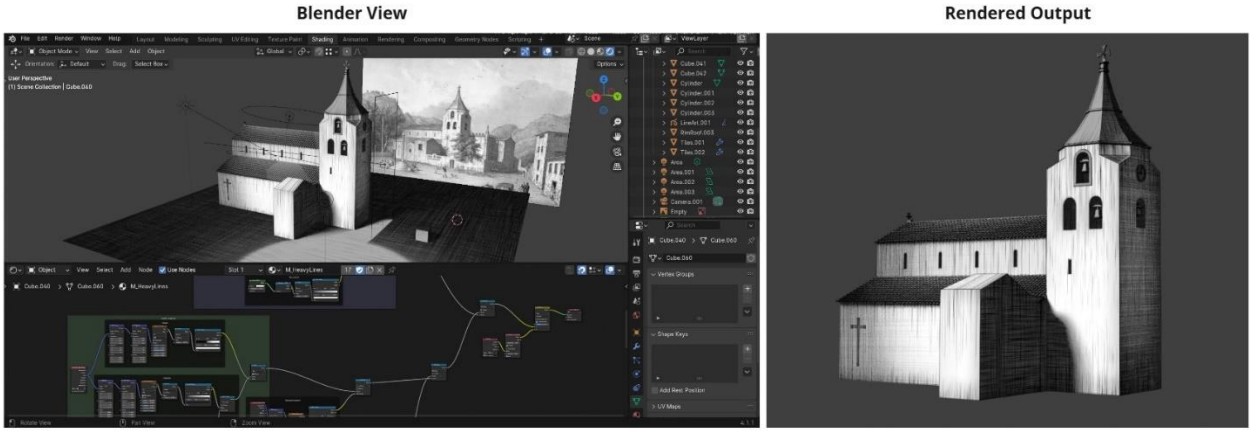


Figure 44 - Etched Building Blender Model and View

This version of the procedural material features three types of hatching – vertical, horizontal and decorative.

- **Vertical and horizontal** hatching are affected by the scene's lighting and represent the objects' shading just like in the Vase experiments. However, in this version, in light areas, only the vertical hatching is visible, while in the dark areas both the vertical and horizontal hatching are visible, as the horizontal lines are restricted to only show up at lower light values. This emulates the real application of the cross-hatching technique, which layers on multiple stroke directions to darken a shadow and indicate volume (Figure 45).

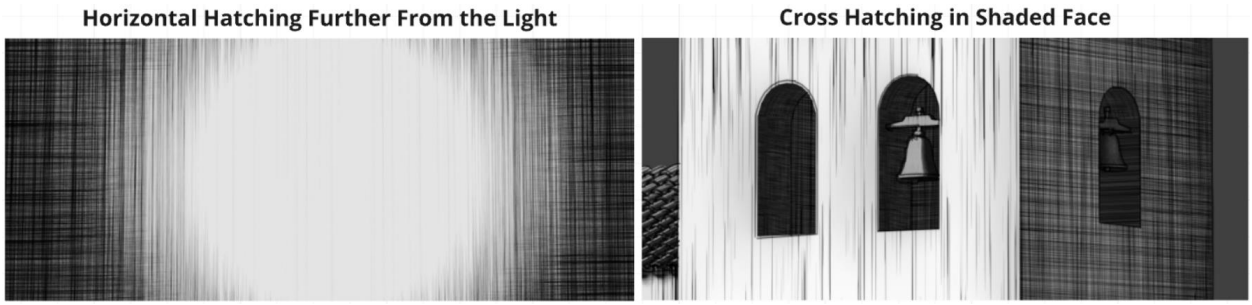


Figure 45 - Dynamic Cross Hatching

- **Decorative cross hatching** is visible in every lighting situation (Figure 46). These vertical lines are prominent at the top and bottom of a building, adding texture to an otherwise flat face. This hatching was used to imply rain degradation from the rooftops (Blue), and dust and dirt gathering around the building's base (Green).

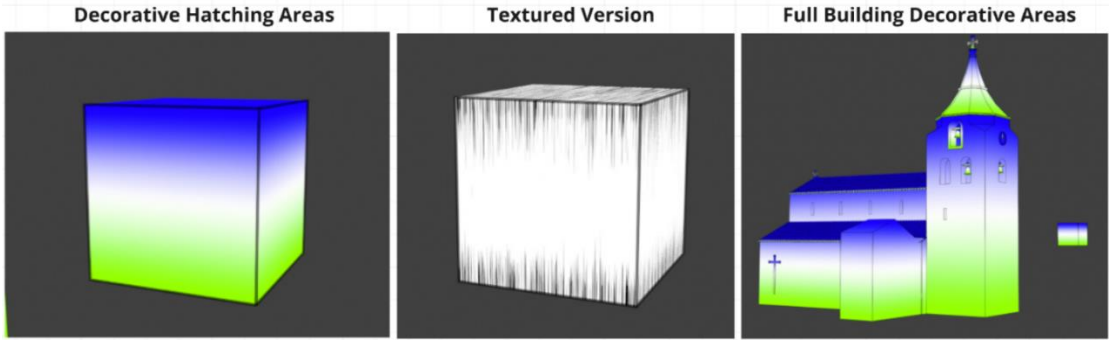


Figure 46 - Decorative Hatching Gradient

With the final textured building the render was imported into Photoshop, where it was composited into the original artwork, adding noise and color correction to match original image's quality and contrast. Additionally, the trees and buildings which were present in front of the original building were masked and placed in front of the 3D render to correctly composite it into the image (Figure 47-Figure 48).

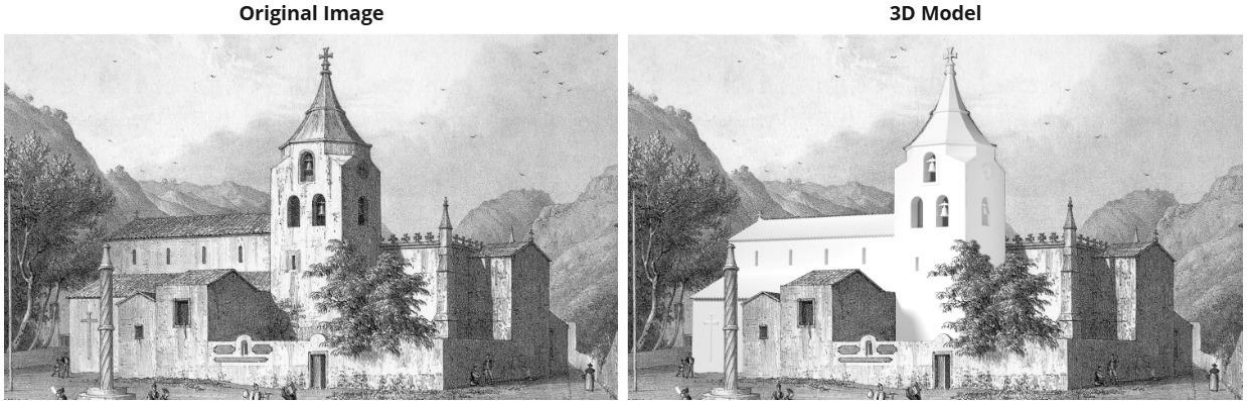


Figure 47 - 3D Building Composited In Original Artwork [69]

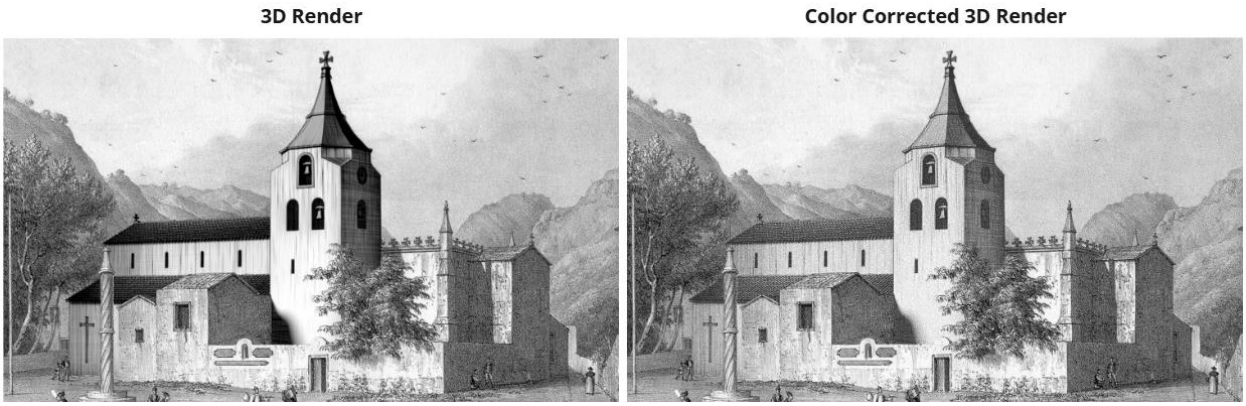


Figure 48 - 3D Stylized Building Color Corrected into Original Artwork [70]

3.8.4.2. Colored Lithography:

The second experiment used "Convento de São Francisco" by Frank Dillon [71] (Figure 51) as a base. This colored lithography features light outlines around buildings, hard cast shadows and overall low contrast. The building was modeled accordingly, and these features were promptly added and adjusted in the cross-hatching material developed previously. Here, the lines were made fainter, thinner and tighter (Figure 49).

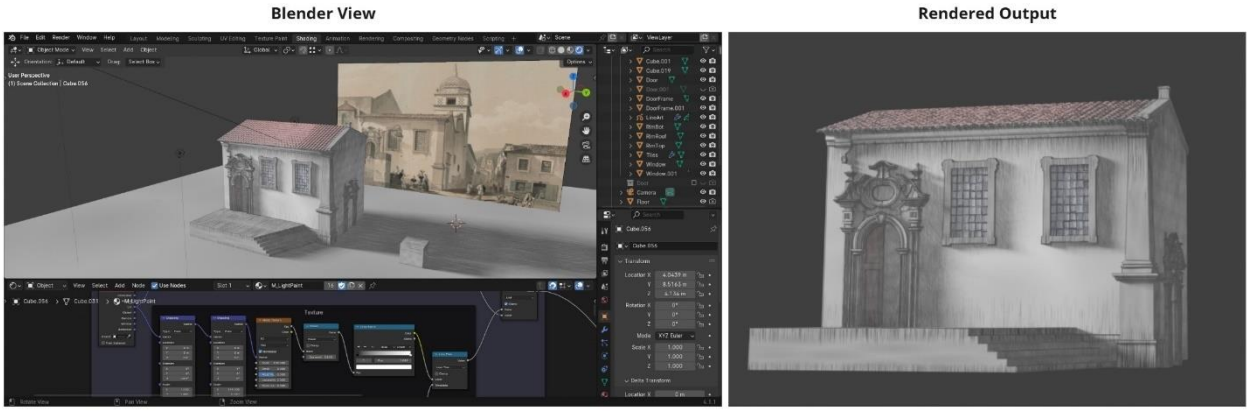


Figure 49- Colored Lithography Building Blender Model

However, the addition of color demanded further additions. A custom object property was added to every object that makes up the building, such as red for the roof tiles, brown for the door, blue for the windows, and white for wall façade. This custom property named "matcol" (material color) allows an RGB color to be assigned to each object in the viewport. Then, in the shader editor, a custom attribute node was added at the end of the procedural material, mixing the cross hatching shader with the RGB value assigned to the object, coloring each part of the building individually, without having to use multiple materials for a single scene (Figure 50).

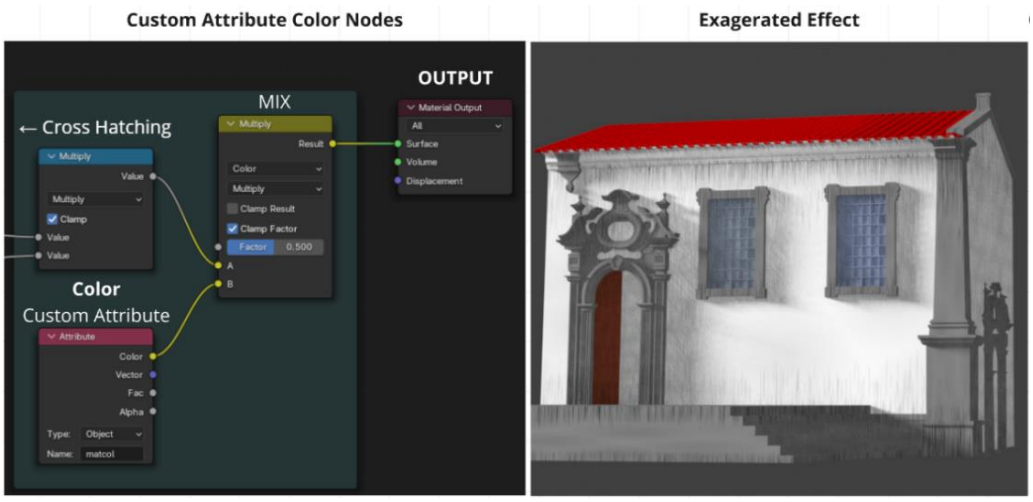


Figure 50 - Custom Object Property In Use

To make the building look dated and match the rest of the artwork, the render was taken into the Photoshop file used for the black and white etched building. Here, the filters and layers were tweaked to apply the sepia color correction and textures to the rendered image. This process was repeated for each iteration of the material until it reached a pleasing result (Figure 51).

Figure 51 - 3D Stylized Building Composited In Original Artwork [71]

3.8.4.3. Building Replacement Results:

Both of these experiments were successful in their applications, as during casual showings of the final composited images to a small selection of individuals, viewers were surprised to discover that the main subject in those pictures were not actually hand drawn. Additionally, these tests proved fruitful in further developing and understanding the custom properties of procedural materials, as well as compositing procedures, as it evidenced that the colors, contrast and multiple features of the render could be customized after a render was exported. For example, rendering the building with high contrast and strong colors, and in post-production lowering its values and saturation to achieve a "dated" look. Another major feature in emulating a dated appearance is adding that artwork's medium on top of the 3D render. For example, adding a paper texture in an "overlay" mode onto the 3D building to emulate it having been painted on top of that same paper. Additional effects such as noise, grain and artificial sharpening can be added to the 3D rendered building to match the low resolution of the digitalized painting to aid in selling this effect further.

Art styles closer to sketches and paintings can be more accurately stylized as their lack of complex detail allows for a bigger departure from perfect geometric details. When attempting to emulate fairly detailed paintings techniques, as seen on Figure 51, 3D stylization faces a pitfall. The fairly high level of detail and lack of artifacts (visible brush strokes or strong linework) creates a tendency to emulate an "old photograph" as opposed to a 2D drawing, especially concerning buildings or geometric props, as the procedural materials have proven to be the most effective method to texture these kinds of inanimate objects quickly.

These experiments were solely meant to develop these stylization techniques on one subject "surrounded" by a 2D style to then match and blend the 3D within it. The final animation features fully 3D modeled sceneries and characters for maximum flexibility in animation and visual development, as opposed to Figure 48 and Figure 51, since using any outsourced 2D assets or paintings integrated within the 3D scene would restrict the 3D animation to only the available artworks' perspectives, subjects and styles.

3.8.5. Using Procedural Materials (Creating A Full Composition)

3.8.5.1. Building Composition & Applying Procedural Material:

The goal in this chapter was to create a fully computer-generated scene, textured with a singular procedural material in order to analyze the implications of creating full compositions with this method. Here, the previously modeled buildings were duplicated and assembled to form a makeshift alley composition, not adhering to any specific painting or real-life location. Here, the procedural material created for the sepia lithography was applied to every asset in the scene. In a full composition, however, the pitfall of this style looking like an old photograph rather than a painting was more evident than ever, proving that overly "clean" styles with a low amount of visual artifacts or

imperfections struggle to maintain the illusion of 2D art, further exacerbated in CGI compositions with highly geometric forms such as buildings (Figure 52).

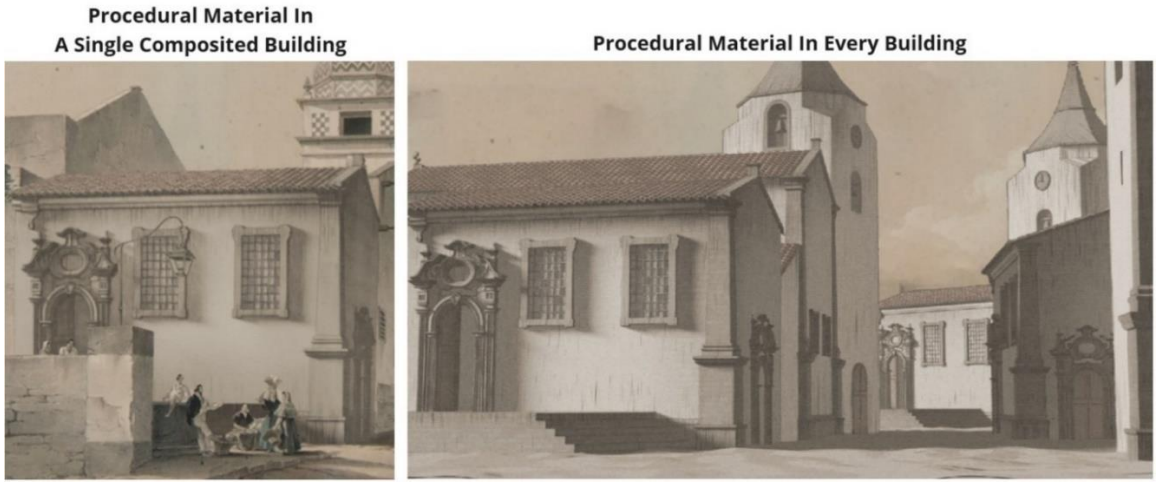


Figure 52 – Procedural Material Applied to A Full CG Scene

To combat this, the Grease Pencil outline was made thicker, darker, and given a "noise" modifier to make the buildings' outlines look warped and inconsistent. Likewise, the material's cross-hatching was made considerably more prominent, aiming for a low contrast and low saturation, lightly engraved lithography with a strong emphasis on sketchy linework to enhance the style's "hand-drawn" qualities and avoid the "old photograph" feel (Figure 52). With the completed material, in Photoshop, cinematic black bars and subtitles were added on top of the render to create a makeshift screenshot of how a shot from the final animation could look with this style and determine if this was the right visual language for *Where Paradise Ends*.

Figure 53 - Full Stylized 3D Composition - Makeshift Film Screenshot

3.8.5.2. Full Composition Results:

This engraving style relies on cross-hatching and strong linework and worked fairly well in an urban environment with solid and straight geometric shapes. However, it was speculated that the style would struggle when applied to scenes with a multitude of vegetation and organic elements, both of which make up a majority of the animation. This finding proved truthful in the later stages of visual development during the project's production, as once the trees and vegetation were fully modeled and assembled into a composition, any excessive texturing on the models was multiplied tenfold creating an extremely noisy image, in which the outlines and cross-hatching textures around every leaf, branch and character generated too much visual noise, making depth, movement and visual accuracy difficult to ascertain, especially when viewed in motion.

3.8.5.3. Reworking The Style:

Based on these results, a decision was made to move away from etchings, engravings and linework focused techniques to embrace a more painterly style for the final animation. Watercolor works and sketched paintings allow for the use of shapes and colors to infer context in a more abstract fashion, allowing for less detailed models and textures, creating a simpler and more visually pleasing image. Therefore, using the same composition, the material was altered, removing the cross-hatching lines and replacing them with plain cel-shading. To compensate for the removal of the hatched textures and reintroduce artifacts to the image, a paint brush texture was added to the material breaking up the uniformity of the colors, which were also made more vibrant to move away from the bland linework style into a more abstract and painterly one (Figure 54).

Figure 54 - Watercolor Stylization in Full Composition

This style was ultimately inspired by a 18th century watercolor artwork by Samuel Davies, dating back to 1779 [72] (Figure 55), which was one of the oldest paintings of Funchal used as reference during this project's production.

Figure 55 - Original Painting [72] and Stylized 3D Emulation

3.8.5.4. Pre-Production Stylization Experiments Conclusion:

Effectively, the stylistic goal for final animation had been mostly defined, as the film was now set to emulate a faded watercolor painting, with low saturation and low contrast, containing sketched graphite outlines on a sepia-colored paper (Figure 55). However, both of these styles still proved successful in their applications, each with their own pros and cons (Table 3):

Table 3 - Etching VS Watercolor Material

Etching	Watercolor
Pros: - Strong hand-drawn and traditional art appearance - Rich texture and graphical look - Strong emphasis on linework and shading	Pros: - Vibrant painterly aesthetic - Allows for abstract depictions & less detailed models - Strong shape language
Cons: - Linework focus requires detailed models to correctly apply outlines - Excessive and repetitive texturing overwhelms the image - Lack of strong colors limits artistic flexibility and results in a heavily monotone image	Cons: - Lack of linework makes it harder to emulate a flat 2D illustrations - Color adds complexity and requires greater artistic sensibility - Small details are lost in overly abstract versions

4. PRODUCTION

With the story and characters defined, as well as the initial phase of visual development complete, the project moved on to the production stage. The production stage of the animation is when all of the final visual elements of the 3D project are created [8], transforming the concepts developed in the pre-production into their fully realized versions, culminating in a close to final product. This chapter was split into four main phases - asset creation, visual development, animation and rendering.

4.1. Asset Creation

4.1.1. Characters:

The animation features three main types of characters, each with distinct designs – the *English Merchants*, the *Portuguese Gentleman*, and the *Portuguese Priest*. Additionally, some shots also feature crowds of various *Madeiran Citizens*, as well as two deceased characters – the *Dead Merchant* and the *Dead Child*. Summed up, counting re-colors, there are a total of 14 characters that showed up in the final animation. As the animation features a multitude of characters, costumes and crowds, the modeling phase required thorough planning to optimize the time and effort required to create all of these assets within the allocated timeframe of one month. In this phase the plan was to fully model and optimize one character (the Merchant) and then modify that character's assets to create the other two key designs. Then, with those completed and optimized models, mix and match their clothing items to create the various outfits for the bystanders and background characters.

4.1.1.1. Body:

First, the characters' concept art was imported into Blender as 2D image planes to be used as a guide during the sculpting and modeling processes, including their unclothed base to model the body. The base mesh of the body was blocked out and then refined through 3D sculpting, with mostly realistic anatomical proportions (Figure 56). While the sculpted mesh is high in polycount, the body itself has relatively low detail since it will not be included or visible in the final models, as it serves only as a base to model the clothing on top of at a later stage.

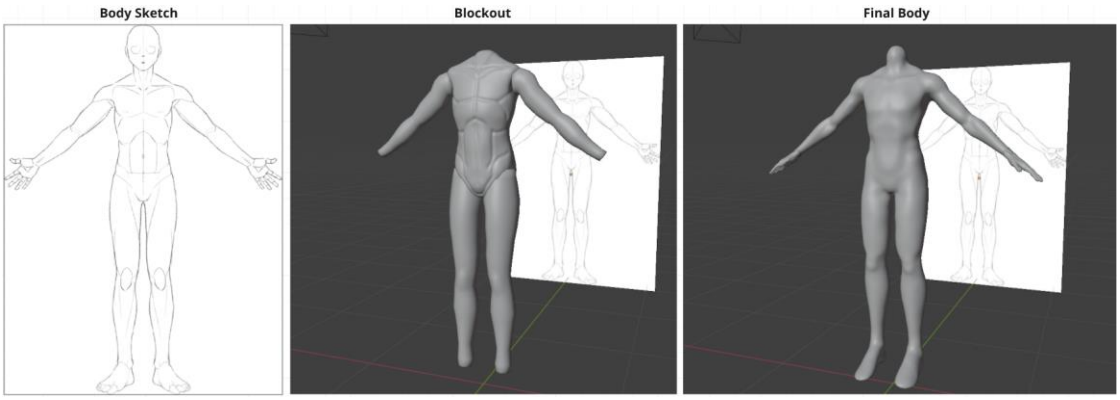


Figure 56 - Body Sculpting Sequence

4.1.1.2. Head & Face:

The character's head was 3D sculpted, loosely following the faces drawn in the concept art. This process involved sketching out the basic head and face, then refining its anatomy and details, all the while stylizing it accordingly throughout the process. The sculpting style employed was purposefully slightly jagged and geometric, this was accomplished by flattening certain features of the face and breaking down their curvatures into larger geometric forms, similarly to anatomical drawing guides. This technique was used to make the characters more visually appealing through simplified proportions and shapes (Figure 57).

On the other hand, besides being a stylistic choice, this method also served as a technical aid. The *Grease Pencil* lines automatically outline the silhouette of the sharpest edges of a 3D mesh when viewed from an angle, ignoring the smoothest or roundest edges. Here the chosen sculpting style emphasized sharpening the edges of the silhouette defining features of the face, like the bridge of the nose, the jawline and the chin, all to ensure that these show up properly when viewed from most angles when outlines are added at a later phase.

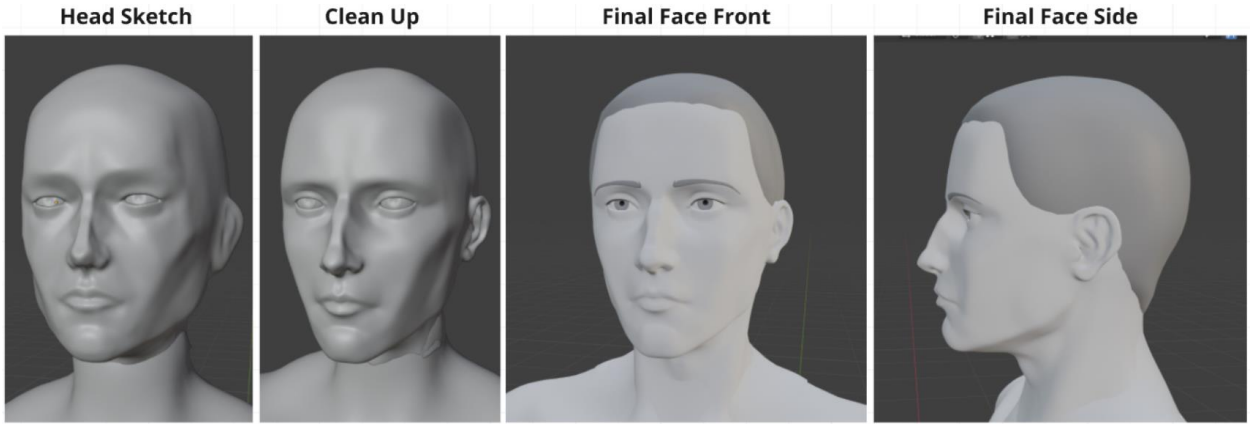


Figure 57 - Face Sculpting Sequence

4.1.1.3. Hair:

The character's hair was 3D modeled using large hair strands to keep the amount of detail cohesive with the rest of the character's features and clothing. Additionally, using this solid mesh approach ensures that the hair can share the same material and line art methods as the rest of the character, techniques which would have been incompatible with 3D simulated hair. Each hair strand is comprised of a *NURBS Path* that can be positioned and deformed within 3D space. This path is connected to a grooved *Bezier Circle* that defines the profile of the hair to be replicated along the path, creating a long and organic 3D strip of hair, which can be extended and customized. These strips were placed on top of the character's head, flowing downwards from the root, finally tapering them at the bottom, ensuring that the curves flow outwards to prevent clipping, since the hair will freely sway back and forth when physics are added at a later stage (Figure 58). Additionally, by removing or altering these strands it became possible to create multiple variations of the same hairstyle, as well as use this same technique to create beards and moustaches later on.

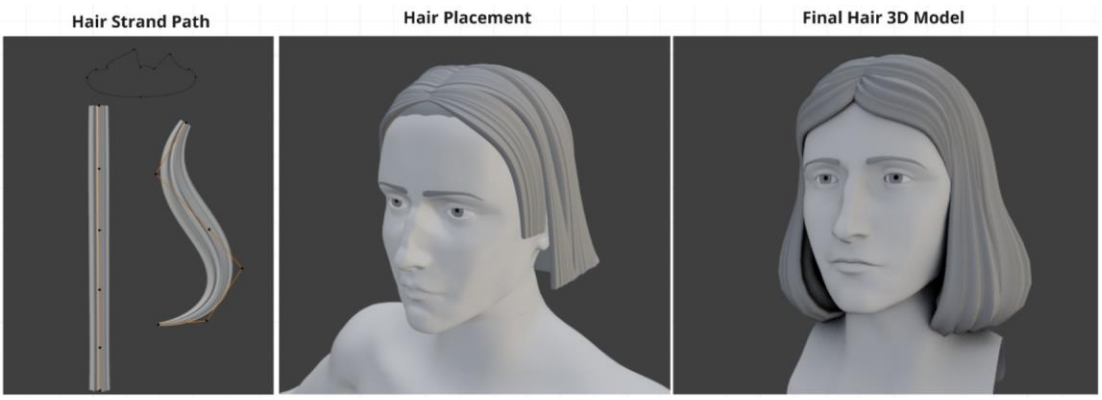


Figure 58 - Hair Modeling Sequence

4.1.1.4. Clothes:

Using the unclothed body as a base, a basic vest, sleeves and pants were made by wrapping 3D planes tightly around the silhouette, similarly to retopology. Then details like shirt flaps, sleeve cuffs, and the cravat were blocked out, including a wide brimmed hat. With these bases complete, each accessory was refined and polished, adding details like shirt buttons, frills and folds. Additionally, all of these assets were correctly UV unwrapped and modeled with optimized topology to avoid repeating these processes for each outfit that used this one as a base (Figure 59). The 3D models themselves don't require an excessive amount of detail or intricate designs, as the chosen style benefits from simple shapes, with the outlines being used to infer the majority of the "details".

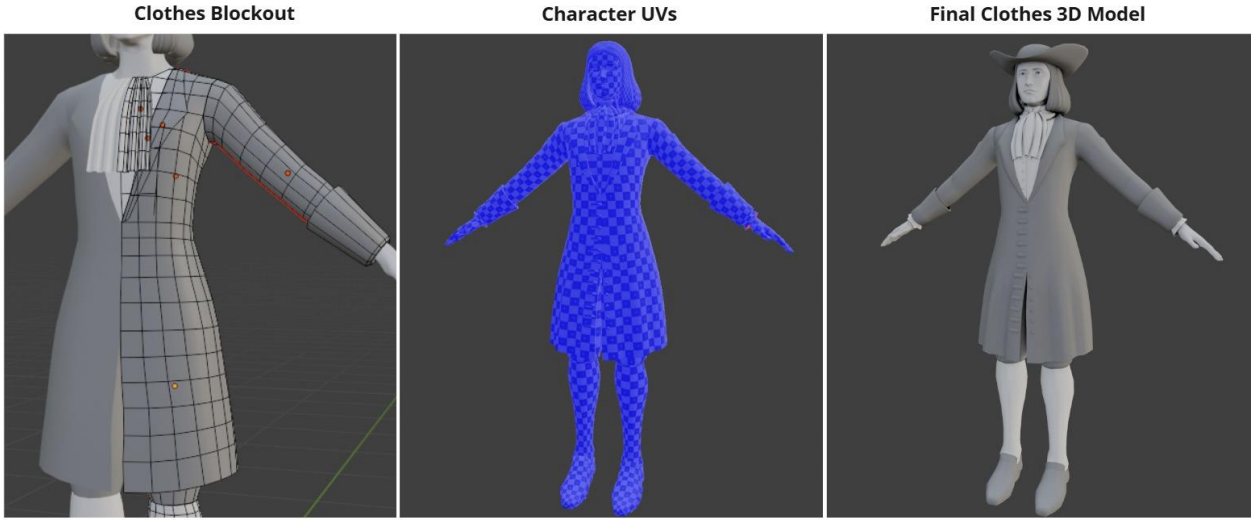


Figure 59 – English Merchant Clothes 3D Modeling

4.1.1.5. Outlines:

With the model complete, the Grease Pencil line art was added to the scene, which automatically outlines the silhouette and sharpest edges of the character. In this stage the detailing process includes adding custom line art to the model, specifically within its silhouette with the *Freestyle Edge* feature. This tool allows the user to select any edges on a 3D model and turn them into permanent

lines that show up at every angle. This was used to add folds, slits, and other details to the character's clothing and facial features (Figure 60), implying these visual elements through line art, rather than modeling them from scratch. Additionally, at this stage a "thickness" modifier was added to the line art to make the lines more dynamic and taper off as they approach their edges (Figure 61).

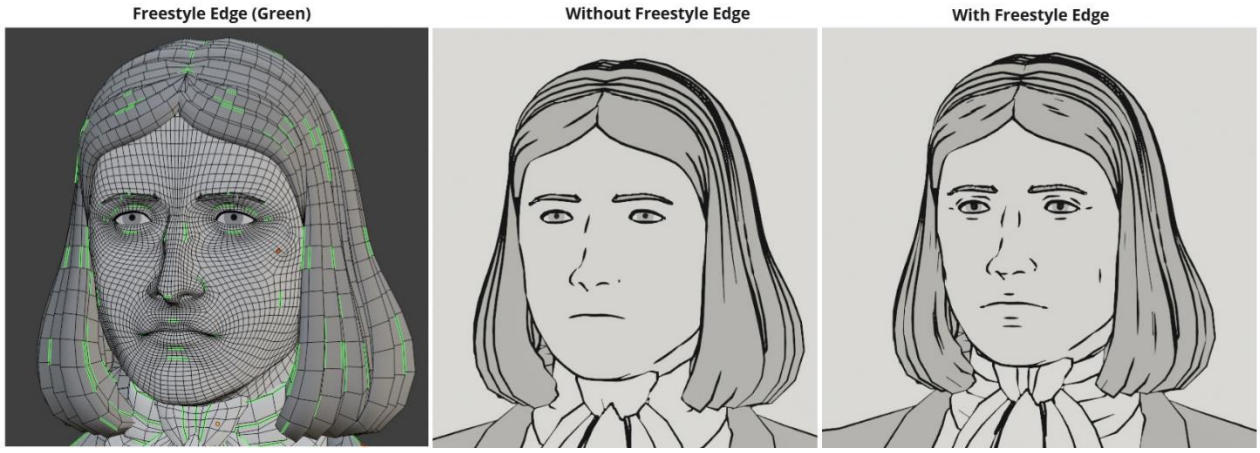


Figure 60 - Freestyle Edge Sequence

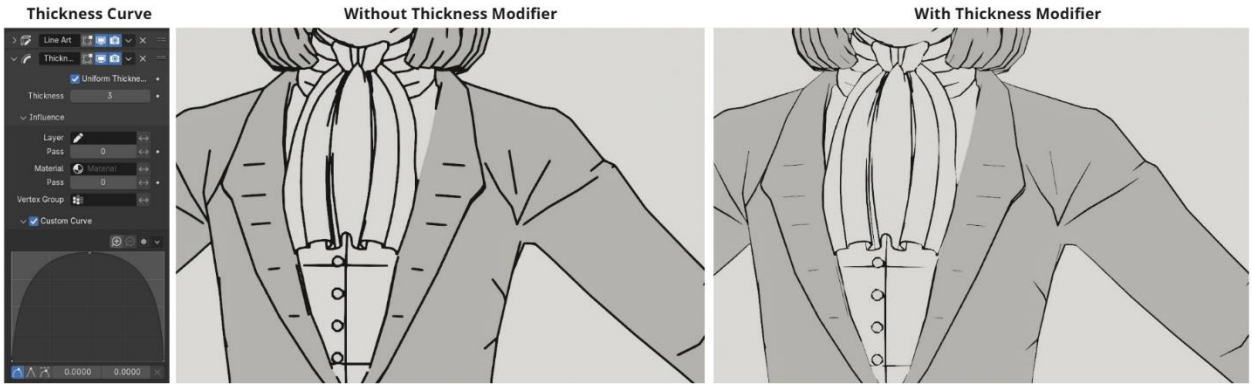


Figure 61 - Grease Pencil Thickness Modifier

4.1.1.6. Retopology:

Clean topology is crucial for rigging and optimization, as the number of polygons in a 3D model and scene heavily impacts performance. With this project specifically, the *Grease Pencil* lines are equally affected by high polygon counts and the amount of 3D assets on screen at a time, which, in turn, negatively impacts Blender's performance and rendering times. In this step of the modeling phase, the head and hands were retopologized, this process involves taking the high poly model and breaking it down into simpler shapes, all the while carefully preserving the details and silhouettes of the subject being remade. For example, to retopologize the face, the high-poly model was isolated, then 2D planes were drawn around the features which required the highest amount of detail – eyes, nose, mouth, ears. Those planes were then extruded and seamlessly connected to properly fill the space between each loop, ensuring that the head and face's silhouette remains unchanged to not

disrupt the outlines, as well as provide clean topology to manually add the *Freestyle edge* line art. Once completed and refined, this process results in a separate and optimized 3D model that retains the details and features of its high-poly counterpart (Figure 62), while significantly improving the project's performance and workflow, and allowing the use of the *Freestyle edge* technique in the character's face (Figure 60).

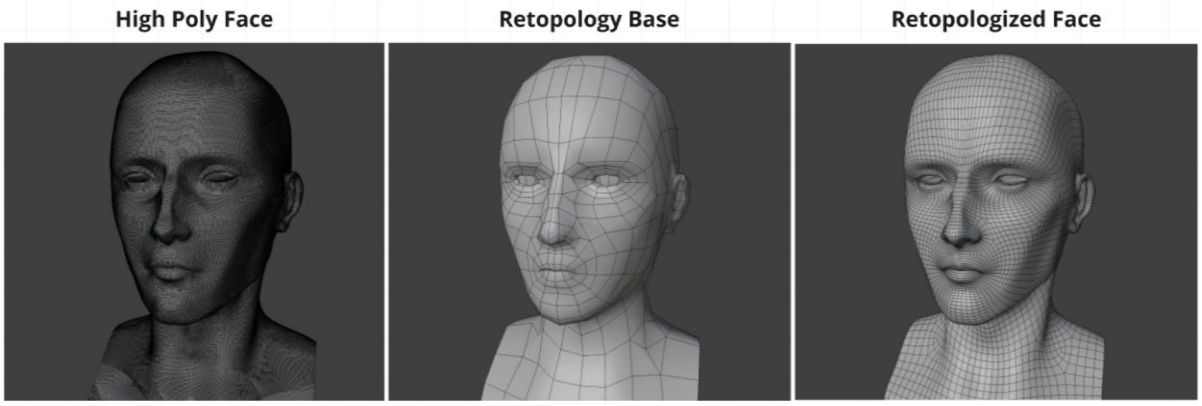


Figure 62 - Face Retopology Sequence

4.1.2. Portuguese Priest And Gentleman:

With the character complete, then came applying the same workflow to the other two key designs, the Portuguese Priest and the Portuguese Gentleman. For the priest, the merchant's *justacorps* was extended to reach his ankles, then the cuffs and frills were removed from his arms to create basic sleeves, finally the cap, belt and habit collar were added to complete the design (Figure 63).

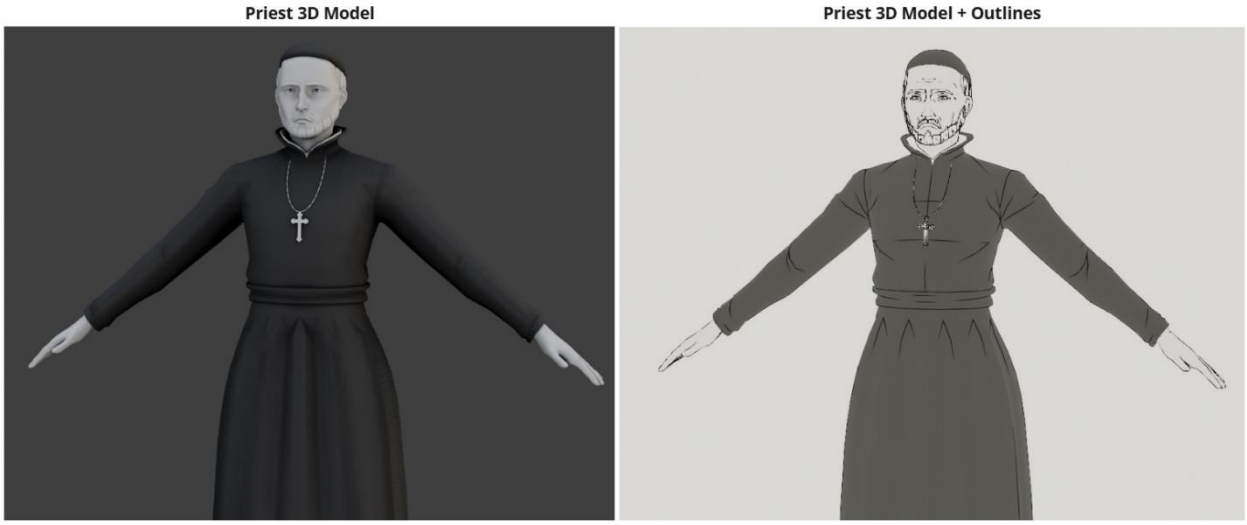


Figure 63 - Priest 3D Model

The Portuguese man had his sleeves puffed out, divided and slit into segments, the vest was also parted into a checkered pattern to make his gambeson, along with an added collar similarly to the priest, finishing his look by modeling his iconic cavalier hat (Figure 64).

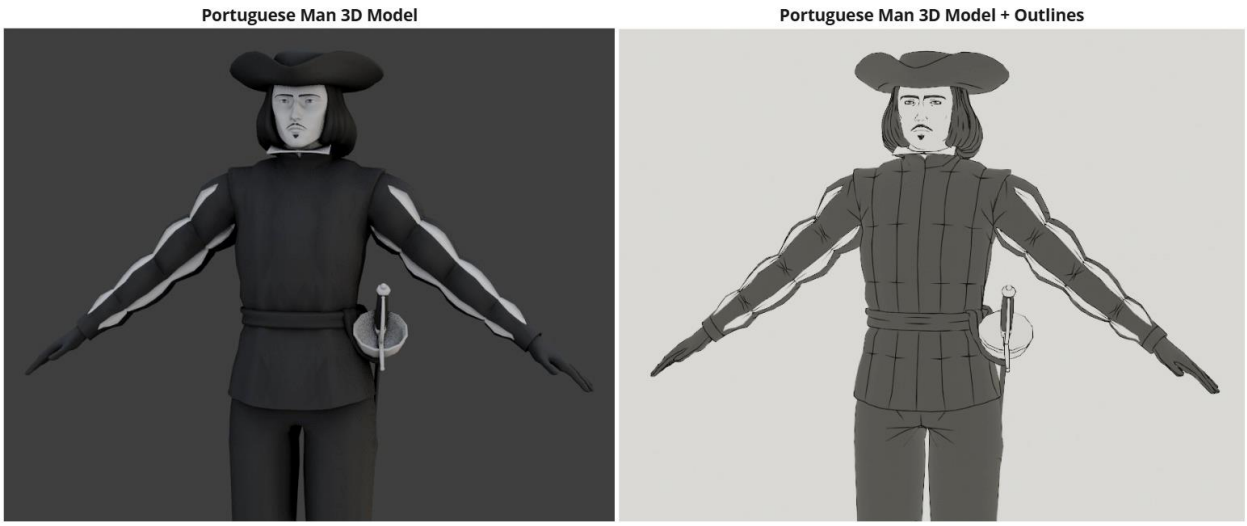


Figure 64 - Portuguese Man 3D Model

4.1.2.1. Head Variations:

Each character's head is a variant of the base model, which was duplicated and deformed with the grab tool to slightly alter their base shapes (Figure 65). However, the main distinguishing factor in this process was the line art, which allowed the creation of three distinct face designs, all from the same 3D model. For the sculpting, the Portuguese Gentleman's face was left as the default, while the English Merchant's face was slightly puffed out, and the Priest's face was slightly shrunken inwards and drooped to show his age.

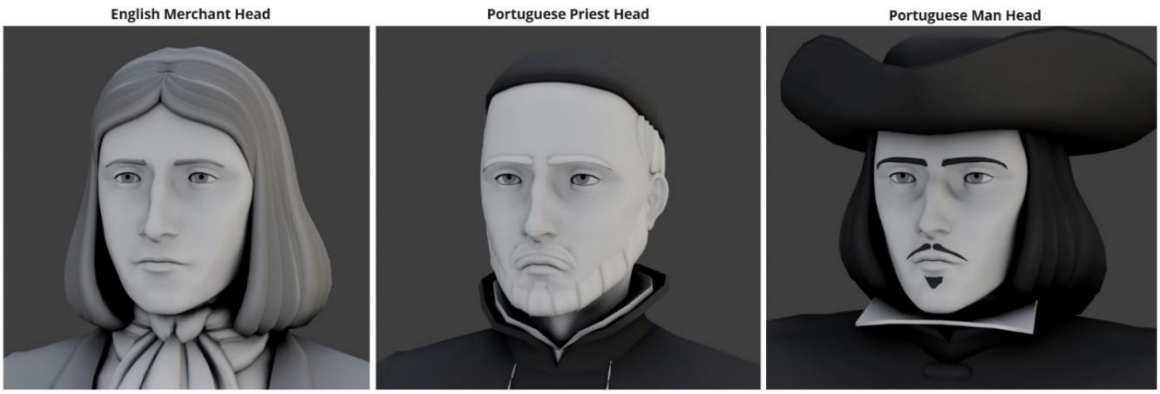


Figure 65 - Main Characters' 3D Faces

For the line art, using the priest as the best example, adding wrinkles and age lines to his slightly droopier face made him stand out the most from his younger counterpart. Likewise, the lines on the English merchant's face were also altered to differentiate him from the Portuguese gentleman (Figure 66). Additionally, giving each character different eyebrows and beard styles between them, as well as placing them in their respective outfits, sells their uniqueness even in greyscale, with this

distinction being further emphasized when their models were textured in the later visual development stage.

Figure 66 - Main Characters' Faces Line Art

Finally, the characters' props were modeled, these are objects that show up as focal points during key moments of the animation, and each character has their own. The Portuguese Gentleman has his sword, the hatless merchant carries a body bag, the hat-wearing merchant has a shovel, and the priest has his cross (Figure 67).

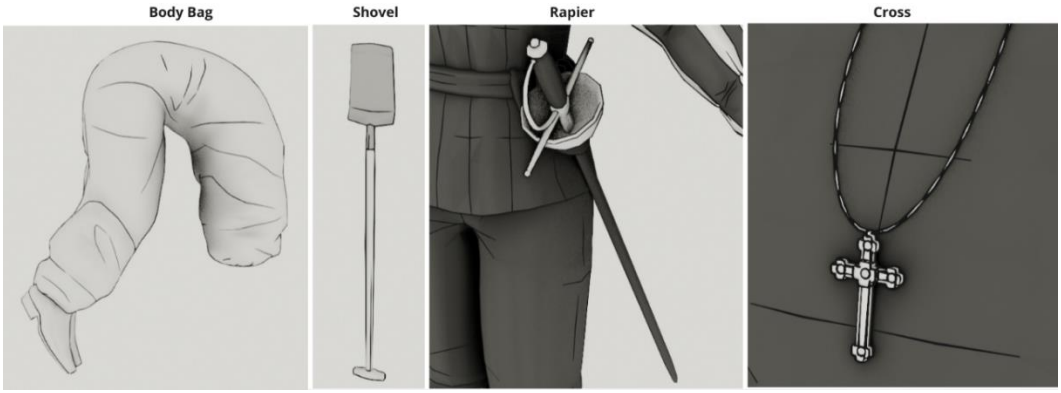


Figure 67 - Main Characters' Props

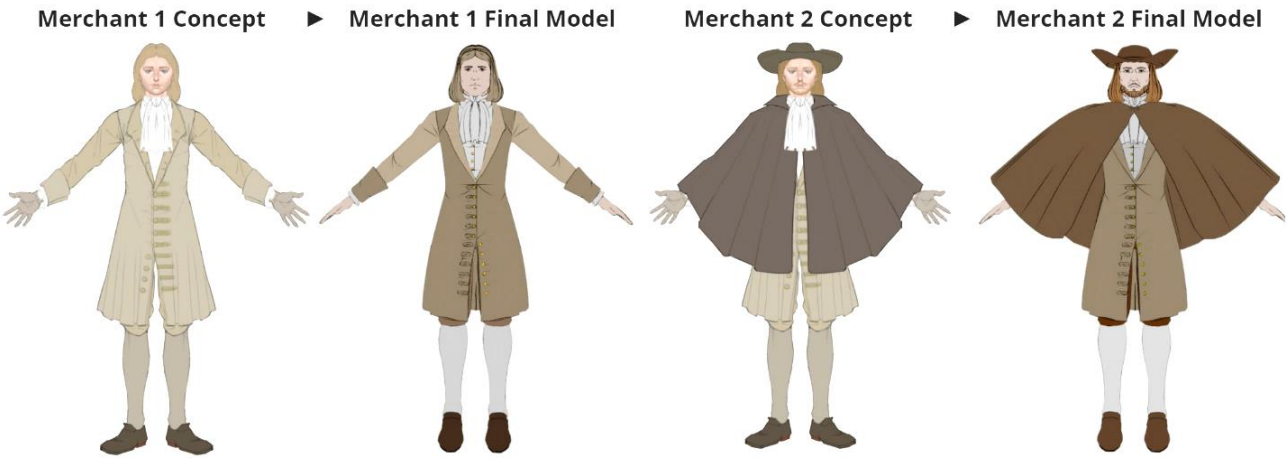


Figure 68 – English Merchants Concept Art VS Final 3D Model

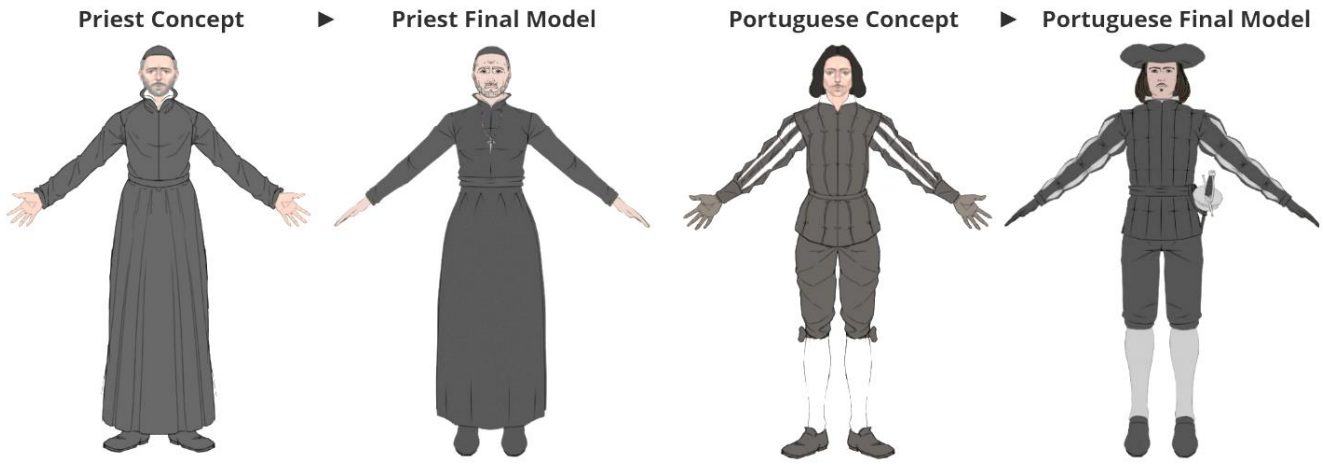


Figure 69 - Portuguese Priest and Gentleman Concept Art VS Final 3D Model

4.1.3. Bystanders & Character Variations:

Every single aspect of the characters was modeled in a modular fashion, separating each body part, clothing and accessory into various categories that can be combined and interchanged between each other to create a multitude of unique 3D characters from the same pool of assets. For example, to create a bystander for the animation, it was possible to take the sleeves from one character, the vest from another, and add a unique hat on top to create a whole new outfit. As early as the storyboarding phase, these Madeiran citizens were introduced in the story in ways that would omit their faces and allow for the recycling of assets to optimize the workflow and seamlessly populate the animation. For the animation, multiple versions of these characters were made by mixing and matching various props, deforming hats and changing their proportions, even being able to create convincing "female" versions (Figure 70).

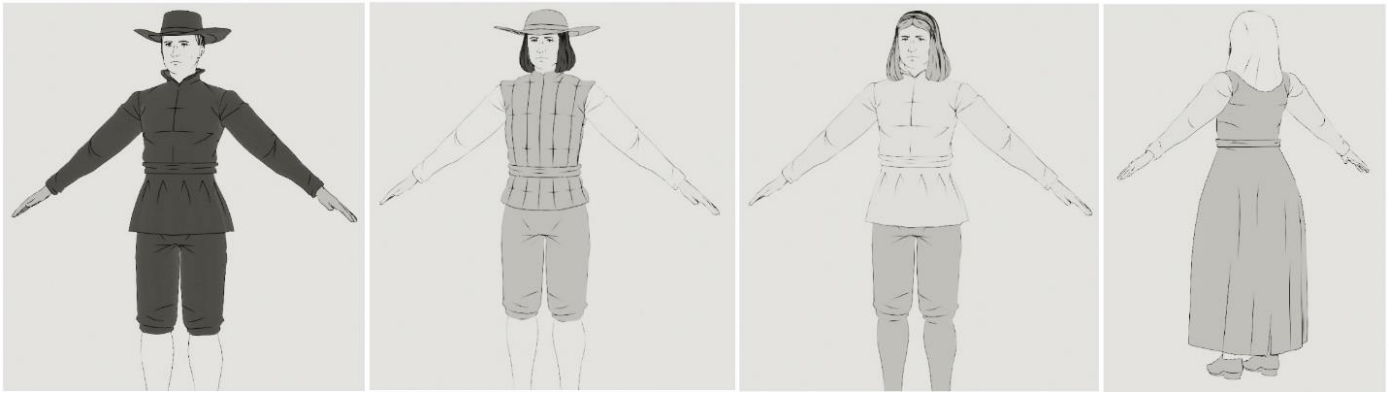


Figure 70 – Madeira Citizens / Bystander Characters

4.1.4. Rigging:

∘ **Bones:** With every character modeled then came the rigging process, as they all share the same body type, only one skeleton was created, which features basic controllers and constraints including toggleable IK (inverse kinematics) and FK (forward kinematics) bones for the hands and feet (Figure 71). A consequence of the modular approach to modeling is that each character consists of a multitude of "disconnected" small props and assets (Figure 71), which added an extra step to the rigging process. Before the weight painting, each of them had to be "sewn" together, manually going around each character, merging and bridging all the vertices at their seams to create one complete mesh that is suitable for weight painting.

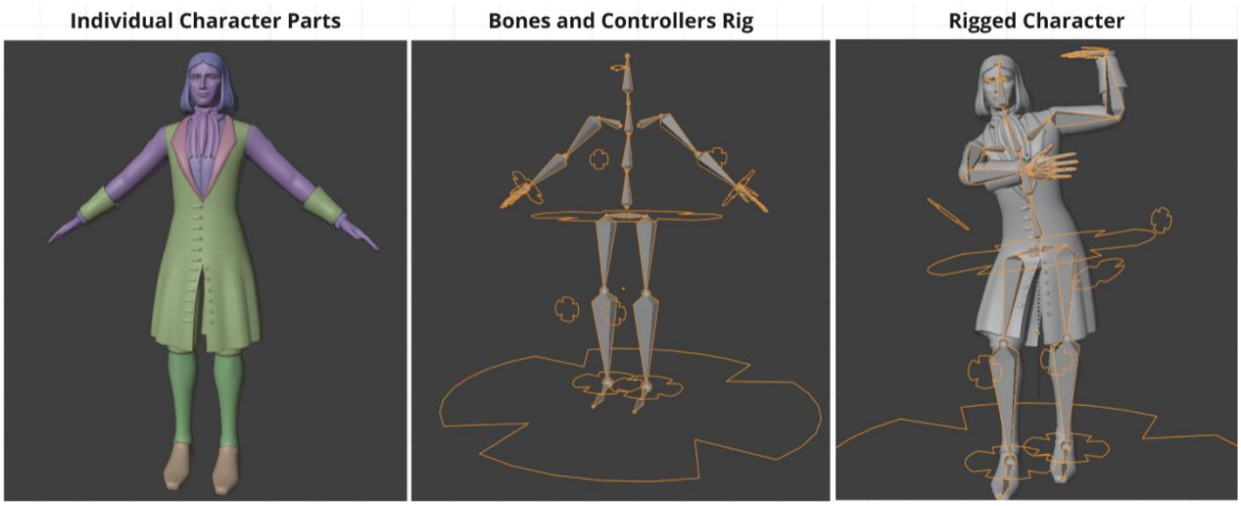


Figure 71 - 3D Character Rig

∘ **Weight Painting:** Weight painting is a complex process, further impacted by the amount of layers and clothing accessories in these character designs, though there is an "automatic skin weights" feature, each character required an extensive amount of clean up before becoming animation ready, testing their rigs by posing them in the most extreme poses that they can perform in the animation – crouching down and digging, walking uphill, carrying heavy objects (Figure 71). These poses stretch the characters to purposefully highlight any flaws they might contain in their skin weights. After weight painting, these assets were separated once more into individual parts to be able to assign each object a custom object property to color them.

∘ **Props:** The props in the animation were also rigged accordingly: the priest's cross has one bone connected to his neck to allow it to sway back and forth. The Portuguese gentleman's sword has one bone connected to his hip. The merchant's shovel has two bones, one for the handle and one for the shaft, these were rigged accordingly to be able to correctly parent any character's hands to the shovel, both one-handed and two-handed ensuring a smooth interaction between the characters and the prop. The body bag has a sequence of bones to allow it to bend at each of its major joints – the neck, back, waist, hips and knees – as this prop will flail and bob throughout the animation within the constraints of the human body (Figure 72).

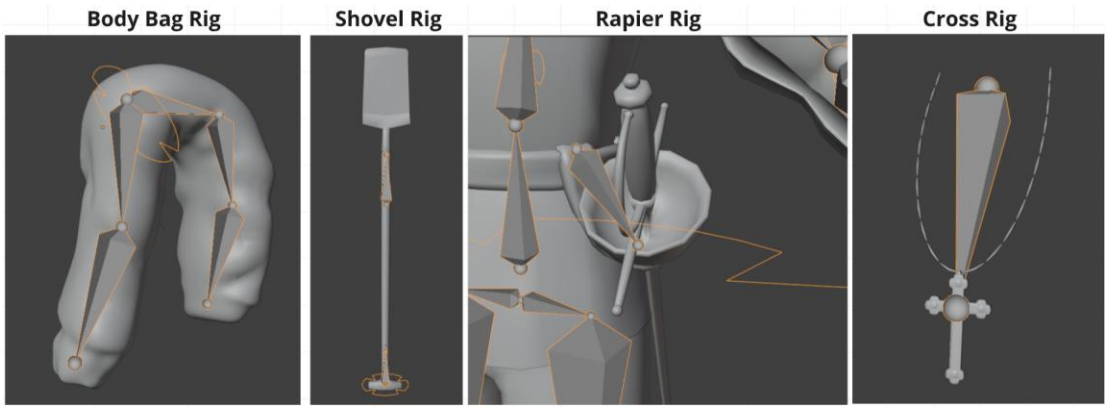


Figure 72 - Prop Rigs

- **Hair:** Each character with long hair had two bones added to the top of their head (Figure 73), instead of using hand keyframed animation, these bones were instead simulated with gravity and physics through a plugin added during the animation phase.

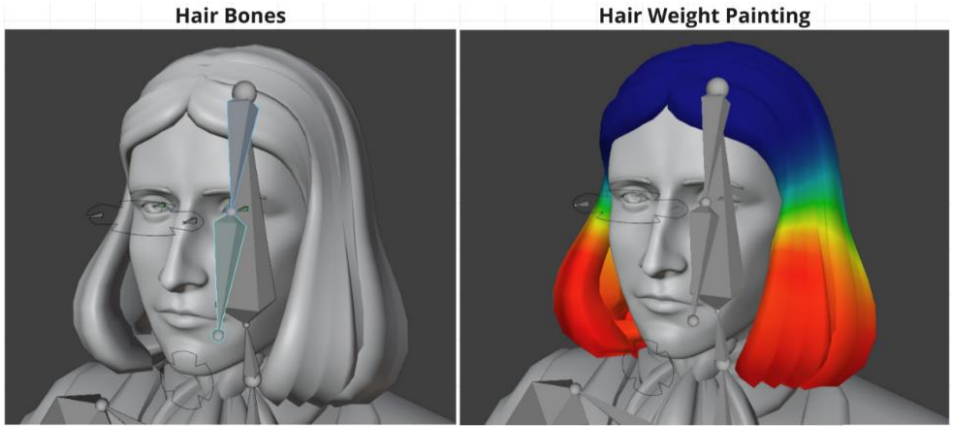


Figure 73 - Hair Rig & Skin Weights

- **Cloth Simulations:** Most characters were given cloaks, a common accessory of the time. This prop was modeled accordingly from a flat plane, opened at the front and the neck (Figure 74). The edges of the cloth that surround the character's neck were assigned a static "pin group" – a collection of vertices that are exempt from the cloth simulation – pinning it to the characters neck and ensuring the cloak stays on as it flows and wraps around them. Additionally, to ensure the cloth simulation behaves correctly and optimize its performance, a hidden body/clothes collider was added to every character (Figure 74). This is a low poly version of the characters' upper body, which was also weight painted to their skeleton and is actually the only object colliding with the cloth simulation, as opposed to calculating the modifier's interaction with every asset that makes up the character's clothing, which would severely impact performance. These secondary motions add more depth and realism to the characters' movements, all through simulations, which, though "automatic", require a considerable amount of foresight to correctly optimize and plan for.

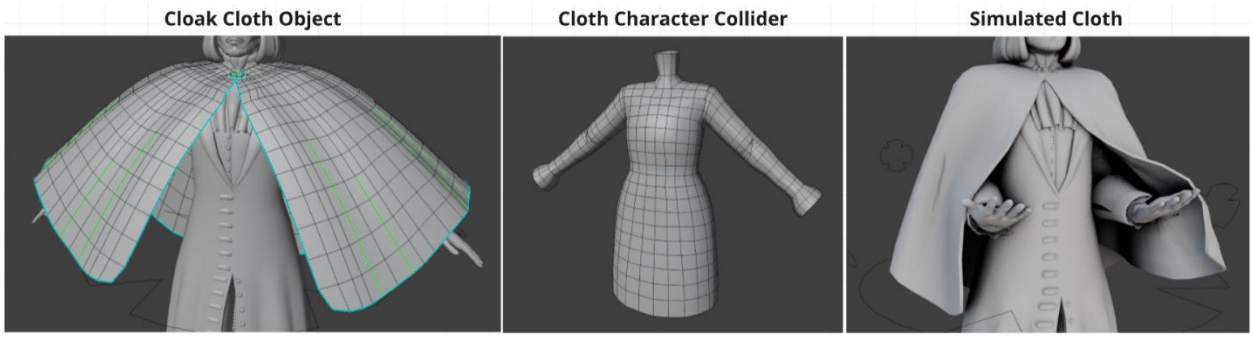


Figure 74 - Cloth Simulation Setup

- **Facial Animation Shape Keys:** Besides bones, the characters also used shape keys to convey various emotions. Shape keys are a feature that allows a 3D model to deform into different states as long as the number of vertices remains unchanged, this deformation can also be keyframed through sliders to create animations (Figure 75). Every character has a basic "Eyes Closed" shape key for blinking, however, the Priest and the Portuguese Gentleman were assigned more expressions, as they are the only characters that have their faces on full display in conversations or interactions during the animation. With these expressions being - serious/angry (eyebrows down), surprised/sad (eyebrows up), doubtful (one eyebrow up) and breathing (open mouth).

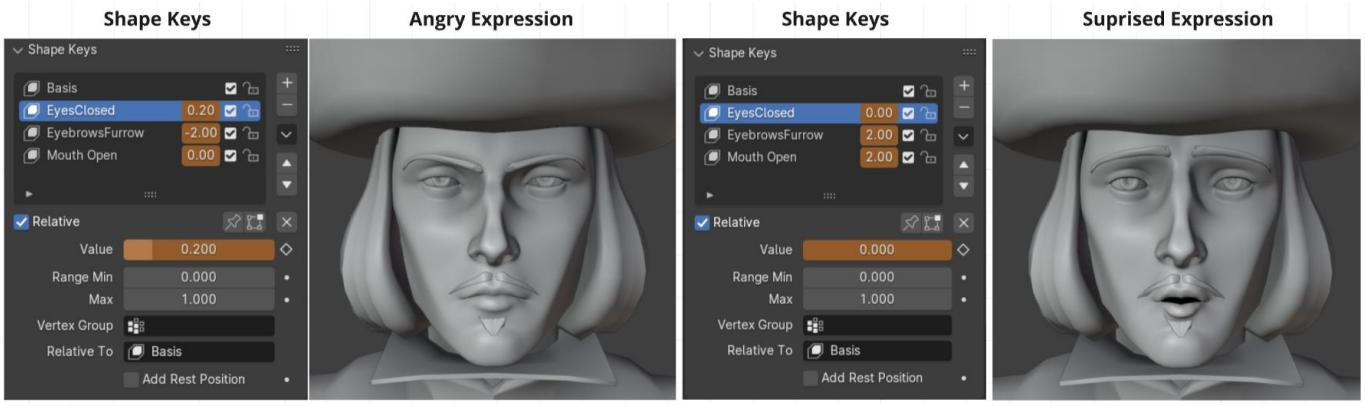


Figure 75 - Facial Shape Keys

4.1.5. Environment:

With the characters completely modeled and rigged, then came creating the animation's environments. The animation takes place across a multitude of sceneries portraying a depiction of Madeira Island, from deep forests and seaside cliffs to city alleys and cemeteries. Most of the city's assets, including buildings, walls and debris, were already created during the initial phase of visual development in pre-production, so the following section will mainly focus on the creation of the forest's models.

4.1.5.1. Trees:

- ***Tree Trunks*:** These were modeled in the same fashion as the characters' hair, using NURBS curves to customize the length and shape of the log, including its grooves. These simple leafless logs were used multiple times to populate the forest's background and foreground since they have the lowest impact on performance, avoiding repetition by varying their shapes and sizes.

- ***Full Leaves*:** These trees were created with blender's *Sapling Tree Gen* feature, a tool that creates a highly customizable tree from a pool of presets, allowing the user to easily modify them from a set of curves, with settings like geometry resolution, branch quantity and leaf distribution among many others. 3D foliage is usually made up of 2D image planes, which are given their shape through opacity maps, shaped like branches, leaves and grass among many others, as this technique aids in reducing the performance impact of these assets even in extremely high quantities. For this project, however, these assets were instead modeled to contain physical edges in order to apply and be compatible with the Grease Pencil outlines and the Freestyle Edge feature. The tree created for the project is relatively low in polycount to aid in optimization, as trees and leaves heavily impact render times and the program's general performance. The tree's leaves are instanced from a single "leaf" object, comprised of a simple hexagonal shape bent at the middle. Even with low poly branches and simple leaf geometry, this tree remained as the heaviest asset in the whole project, and was therefore used sparingly, mostly in the foreground and middle ground to show off its leaves, as when placed far away from the camera the leaves and branches became less perceptible while still heavily impacting performance.

- ***2D Leaves*:** These trees were created in the same fashion as the previous, but instead of individual leaves, they are comprised of big 2D bush-like shapes, which were used to make its silhouette look like a full tree when seen from a far. These were used exclusively in the background to fill it with foliage in a highly optimized way, as opposed to its leaf-filled counterpart.

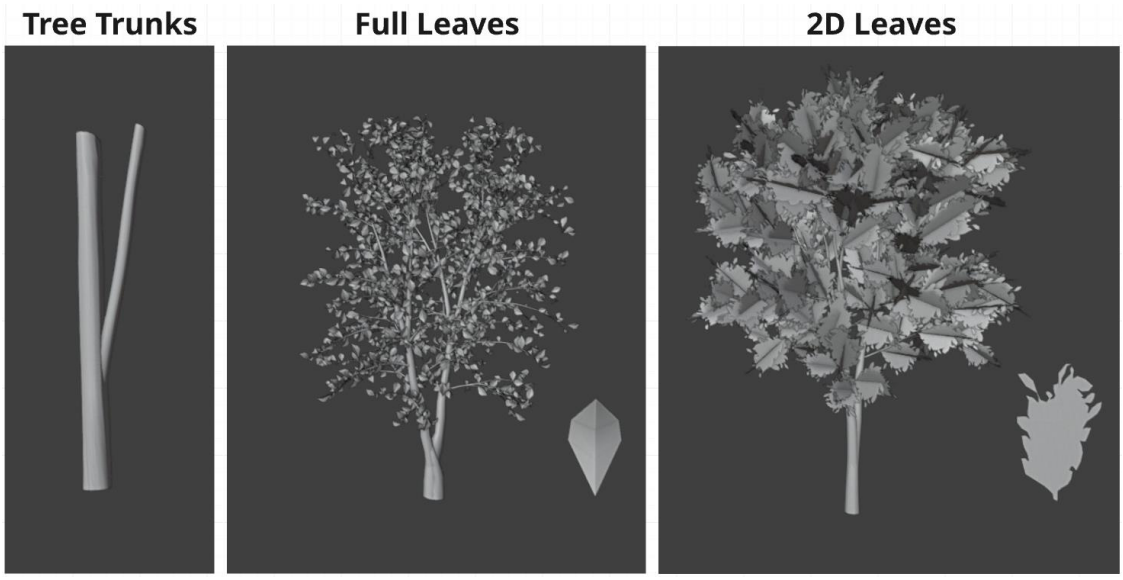


Figure 76 - 3D Tree Models

4.1.5.2. Geometry Nodes:

Geometry Nodes are a powerful system for creating and manipulating 3D geometry through a node-based interface, similarly to the shader editor, and allow for a multitude of highly complex operations. For this project however, this feature was mainly to take a group of 3D models from a within a specified collection, and randomly distribute them along the surface of another 3D model, creating random clusters of these selected objects. The geometry node setup used for these models was adapted from the previous "Donut Tutorial" [66] (Figure 77).

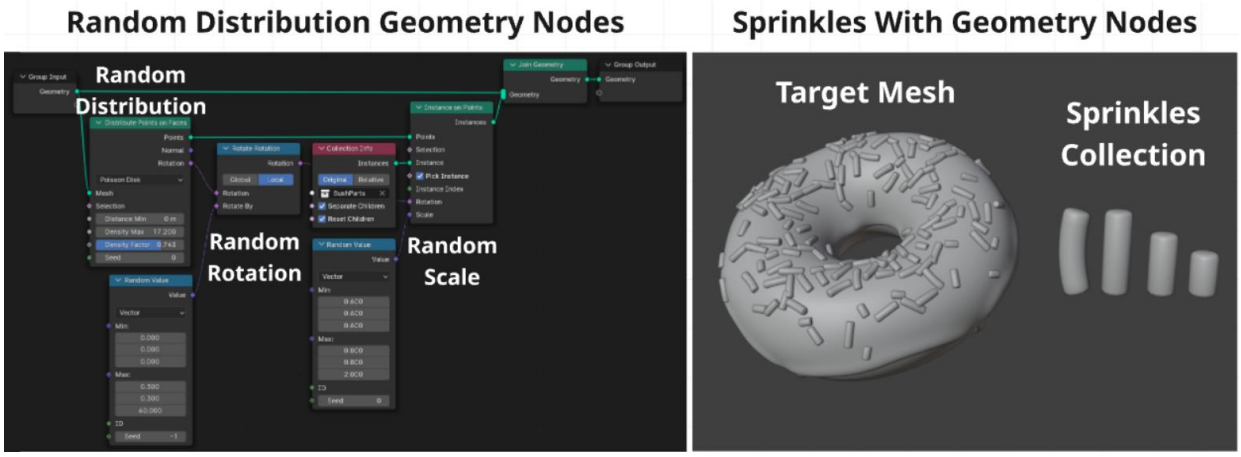


Figure 77 - Geometry Node Setup & Use

∘ **Floor Debris:** The forest's floor is a flat plane that uses a selection of colorful debris like fallen leaves, grass, stones and sticks, breaking up the monotony of the texture and making it look more lived-in and believable (Figure 78). Additionally, the Geometry Nodes used on the floor include a custom property that limits the placement of the debris to areas manually defined by weight painting. This addition optimizes performance, avoiding any excess geometry being generated across the entire floor plane, focusing it only on the regions visible to the camera (Figure 78).

Figure 78 - Forest Floor Debris Collection and Distribution

∘ **Bushes, Grass Patches and Rock Piles:** One flat plane with fallen leaves and debris isn't enough to create and populate a believable nature setting. Here, bushes, grass patches, and rock piles were created using dome-like planes with geometry node collections which select a variety of low-poly plants, flowers, and rocks distributing them randomly across their mesh (Figure 79).

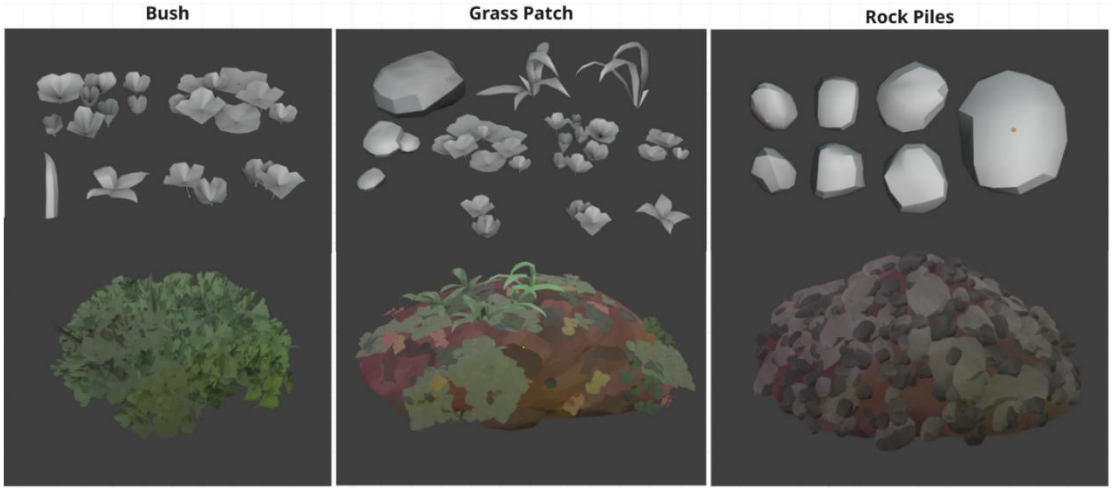


Figure 79 - Bush, Grass Patch and Rock Pile Created With Geometry Nodes

∘ **Mountains:** The far away mountains are comprised of huge one-sided 3D planes that use a selection of extremely low poly trees and houses, these simple objects were scattered around the mountains to imply a heavily forested backdrop (Figure 80). Unlike the Geometry Nodes used on the previous assets which are scattered with random rotations and directions, the mountains' nodes always instance the objects upright and facing the same direction as the mountain, to avoid any planes being seen from the side or overly tilted trees.

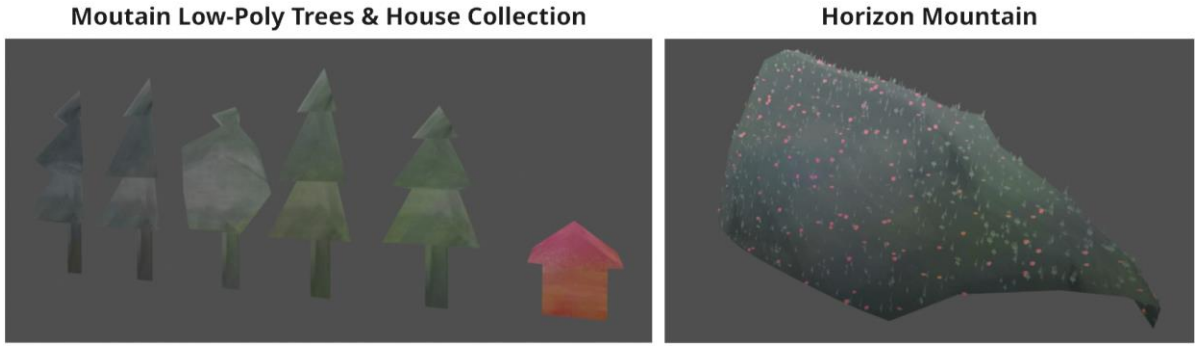


Figure 80 - Mountain With Geometry Nodes

When all of these assets and decorative props are combined correctly, their varied models allow for complex and lush sceneries which fully complement the visual style of the animation (Figure 81). While the geometry nodes allow for quickly generating foliage and minute details, these must still be strategically placed and designed to create visual pleasing compositions taking care to: Avoid overcrowding the frame – using the complex trees for the foreground and the simple ones in the background; Create the illusion of a 2D image – placing bushes around the bases of the trees to mask

their intersection with the otherwise flat ground plane; Create points of interest – using grass patches and logs in the foreground to frame the shots and highlight the middleground layers.

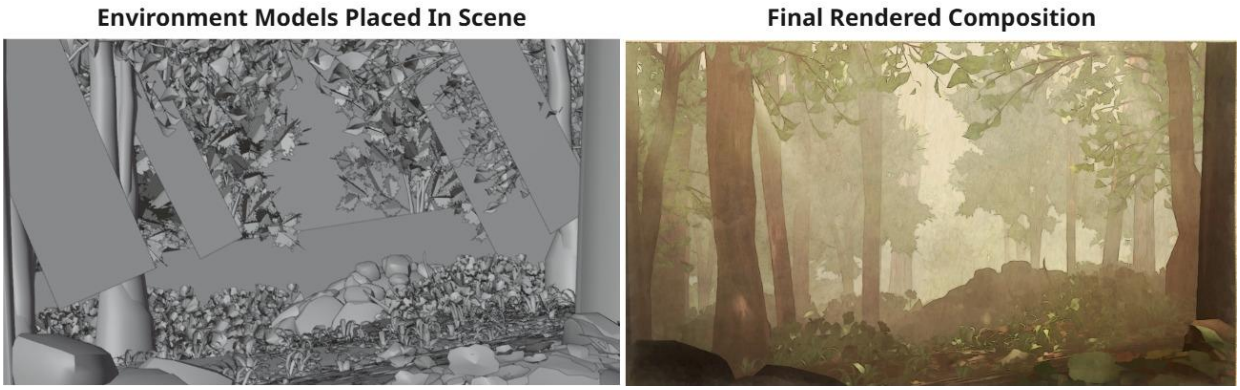


Figure 81 - Final Assets Used In Compositions

4.2. Visual Development

While the pre-production visual development provided valuable insight and created a solid base for the procedural material, the final style of the animation had yet to be finalized. In a usual 3D production, each asset and prop would be assigned its own individual material, which defines that specific object's textures, colors and lighting interactions, afterwards these complete models can "just" be assembled into a scene and animated. However, the highlight of this project is that all the assets in a scene share a single master procedural material to ensure a cohesive and unique visual style across every 3D model in frame. This singular material approach was essential, as stylized procedural materials require every aspect of an image to be manually defined, and having to edit each node individually on each asset present in a scene would severely cripple the project's workflow when striving to create multiple cohesive iterations. Therefore, with the final assets for the characters and environment fully modeled the next step in the pipeline was to refine the style of the animation, comparing each iteration to deduce their strengths, weaknesses and behaviors.

4.2.1. Refinement And Comparison Process:

The style refinement and comparison process was performed continuously throughout the visual development phase, conversely, this process was not carried out purely by intuitive means or "by eye". While a degree of subjective judgement (simply deciding what looks "better" or "worse") was required and inevitable when developing a unique visual language, the comparative methodology was also guided by quantitative metrics. These are objective features such as light values, compositions, color palettes and painting artifacts characteristic of that material and style.

For the majority of this comparison process, multiple 18th century artworks by Samuel Davies [73], [74], specifically ones pertaining to Madeira island, were used as reference. Here, the 3D renders and paintings were arranged into a mood board-like sequence, placing the CG image in between the real watercolors to evaluate how well the stylized 3D blended in with them (Figure 82-Figure 83). In this process, rather than copy a specific 17th to 18th century artist's style, these artworks were instead used as a reference point, analyzing the qualities and artifacts that define them in order to improve the render's artistic quality by implementing them in 3D.

Figure 82 - Watercolor Artworks [73], [74] VS 3D Render - Before Comparison

Figure 83 - Watercolor Artworks [73], [74] VS 3D Render - After Comparison

The iterative nature of this process is essentially infinite, as every change opened new possibilities to improve the style further, evolving exponentially with each iteration and time allocated. To avoid iterating on the material, composition and rendering settings aimlessly, the refinement and comparison process followed a problem-solution-implementation workflow. This discipline was essential to prevent an endless cycle of improvised readjustments as new discoveries were made, instead maintaining consistency and coherence by clearly defining which artistic features were missing or required improvements.

The steps taken to refine the stylization can be broken down into the following framework:

> **1º *Identify the Problem*:** What looks incorrect or is missing from the 3D rendered image.
>
> **2º *Find the Artistic Solution*:** Analyze traditional watercolor paintings and deduce what painting techniques resolve these issues.
>
> **3º *Implement in Blender*:** What tools can be used to recreate and implement these features.

The following table represents an example of this process:

Table 4 - Problem - Artistic Solution - Blender Implementation Table

THE PROBLEM	
"In a wide frontal shot of the forest, the mountains in the background, look like they are as close to the characters, as the trees in the foreground"	
ARTISTIC SOLUTION	**BLENDER IMPLEMENTATION**
Add Atmospheric Perspective:	*Procedural Material*
a. Far away objects are lighter, lower in saturation and use cooler colors; b. Closer objects are darker to further contrast;	a. Added a color ramp node to adjust object color and saturation according to their distance to the camera b. Added another color ramp node to adjust object brightness according to their distance to the camera
Lower objects' details as they get further away:	*Modeling*
c. Far away objects are simpler and abstract;	c. Used low poly mountains and trees for backdrops c. Used simpler trees in the background
	Render Engine
d. Far away objects have no shadows;	d. Limited the shadow render distance in the renderer
Add atmospheric fog:	*Texturing*
e. Distant objects are separated by a light gradient between them;	e. Added a 2D plane with a white vertical gradient texture between models to separate them further

Effectively, the methodology applied in the style development and iteration process was informed by both subjective artistic sensibility and objective style analysis. Additionally, this analytical process led to several breakthroughs in the development of both the material and the overall style, with these and more significant milestones being described further in the next chapter.

4.2.2. Style Development Timeline

The following is a considerably simplified version of the style development process, broken down into its crucial stages, further developing the most impactful discoveries in its development. With the final assets for the characters and environment fully modeled the next step in the pipeline was to create a full composition in which to texture the models with the material developed in the pre-production, to deduce its strengths, weaknesses and behavior in a heavily forested scene, which comes in stark contrast to its previous urban environment application. Here, the material, render settings, compositing filters and compositions were refined through an extensive trial-and-error process, adjusting the over 50 interconnected nodes in the procedural material to define and approximate the animation's style to match the faded watercolor look and historical visual language the documentary aimed to achieve.

The workflow for developing the procedural material and defining the animation's visual style was the following:

> 1º Model a scene from the story board
>
> 2º Add and adjust procedural material to improve the style
>
> 3º Identify missing or incorrect stylistic features
>
> 4º Implement, iterate and refine until satisfactory

4.2.2.1. Transferring The Material:

The material created during the pre-production was applied to a full 3D scene built according to a shot from the storyboard (Figure 84). This forest scene with the characters framed in the center, served as the "canvas" in which to experiment with and iterate on the procedural material during this initial stage of visual development.

Figure 84 - Transferring Pre-Production Painterly Material To New Forest Scene

4.2.2.2. Removing Ambient Occlusion:

After Transferring the material and project settings to the new environment, the characters looked distinctly three-dimensional. This was discovered to be an effect of ambient occlusion which proved to be an extremely impactful feature in making objects look three-dimensional. Evidently, traditional artists make use of ambient occlusion to define an object's volume, giving 2D shapes soft shadows around their curves and crevices to simulate depth and create the illusion that they are in fact 3D. In contrast, the opposite effect can be exploited, removing ambient occlusion from a 3D object or scene to make it look 2D (Figure 85). In this project, this setting was disabled in the EEVEE render settings to make the models appear flatter and illustrative.

Figure 85 - Scene With And Without Ambient Occlusion

4.2.2.3. Adding Atmospheric Perspective:

Without ambient occlusion, while the characters and the environment became two dimensional, it was now harder to differentiate them from the background, creating an image without a clear focus. Here, atmospheric perspective presented itself as an essential technique to separate the foreground, middle ground and background planes of the image.

This effect simulates depth by making distant objects lose contrast and saturation as they get further away, blending them with the atmosphere or the color of the sky, with closer objects becoming darker and more saturated. In this project, a stylistic choice was made to greatly exaggerate this effect, tightening the distance between each plane of the image to greatly contrast between each layer and enhance its two-dimensional effect and artistic quality, allowing for subjects to be framed in a scene through dark foreground elements, and making them stand out from the scenery with light background elements (Figure 86).

Figure 86 - Atmospheric Perspective Effect On Scene Legibility

4.2.2.4. Initial Satisfactory Result:

Figure 87 - Initial Style Applied to Scenic Shots

This version of the material was deemed as visual acceptable, as it worked fairly well in wide shots without characters in them (Figure 87). This style was applied to new shots built from the storyboard to begin creating its 3D version. These scenes were created, assigned the material, and then rendered, organizing them into a sequence to compare how each iteration had evolved visually (Figure 88). This process provided an overview of the animation's current style and its adaptability to multiple scenarios and camera angles to deduce which steps to follow to improve the style further.

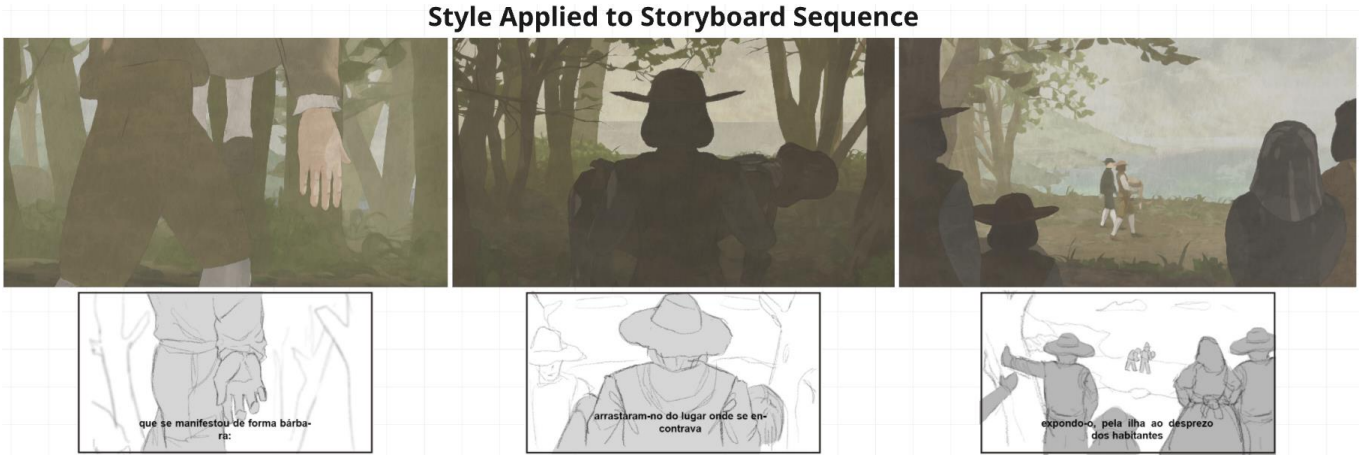


Figure 88 - Storyboard Sequence In 3D

4.2.2.5. Refining Close-ups:

Evidently, this iteration of the material suffered greatly in close-ups, medium shots, and any scenes where the camera was tilted downwards or upwards. To develop a solution to this issue, one close up shot was isolated (Figure 89) in which to iterate the material on, here, the style was refurbished, raising color saturation and contrast, while darkening the shadows, and adding textures to the models themselves instead of on top of the whole image during compositing.

Figure 89 - Close Up Shot Evolution

4.2.2.6. Minimal Shading:

This version of the material contained every node and property deemed necessary to develop the final style, such as atmospheric perspective, textures and customizable gradients. While this iteration was considerably more vibrant and detailed, the directional lighting created complex cel-shading patterns of the surrounding leaves on both the characters and the environment. These complex patterns both highlighted the characters' three dimensionality and heavily textured the image with distracting visual information, which raised a recurring thought that "an artist would not paint all of that".

To fix this issue, instead of iterating on the material to alter the shading, a choice was made to have characters and environments constantly in shadow, defining them mostly by their line art and shape language, inspired by The Iron Giant [45] and other contemporary NPR works researched in the state of the art, which showed that a lack of shading creates a stronger 2D appearance. Therefore, the previously built shots were updated with the new material while making use of 2D planes to block the sun's directional light, while still allowing for small highlights to shine through to enhance the compositions' artistic effect (Figure 90 - Figure 91). This step highlighted that the visuals of a stylized 3D animation are not solely dependent on its materials and textures, but also how its compositions and lighting complement or hinder the visual language.

Figure 90 – Character With and Without Complex Shading

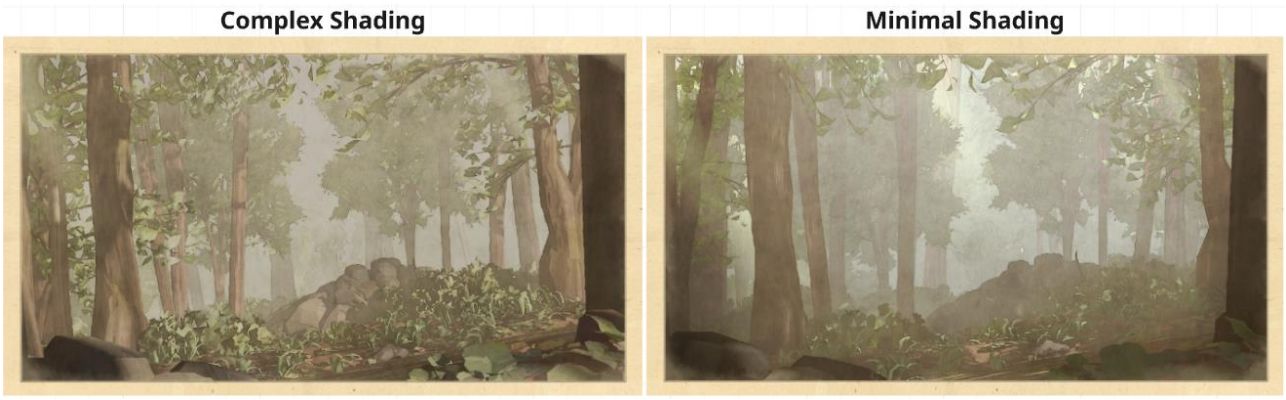


Figure 91 - Blocking Light To Simplify Image

4.2.2.7. Final Procedural Material:

With the procedural material and style finally set in stone, the shader and project settings were ready to be used to create the remaining compositions for the animation. And with each major iteration of the style, earlier compositions were updated to ensure the same consistency across every shot of the film during its journey to the final result (Figure 92).

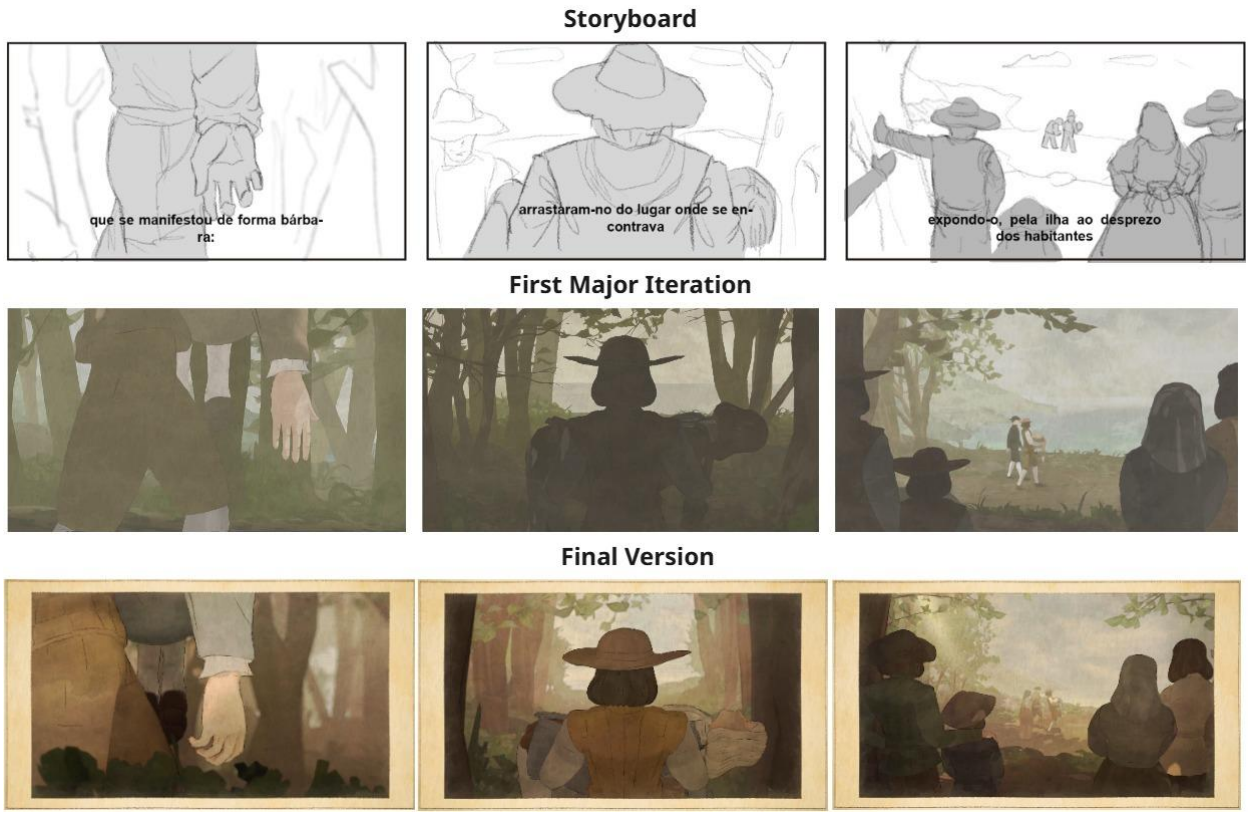


Figure 92 - First Major Iteration VS Final Versions

4.2.3. Final Style Specifications

The final style of the short film is a culmination of contemporary stylization techniques and traditional watercolor painting artifacts, all of which culminate in this animation's unique visual language. The following is an objective breakdown of the final style's specifications.

4.2.3.1. Render Engine:

EEVEE was chosen for its real-time rendering capabilities, and non-photorealistic qualities. Additionally, indirect lighting, light bounces, reflections, and ambient occlusion were disabled to create the animation's flat stylized look.

4.2.3.2. Final Material:

Each scene is comprised of a single master material, duplicated into two versions with essentially the same attributes, one for the characters and one for the environment, to allow for greater flexibility. This procedural material's attributes are the following:

- ***Cel-Shading*:** Cell-shading is controlled by a color-ramp which removes soft shadow gradients, creating a harsh cutoff between light and dark. The material applied to the environment has added nodes which break up the shadow with a "*Painterly Normal Map*", a patchy texture with the same method as the "Painterly" procedural material previously developed (Figure 37), making trees and rocks more textured, and further distinguishing them from the characters.
- ***Color*:** Solid color is added on top of the shading, controlled through a custom property node that allows each individual object to be assigned a color directly through the viewport.
- ***Textures*:** Watercolor washes and dirt textures are layered on top of the base color, breaking up the monotony of the material and creating different consistencies to emulate traditional painting artifacts.
- ***Extra Custom Properties*:** These include toggleable ambient occlusion (AO) for the character's faces to better define their shape and features (Figure 93), colored gradients on the leaves and grass, and a folding texture for the body bag.

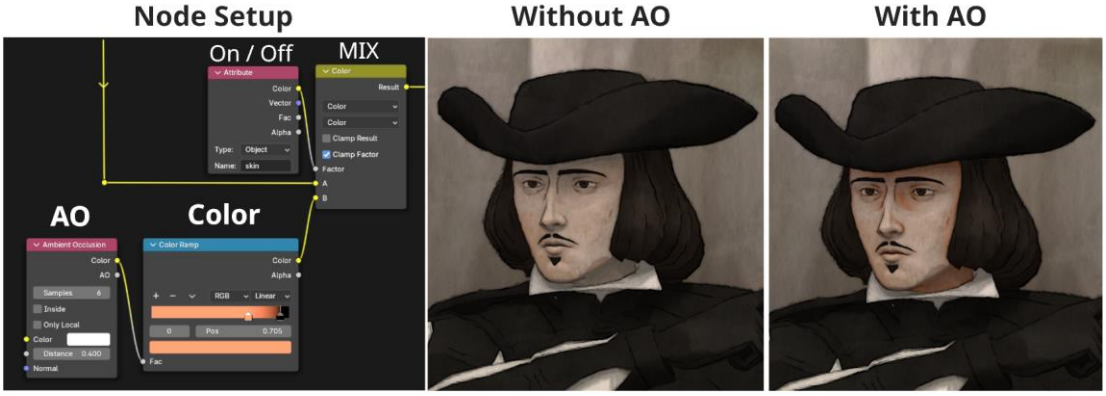


Figure 93 - Character Face Without And With Ambient Occlusion (AO)

- ***Atmospheric Perspective*:** Two gradient maps overlay a lighter and darker value to objects according to their distance from the camera to create a sense of depth (Figure 141). This is essential to separate the foreground, middle ground and background planes of the image, with distant objects becoming lighter as they fade into the background, and closer objects becoming darker in the foreground.

- **Vertical *Gradients*:** Similar to the atmospheric perspective nodes, these are layered vertically on the material creating a gradient that fades from light to dark, from top to bottom, creating a sense of depth as if the sunlight were fading as it approaches the ground.

- **Full Procedural Material:**

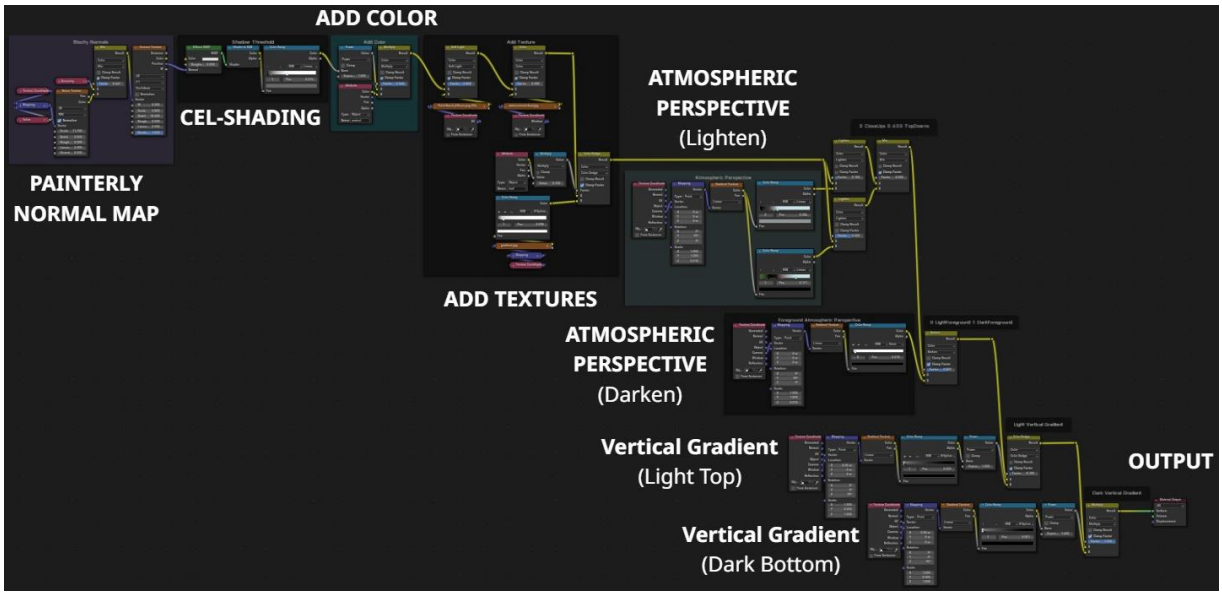


Figure 94 - Full Environment Procedural Material

4.2.3.3. Outlines:

Characters and foreground props received outlines to separate them from the background with varying line weights and textures:

- ***Inside*:** The lines on the inside of the characters are thin and dynamic, tapering off at the ends and lightly transparent, being used to define smaller shapes and clothing details.

- ***Outside*:** The lines on the outside are thicker and only around the silhouette to define the characters' shape and further separate them from the background.

- ***Face*:** The lines on character's faces are textureless, thin and lighter in color to define the smaller details of the face and blend with the skin tone.

- ***Environment*:** The outlines used on environment props are thin and are only present on a small number of shots which featured foreground props in focus or being interacted with.

- ***Textures*:** A "scratchy" texture was applied to the grease pencil outline to create a sketched graphite look rather than a graphic 2D outline (Figure 95).

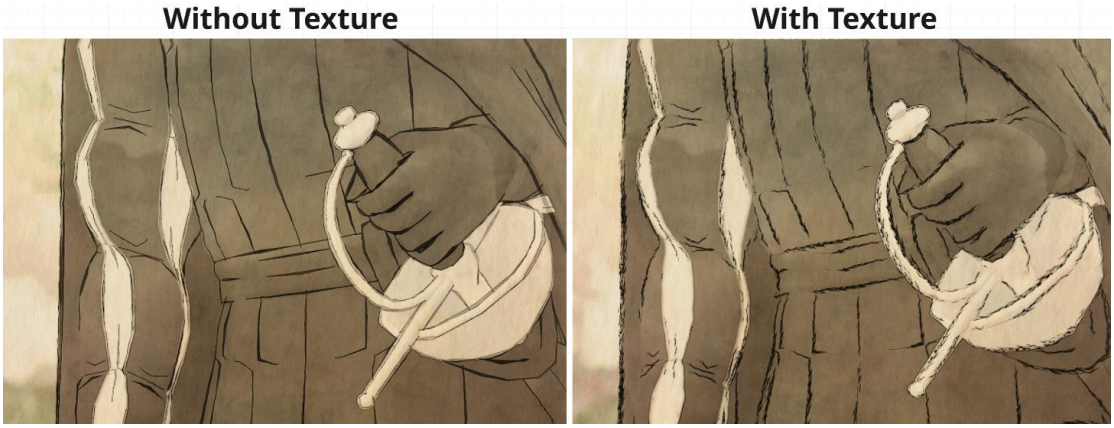


Figure 95 – Line Art Without And With Textures With Contrast Enhanced For Easier Recognition

4.2.3.4. Compositing (Blender):

While atmospheric perspective and selective ambient occlusion were used to remove realistic rendering qualities, Blender's compositing filter nodes played a greater role in enhancing the animation's painterly effect. Blender's *Compositing* tab allows the user to assemble or enhance a render through a multitude of nodes, similarly to the shader editor. During the visual development process these nodes were permanently enabled on the camera's point of view to iterate on the material in real-time while previewing it in its composited state. The post-processing effects applied to the renders were the following:

- ***Kuwahara Filter*:** Removes sharp geometry and fine details creating an interesting "painterly" look when turned to high values. This filter was applied uniformly across the whole image at a relatively low value to remove overly sharp edges in the final render. Later in post-production a close equivalent, the *Dust & Scratches* filter, was applied in a way that preserved the outlines.

- ***Displace Node*:** Distorts the render according to the levels of a selected image plane, breaking up overly clean geometry, warping silhouettes and creating inconsistencies in the image to make the 3D look more organic, both static and in movement.

- ***Kirsch Filter*:** Creates a negative layer that automatically highlights the edges found within an image, this filter was added on top of the render with an "overlay" node to give the forms of the image a colored outline through compositing rather than the Grease Pencil. This allowed shapes like shadows, textures, and every object excluded from the Grease Pencil outline to retain their own

outline, becoming darker at their limits. This served to emulate a common effect of paint drying outwards when applied to a physical medium, making a brushstroke's edges retain a darker color.

- ***Color-correction*:** In Blender the image is lightly color-corrected with lower contrast and saturation, as compositing was further developed during post-production in Premiere.

- ***Textures*:** Paper and grunge textures added onto the render to emulate the image having been painted on top of that physical medium. These were also further developed during post-production.

- **Full Compositing Nodes:**

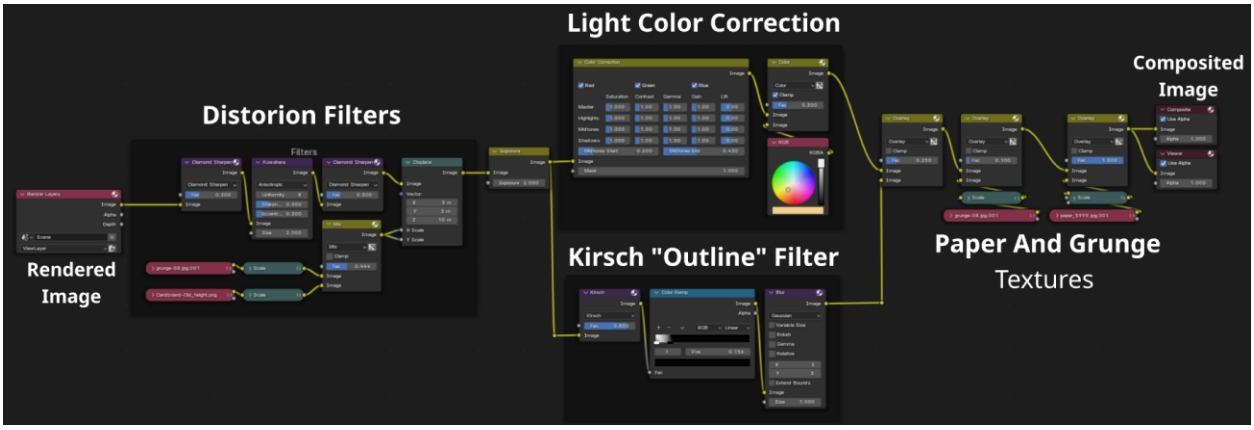


Figure 96 - Blender Compositing Nodes

4.2.4. Building The Final Compositions

With the materials and style set in stone, the next step in the production pipeline was to build the remaining final sceneries and compositions of each shot before finally moving on to the actual animation process. In this phase, correctly applying the style and materials was equally as important as their actual development. Ultimately, the animation's goal is to create a painterly 2D look, with a strong emphasis on building dramatic compositions that serve a narrative purpose, framing subjects with foreground elements, exaggerated perspectives and light values.

Consequently, to achieve this visual language, every scene had to be built almost entirely from the ground up, customizing the procedural materials, assets and lighting to specifically fit that moment in the story, and since the film is a journey that takes place through multiple locations and situations incapable of fitting into a single 3D environment or file, every shot required whole new backgrounds and compositions. In effect, each composition and its visuals had to be hand crafted to support the style, akin to creating over 30 individual "paintings", making every shot feel intentional and meaningful, while striving to find a balance between stylization and legibility.

The methodology to create each composition was the following:

> 1º Block out the shot according to the storyboard
> 2º Replace the placeholder assets with the final props and posed characters
> 3º Customize the material to adjust lighting and atmospheric perspective
> 4º Add & adjust extra visual aids
> 5º Refine and iterate composition until satisfactory

4.2.4.1. Adjusting Material Between Compositions (Atmospheric Perspective):

While the material features over 50 nodes, to copy it from one file to another there was essentially only one property to be edited - the color ramps that control atmospheric perspective (Figure 97). Since these nodes are dependent on the camera's position, their properties had to be altered to accommodate for the specific camera angle and distance of that shot, in order to correctly separate the layers of the image (foreground, middleground, background) and make the characters or actions stand out. For example, when transferring the material from a wide forest shot to a top down one, the atmospheric perspective color ramp had to be adjusted for the new composition. Top-down shots with leaves in the foreground featured a dedicated color ramp to make these leaves bright green as if the sun were hitting them, making them stand out from the forest floor (Figure 98). In Figure 99 it is visible how incorrect use or non-adjustment of these nodes negatively affects the scenes.

Figure 97 - Wide Shot Atmospheric Perspective Color Ramp

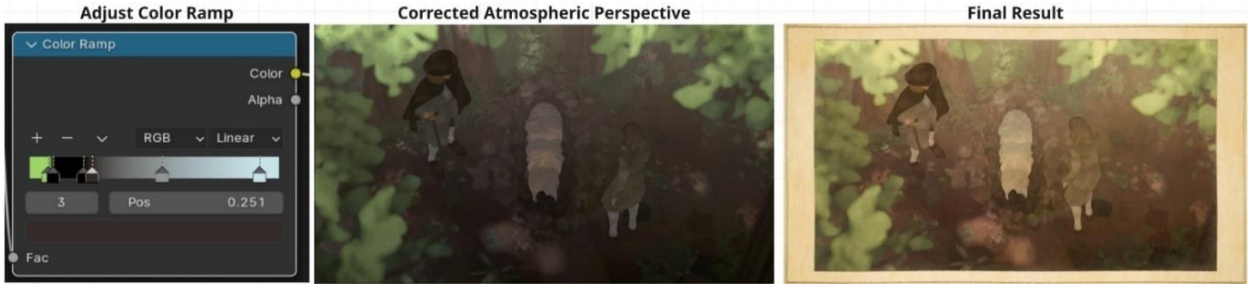


Figure 98 - Top-Down Shot Corrected Atmospheric Perspective Color Ramp

Figure 99 - Unadjusted Color Ramp Incorrect Application

Additionally, some shots made use of this gradient in unconventional ways to highlight specific parts of the image. A pertinent example can be found in the shot where a citizen is carrying the dead merchant to the cliff. Here, the characters' atmospheric perspective color ramp was inverted to darken as it got further away from the camera. This ramp was tightened starting from behind the hand, around the middle of the carrier's legs, darkening the underside of the merchant and highlighting the hand in front (Figure 100). Effectively, besides refining their compositions with foreground elements and visual aids, every shot in the animation had to have its atmospheric perspective node altered to highlight the action in that scene.

Figure 100 - Inverted Ambient Perspective To Highlight Foreground

4.2.4.2. Extra Visual Aids:

Some visual effects which were too complex to add to the master material were instead recreated with additional objects placed in and around the scene (Figure 101), allowing for greater flexibility in compositions and less strain on the procedural material.

- **Light Streaks** are long and narrow 2D planes with a yellowish gradient texture; these were used to create "fake" light streaks breaking through the trees, making the image more visually appealing and providing some more depth detail.

- **Gradient Planes** are long 2D planes with a white or black gradient texture. White gradients were used to emphasize and separate the layers of a composition. For example, placing them behind a line of trees, building or cliffside to further separate them from the background. Dark gradients were mostly used to darken graves with "fake" depth.

- **Light Blockers** are 2D planes with a specialized “leaves” texture which were used to block the sun and create strategic shadow spots. The sun passing through each tree’s leaves created complex shadows patterns resulting in a messy image. Since the characters’ 2D effect is enhanced without the sun’s shading to denote their form, these planes were used to place the characters under shade for most of the animation, with the “leaf bunch” texture used containing little holes for the sun to create little light spots.

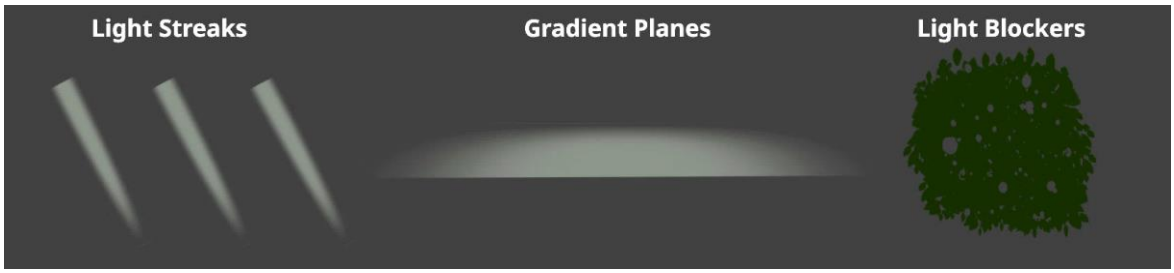


Figure 101 - 2D Visual Aids

4.2.4.3. Compositions With a Purpose:

A majority of the animation’s shots feature compositions that serve a narrative purpose, highlighting the actions and inferring context through visuals alone, without recurring to animation or narrated exposition (Figure 102).

Figure 102 - Compositions And Their Uses

Similarly to the style development process, each shot was refined through dozens of test renders, saving separate files for each version, switching foreground elements, lighting situations and general composition tweaks, comparing their variations in order to find a balance between stylization and legibility, ensuring that the character’s actions are correctly framed, and that the viewer isn’t overwhelmed with visual information.

After hours of iteration, a usual occurrence involved discovering that an earlier version of a shot was more visually appealing than the latest. Consequently, if that older version hadn't been saved in a separate file, valuable time had to be wasted attempting to reconstruct what made that previous render "successful". This trial-and-error approach was as important as it was time consuming, and during this process multiple low priority shots were discarded in order to complete the animation within the allocated timeframe. Additionally, as new scenes were created, earlier compositions were revisited and refined to ensure the same consistency across every shot of the film.

4.2.5. 3D Storyboard

With the completed and stylized compositions, each shot was rendered and replaced on top of the original 2D storyboard, a process which provided the first pre-visualization of how the final animation would look in its rendered form (Figure 103), which can be seen in its entirety in the annex starting with Figure 132. At the end of this process every scene of the storyboard had a dedicated Blender file, with the final material and style correctly set up and ready to be animated.

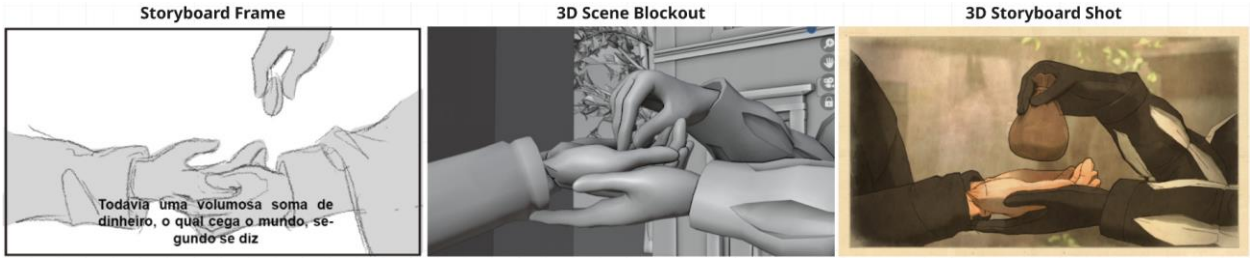


Figure 103 - Storyboard To 3D Render Sequence

4.3. Animation

With every scene's composition set in stone and the 3D animatic completed, the next major step in the production pipeline was to finally animate the film and bring its characters to life. Stylization is a complex endeavor with no master method, and while the visual development process required thorough experimentation and a lengthy development process, the workflow of the project returned to normalcy in the animation phase by sticking to the following conventional animation workflow:

> 1º Block out/Rough animation
>
> 2º Cleanup the animation
>
> 3º Facial Animation
>
> 4º Extra Blend shapes
>
> 5º Simulations & Extras

4.3.1. Block Out:

The characters were manually animated with keyframed animation, wherein the subjects are posed in a sequence of key-positions, and then the 3D program interpolates the motion between them, this technique is also known as "Pose-to-pose" animation [8]. This hand keyframed approach ensures full control over the character's movements and timings and is especially important in shots where characters perform complex interactions, like handing items to each other, multiple instances of carrying bodies, and close-ups of hand movements.

To animate a shot, first the characters are posed and keyframed in their primary positions according to the action they are going to preform – for example, the stages of a walk cycle – then the software interpolates the transition between those states creating an animated sequence. In this stage the rough animations serve to check the overall positioning, timing and flow of the action rather than define intricate details. For example, many walking or simple animations had already been blocked out during the creation of the compositions for each shot, as this process was essential to define the range of movement of the characters within that shot.

4.3.2. Cleanup:

With the rough animation complete the motions are refined by adding additional keyframes and customizing their curves in the graph editor to better define their arcs with ease-ins, ease-outs, sudden stops and a plethora of corrective movements to improve the animation.

The majority of the animation consists of characters walking, for example, after animating and cleaning up the walk cycle of one character, it then served as the base for all others performing this movement, albeit with some variations – walking uphill, downhill, straight ahead; carrying items on the shoulder, in front, by the side; walking rushed or slow. This was a deliberate choice, as the expected runtime of around 5 minutes required extensive optimization efforts, even during animation. The characters' forward walking movement was created by constraining their root to a motion path - a feature that moves an object along a predefined path over a set number of frames [8]. To prevent characters' feet from sliding across the ground during walking animations (which is a common animation mistake), the keyframe with denotes the forward motion of one foot is copied and then applied to the motion path controller ensuring that it advances with same timing as the characters' footsteps. By reusing and adapting similar walking animations, valuable time was allocated to the more complex scenes in the story, involving interactions between characters, intricate compositions, or closeups of complex hand movements (Figure 104).

One of the most complex types of shot in this animation was when characters interact or hand items to each other, to accomplish this they were keyframed in three major positions - their resting pose, their connection point (when both characters are touching the same item), and their final position. To give an item to another character, the item's rig has two "Child of" modifiers, one for each character in the scene and serves to connect the item to any character's hand bones. Before the point of contact the item is connected to the giving character's hand, then at the point of contact,

the modifier is keyframed to connect itself to the receiving character's hand, ensuring a smooth handoff (Figure 104).

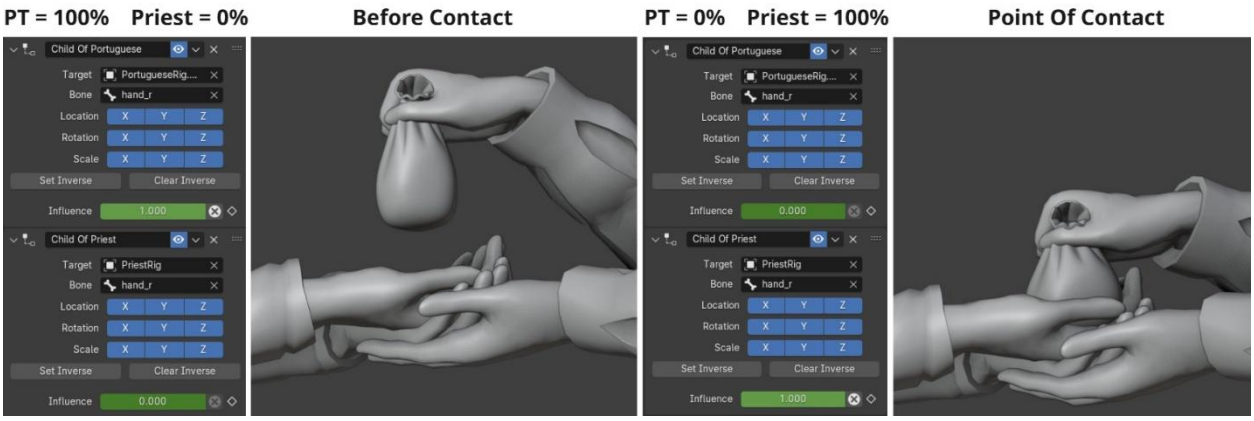


Figure 104 - Handing Props Between Characters

On the topic of workflow optimization, any actions that were not visible to the camera were not animated, with many close-up scenes requiring the character's rigs to be deformed offscreen to create their intended vision. The short-film features a myriad of "impossible" shots, which are compositions which required camera tricks and clever omission of "broken" elements to achieve for artistic effect (Figure 105).

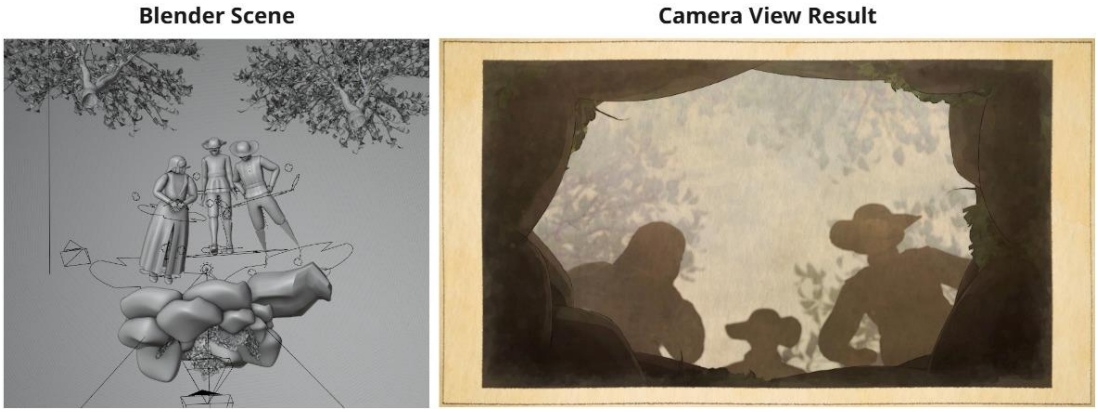


Figure 105 - Blender Scene VS Final Result

4.3.3. Facial Animation:

With the animation of the body completed, the face is then animated (Figure 107). In this stage the eyes are keyframed to follow the action and add purpose to the character's gaze while the face's blend shapes are animated to convey the character's current emotions, mostly through their eyebrows and eyelids. These were used to create micro expressions, like slightly raising an eyebrow and narrowing the eyelids to show distrust, raising both eyebrows to show surprise or furrowing them to show anger (Figure 106).

Figure 106 - Facial Expressions In Final Animation

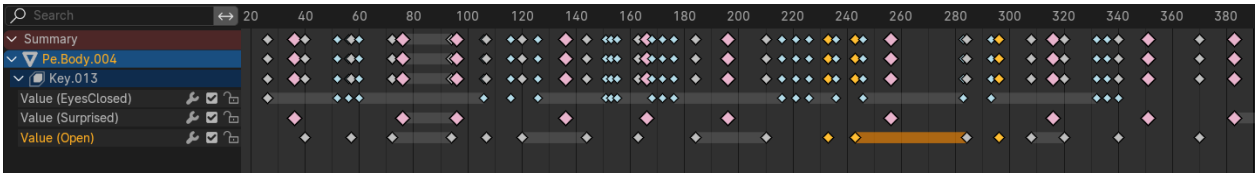


Figure 107 - Color Coded Keyframes For Facial Animation

Facial animation is the most important factor in bringing characters to life, highlighting their emotions and intent, however, it is also time costly, so as early as the storyboarding phase, most shots were planned and designed to omit character's faces as much as possible. Although characters like the Portuguese Gentleman and Priest have scenes which highlight their emotions and intent, the choice to omit characters' faces during most of the animation was as much of an optimization choice as it was a narrative driven one, as it allows them to be portrayed as a generalized group of people, rather than individuals, allowing the viewers to become invested in the larger scope of the story rather than singular characters.

4.3.4. Extra Blend Shapes:

These extra blend shapes are reserved for props and corrective movements. For example, in the scene where a money bag is handed to the priest, the bag itself features blend shape states to control its swaying, stretching and crumpling, which were keyframed to deform the bag during its interactions without having to create a separate rig for it (Figure 108). This was also the case for the priest's cross and his loose sleeves which sway with his movement.

Figure 108 - Money Bag Animation Through Shape Keys

4.3.5. Procedural Animation:

Procedural animation is a technique in which the motion of a subject is generated in real time by the 3D software, instead of being manually keyframed by the animator [8]. This is especially useful to create dynamic and repetitive motions that would otherwise be difficult or inefficient to animate by hand. These motions are controlled by a set of parameters and rules defined by the animator and vary greatly between 3D software.

- **Trees:** To add more life to the scenes the trees with leaves were given procedural animation to make their branches sway and move with the wind (Figure 109). This was accomplished by assigning a "Simple Deform" modifier - a tool which can twist, bend, taper or stretch an object to an assigned angle, which can also be keyframed to deform said object in multiple directions. To create the trees' movement, in the graph editor, a single keyframe was assigned to the angle of deformation, this keyframe was then given a "Noise" modifier, which randomly alters the properties of the selected keyframe in random intervals defined by frequency and strength (Figure 109). These properties were adjusted accordingly to give the trees a slight sway to liven up the image but not distract from the action. Additionally, since every tree in a scene was instanced from the same asset, these modifiers were only applied to the branches and leaves of the "master" tree, which automatically updated all of its instances in the scene.

- **Bystanders:** This "noise modifier" technique was also applied to the bystanders to quickly add movement and make them look alive. This was accomplished by inserting a single keyframe on the hips and neck of the characters and then adding a noise modifier to these keyframes to make them sway back and forth in a similar fashion to the trees; this effect is extremely useful for automatically giving motion to multiple characters that aren't the focus of attention (Figure 109).

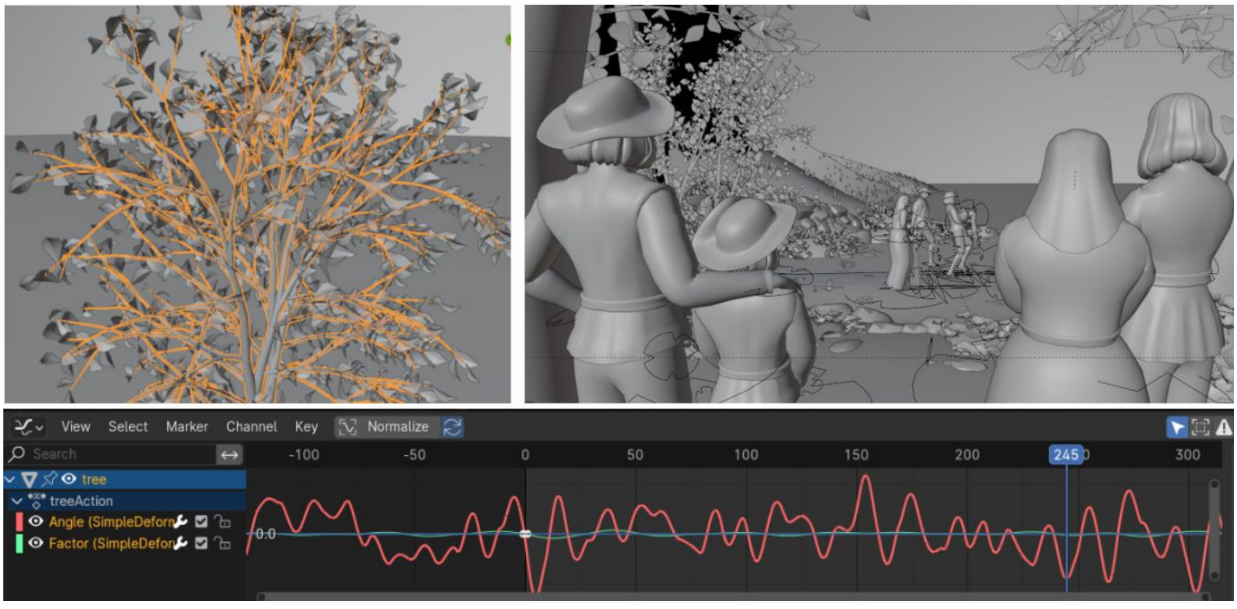


Figure 109 - Tree and Bystanders Using Procedural Noise Animation

4.3.6. Simulations:

When the character animation is complete, the simulations can finally be added on top of their motion. These simulations serve to add more depth and realism to the movement of the characters, akin to secondary animation [8]. These simulated animations need to be calculated frame by frame and thus take time to preview, hence why they were assigned last in the animation workflow.

- **Wiggle Bones:** *Wiggle Bones* [75] is a blender addon that allows the user to select any bones on a rig and apply a simulation to make them "wiggle", this simulates factors like gravity and elasticity along the bone hierarchy that can make an otherwise rigid chain, sway and flop around by customizing its properties.

- **Hair:** For the characters with long hair, the bones atop their heads were simulated with the plugin, carefully adjusting their properties to achieve an acceptable level of stiffness, as if the bones were too flaccid, the excessive hair movement would become extremely distracting and clip through the character's head (Figure 110).

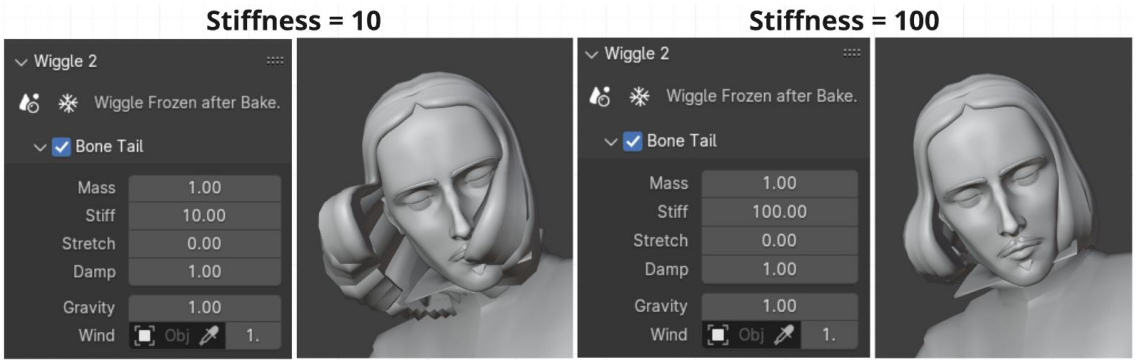


Figure 110 – Wiggle Bones Procedural Hair Simulation Stiffness

- **Ragdolls:** Besides the hair, this plugin was also used in shots where the deceased merchant and the deceased child are carried. These simulations can work in real-time but reduce performance significantly, to aid in the workflow, these bones were used sparingly and in select body parts. In these shots, the characters' bones from the shoulder to the hand, and from the knees to the toes, were simulated to flop around limply as they are carried by other characters. As a side note, the shot where the merchant is thrown off the cliff was manually animated with keyframes, as the Wiggle Bones became unstable when applied to a full rig.

- **Cloth Simulations:** In this process, after the characters' movement was defined, the cloak object was assigned a "Cloth" modifier. This complex simulation requires multiple passes, each taking a considerable amount of time between each iteration, hence the need to go to great lengths to optimize the geometry and workflow for these processes. Every cloak in the animation collides only with their respective character's invisible collider, additionally, the cloaks rim around the neck is exempt from the cloth simulation, pinned to the chest's bone to ensure the cloak stays in place. Additionally, apart from the "Cloth" modifier, a "Smooth" modifier was added to the cloth to iron out

any unwanted artifacts or inconsistencies with the simulation (Figure 111), along with a “Solidify” modifier to turn the flat cloth plane into a solid mesh with a set thickness.

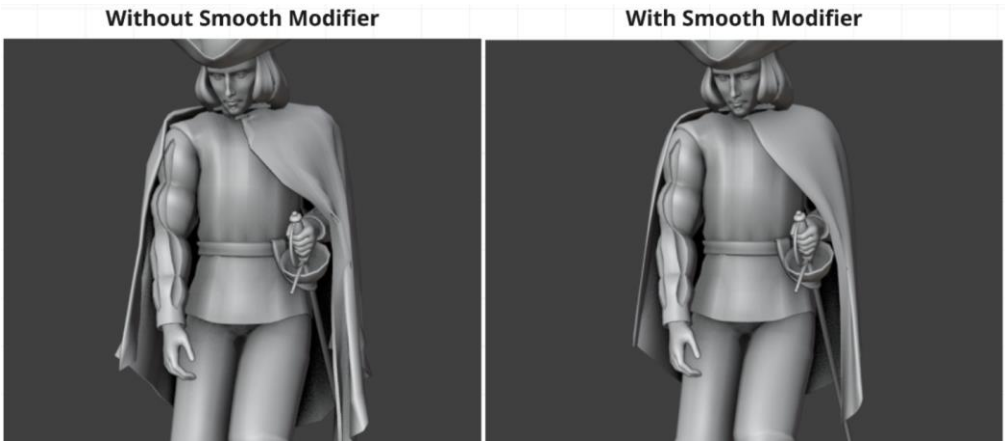


Figure 111 - Cloth Simulation Without And With Smooth Modifier

Furthermore, the priest’s habit features a mixture of cloth simulation and weight painting, here the cloth only affects the painted area, loosing strength as it approaches the priest’s belt before switching over to weight painting completely (Figure 112).

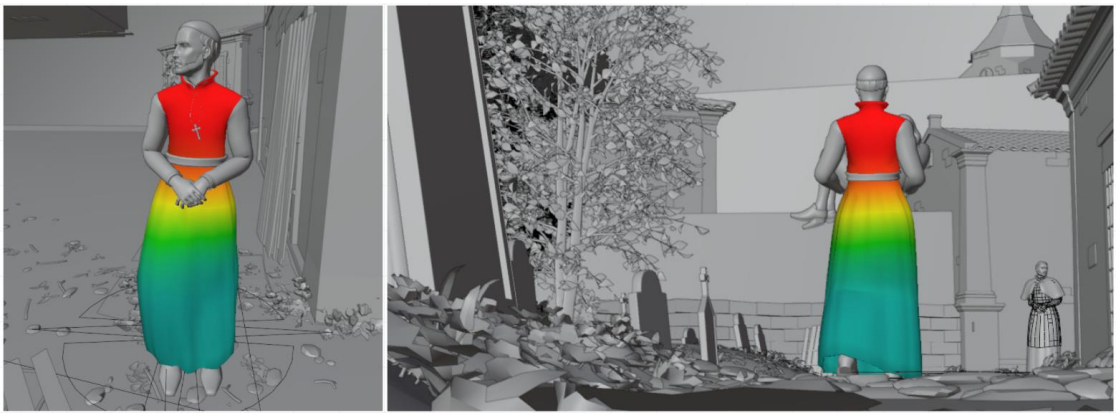


Figure 112 - Priest Cloth Sim + Weight Painting

Once all of the simulations, both hair and cloth, had been tweaked to behave in an appropriate manner, they were then baked into the project file with the completed character animation and ready to be rendered.

4.3.7. Stylized 3D Animation Experiments:

A few experiments were performed to test contemporary stylization techniques on the character animation itself. The first of which was lowering character framerates to create stepped animation. In this process the character’s keyframes were assigned a “Stepped Interpolation” modifier to restrict their movement to 12fps, while the camera still moved at 24fps. While this modifier did create the

intended “choppy” effect, the slow-paced nature of this short-film didn’t mesh well with the stuttered movements, making the slow animations lose precious details in between the dropped frames. Additionally, animated textures were also experimented with, keyframing the textured elements of the materials to flicker at every frame or every few frames, but this technique created too much visual noise, both on the characters and the environment when seen as a full picture. Both of these stylization options were forfeited as they were deemed incompatible with the short-film’s style and workflow, so the project stuck to conventional animation techniques.

4.4. Rendering

Rendering is the final step in the 3D production pipeline, here the completed animation is exported as individual frames in the form of an image sequence [8] (Figure 113). Throughout the visual development phase of the production process the shots were rendered in real-time while being worked on in the viewport, a major advantage of Non-Photorealistic rendering and Blender’s EEVEE render engine, especially on the lower end PC that was used to make this animation. All of the optimization efforts done until now were meant to improve the workflow and allow for this accessibility during the production phase, vital to quickly iterate and adjust the 3D scenes numerous times without long render times, before actually exporting the final image sequence.

Each frame of animation in this style took around 20 seconds to render, and this time can be broken down into its 3 major rendering stages: 6s base pass + 8s grease pencil pass + 6s compositing pass. The base pass or the scene without outlines renders relatively fast as the EEVEE render engine and the created material is relatively light weight. The Grease Pencil outlines, which are added after the initial render, heavily impact performance, and are impacted by every asset they outline and the modifiers that affect them. Finally, the compositing pass is added on top of both.

As most scenes were around 10 seconds long, or 240 frames, the average time to render a full scene was 1h20m. As the film was estimated to be 5 minutes long, this comes around to 7200 frames, taking 40 hours to render the full animation. The rendering process was not left to the very end, after each animation was completed during the day, its frames were rendered straight after in that same afternoon, this allowed the film to be pre-visualized shot by shot in the video editing software at the same time as it was animated. However, in this stage, when viewing the stylized 3D in motion, several “mistakes” and unwanted behaviors were observed, with some of the most pressing concerns being – flickering outlines, incorrect simulations, missing assets and irregular animations. Before advancing to the rest of the files in the rendering process, these issues were ironed out on their respective scenes and their corrections were applied to the remaining shots. Additionally, the textured outlines, which were implemented relatively late, had to be recreated on every file, taking advantage of already having to redo most of the renders for these corrections.

Notably, these shots had to be reworked and re-rendered, which was accomplished over the course of 3 days, making use of two computers, culminating in 34 folders and over 9000 images. While 5 minutes of animation averages out to 7200 frames, the final total is 9000 frames, this is

because every scene was purposefully animated to contain a few extra seconds before and after the animation, to allow for greater flexibility when cutting and editing them in post-production.

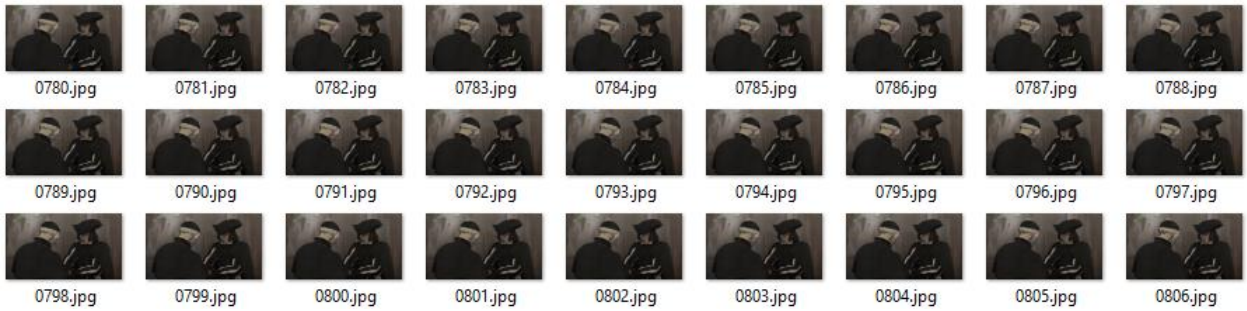


Figure 113 - Rendered Image Sequence

4.4.1. Stylized Vs Realistic:

An experiment was performed by switching the rendering engine and materials of a scene to create a photorealistic render (Figure 114). This involved switching the renderer from EEVEE to Cycles, and giving each 3D model in the scene its own PBR material. One frame with this style and quality took around 6 minutes to render, with a full 5-minute-long animation taking around 30 days to render completely.

Figure 114 - Stylized VS Realistic

Multiple conclusions could be drawn from this experiment: In the realistic version, the 3D models and textures lack the detail necessary for a convincing photorealistic render, as their simplicity becomes painfully evident when complex shading is applied. Here, rather than a real person, the character looks more like a doll in a 3D environment, akin to Claymation or stop-motion. This makes the animation look unintentionally “childish” and risks undermining the serious and historical tone of the film. Additionally, this realistic rendering style is distinctly “modern”, which clashes with the 17th century historical themes and goals of the project.

On the other hand, in the stylized version, the simplicity of the models, textures and shading becomes its greatest strength. Here, the “lower-detail” of the assets and rendering creates a pleasing visual that is capable of conveying a believable character in a painterly 2D aesthetic, rather than a doll in 3D space, ultimately supporting the “dated” and historical visual communication that the project aims to portray.

In conclusion, striving for realism would significantly increase the technical demand of the animation, requiring complex modeling, intricate texturing and costly render times, while ultimately conflicting with the artistic direction of the whole project. Stylization on the other hand, while introducing its own challenges, reduces the specific technical demands of realism and proves effective in conveying the historical atmosphere of the film, through a unique visual language unachievable through realism within the scope of this production.

5. POST-PRODUCTION

Post-production is the final phase of the animation pipeline, here the rendered frames were assembled and edited in Adobe Premiere, the video editing software chosen to create the final short-film (Figure 115). This stage was split into the following stages – Base Editing, Compositing, Sound design, Polishing & Subtitling and Exporting.

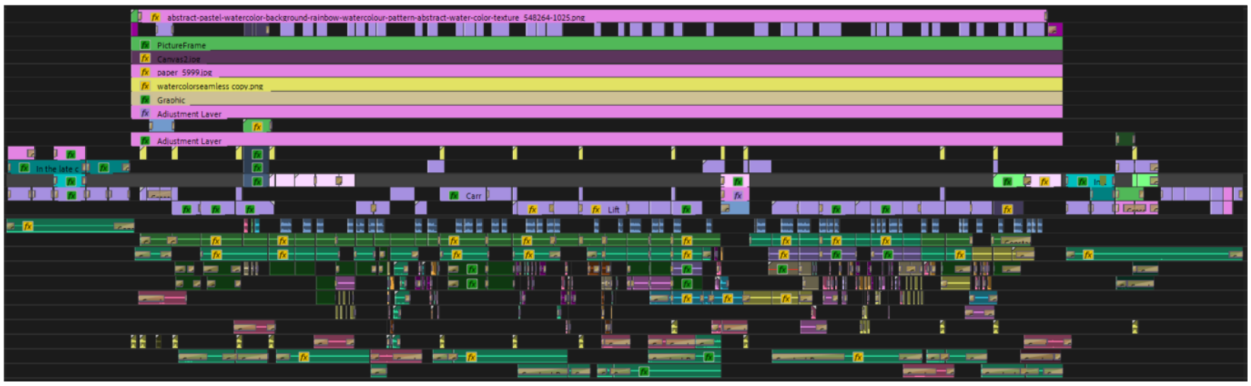


Figure 115 - Full Video Timeline in Adobe Premiere

5.1. Base Editing:

Throughout the animation process, the shots were assembled in Adobe Premiere as soon as they were rendered, replacing the still frames of the animatic with their rendered and animated versions. This provided a solid base to view the full animation, define timings and get a feel for the flow of documentary, including retiming the narration audio from the animatic.

5.2. Compositing:

With the basic editing done, the animation then required compositing, this stage involved overlaying corrective adjustments and visual effects onto multiple shots. While the Blender renders already contained a degree of compositing, with textures, filters and slight color correction, the 3D software's post-processing is baked into the final image and cannot be edited afterwards. In Premiere, the compositing process allowed for a degree of control and artistic expression in editing, even after the frames had been rendered. These effects persist across the entire animation in the following order:

5.2.1. Subtitles: The subtitles should be unaffected by the animation's filters and screen effects, so these were placed as the first layer in compositing.

5.2.2. Border/Painting Frame: The border was developed in Photoshop and went through multiple iterations since pre-production, this 2D image was placed on top of the remaining layers and persists all throughout the animation, except during the exposition sections at the beginning and end of the animation.

5.2.3. Textures: While the watercolor marks and paper textures were present in the Blender compositing, these were re-added in premiere to further enhance their effect and allow for further customization. Textures or filters which overlay the entire screen create a strong “Glass Door” effect, in this case however, this effect was exploited to imply that the animation was happening “inside the paper”.

5.2.4. Sepia & Color Correction: This adjustment layer controls the film’s color correction, which emphasizes low contrast, low saturation and also sharpens the picture, it is equally set to a yellowish tone to create the sepia effect of the animation (Figure 116).

Figure 116 - Without And With Color Correction

5.2.5. Filters: The “dust & scratches” filter removes sharp details and creates a “blotchy” image akin to the “Kuwahara” filter experimented with in Blender. In Premiere however, this filter’s layer was set to “darken” which bypasses the outlines and only affects the colors inside them, preserving the linework while making the surroundings more “painterly”, the higher the value the stronger the effect (Figure 117), for the final animation this filter was left at: 6.

Figure 117 - Dust & Scratches Filter

5.2.6. Visual Effects (VFX):

∘ **Corrective & Artistic Adjustments:** Corrective adjustments mostly involved creating masks to edit specific parts of a shot, for example, masking the foreground to make it darker and highlight the middleground. This can also include artistic adjustments, adding entirely new elements, such as light and dark gradients to better define foreground and background planes; as well as colorful ones to brighten any dull scenes.

∘ **Composite Shots:** Some shots were mostly built in compositing. For example, in the shot where birds fly across the sky with trees swaying in the foreground, the birds themselves are a greenscreen video of birds flying past the camera, behind them is a picture of the sky that was keyframed in Premiere to go from left to right, and the front of the full shot is the actual render of the trees swaying, which had its sky purposely removed to be keyed out (Figure 118).

Figure 118 – Birds Compositing Layers

∘ **Focus Shifts:** In the shot where the priest is carrying the child out of its grave, the camera's focus shifts from the shovel to the priest. This was accomplished by masking the background separately from the shovel and applying a blur to it, then cross-fading into a duplicate version in which the mask is inverted blurring the shovel instead, creating a focus shift effect and adding more intrigue to the scene, entirely in post-processing (Figure 119).

Figure 119- Composited Depth of Field Shift | Left: Shovel in Focus → Right: Background in Focus

- **Animated Particles:** Additionally, almost every shot had animated particles added to them, such as dust floating through the air and light streaks shimmering through the clouds, all to make the forest and other locations feel more alive with small particulates in constant motion.

5.2.7. Full Compositing Sequence:

Figure 120 – Blender + Premiere Compositing Sequence

As a side note, as a consequence of post-processing stylization, over the full editing process, the excessive amount of filters and compositing effects exacted a heavy toll on the Premiere file, which culminated in over 400 crashes over the course of a month and a half, severely halting the post-production workflow.

5.3. Sound Design:

5.3.1. Sound Effects:

With the animation's visuals completed, the next step in post-production was sound design. The short-film features three categories of audio - narration, foley and music. To avoid overwhelming the viewer with audible information atop the narration, the sound effects and soundtrack were designed to subtly complement visuals without omitting the narrator's voice. Notably, many of the core sound effects essential for the story's key moments were already developed for the animatic during pre-production, these served as a base for this process and were refined to match the timing of the final visuals.

These sound effects include **diegetic sounds** – audio resulting from actions visible on screen – such as a character's visible footsteps. To create and edit this foley the animation is closely observed, and the sound effects are meticulously placed in sync with the action seen on screen, oftentimes requiring multiple layers to achieve their intended effect.

Figure 121- Footsteps on Grass SFX

As well as **non-diegetic sounds** – audio that originates from off-screen actions or locations – for example, the sound of ocean waves getting progressively louder as the characters approach the cliff, implying their proximity to the ocean without actually showing it, or using church bells and crowds chatting offscreen to indicate that the story has moved from a quiet forest to a bustling town setting.

5.3.2. Music:

The documentary was initially meant to contain only sound effects and narration, however, adding music to the film greatly complemented the mood and ambience, as it also created opportunities to add new emotional beats to sections where the visuals were incapable of doing so on their own. The music and all of the sound effects were downloaded from Pixabay.com [76], a royalty-free stock media website. The track chosen is “Crawling Danger” by Samuel F Johanns on Pixabay [76]. This song is low impact, without lyrics or strong choruses, and was mostly used for ambience to impede the soundtrack from competing with the narration and the sound effects, instead modifying it to subtly complement the mood of the film. This song was rarely played in full, instead being divided into three sections - suspense, risers and silence – all of which were used to set dramatic moods or raise tension (Figure 122).

- ***Suspense (Green)*** – Letting the dramatic music playout normally and uncut maintains a steady ambience, complementing the visuals and holding the viewer’s attention until the soundtrack picks up.

- ***Risers (Pink)*** – Risers created a sense of anticipation by gradually increasing a stretch of music in intensity or volume. These were used to elevate dramatic moments and set up transitions, for example, as the characters approach the cliff ready to throw the body, multiple risers are layered on in the background, increasing the volume and building up the suspense exponentially the closer they get to the edge. This creates a strong sense of anticipation and riles up the viewers for the upcoming climax, with the risers persisting right up until the body hits the water, and the music cuts of completely.

- ***Silence*** – In contrast to risers, silence was also used to great effect in creating anticipation, adding breathing room to the soundtrack, emotional weight or simply allowing the visuals to speak for themselves. Following the previous example, after building up anticipation with risers, as the body hits the water, the music cuts off completely, here, the silence allows listeners to reflect and wind down from the climax, as the sound of the ocean now takes center stage, and the prolonged absence of music indicates a transition into the next act of the documentary.

Figure 122 – Risers (Pink) Layered on top of "Normal” Music (Green) Ending With A Falloff (Blue) During Cliff Scene

5.4. Polishing & Subtitling:

With the editing and sound design complete, the short-film entered the final polishing phase. This stage involved a myriad of adjustments to every aspect of the documentary, fine-tuning the timing of the shots to improve pacing, adjusting the subtitles and their flow, reviewing credits and their information, additional color correction, audio and music among many other features. All of these small refinements contributed to pushing the short-film ever closer to that final polish. During this process the animation was previewed in private by peers and colleagues, using their feedback at various stages of the post-production to adjust features such as timing and legibility.

5.4.1. Narration:

The order in which the narration and the visuals were handled significantly impacted the viewing experience of the animation. When placing the narration before the visuals, the narrator exposits the information and the visuals complement it; when placing the visuals before the narration, the visuals provide information and the narrator complements it. This approach ensures that both visuals and narration complement each other without fighting for the viewers' attention, as placing one on top the other made it difficult to fully absorb either.

The voice used in the narration during most of the post-production was an AI generated model from elevenlabs.io [58] called George, this "actor" was chosen to represent John Ovington as an older well-spoken British man. As the voice used during this stage was AI generated, this allowed for quick edits and fixes all the way to the end of the editing process, for example: splitting phrases in half, adding pauses, introducing inflections or redoing voice lines entirely. After the animation reached a pleasing final result, an English-speaking voice actor was hired on Fiverr.com to completely replace the AI used during the project's development, ensuring the animation remained AI free and avoided misconceptions on generative AI use and other copyright restrictions.

5.4.2. Subtitles & Translations:

One of the major concerns of the short film was to allow both Portuguese and English speakers to watch the documentary, as it pertains to both their nations, to this end, multiple experiments were performed with different fonts, colors and presentations to achieve an acceptable balance. Ultimately, subtitles should be accessible and as clear as possible in delivering an accurate translation for non-English speaking viewers. The font used to subtitle the film was Arial in bold, making use of strong black outlines and drop shadows, as well as a shade of yellow to help the font stand out in both light and dark backgrounds (Figure 123). This classic font is devoid of decorative strokes at the end of their letters, denoting it sans-serif, which is a common trait of other fonts used in subtitling professional films and TV productions [77].

Figure 123 - Final Subtitles Against Light and Dark Backgrounds

Cursive or "hand-written" fonts are suitable for presenting text in an immersive way fitting of this animation's style and antiquated theme. On the other hand, their organic and exaggerated shapes reduce their legibility, making small text undiscernible from a distance, and oftentimes causing their letters to appear similar or out of order. For these reasons, this hand-written font was only used for the animation's title (Figure 124) and John Ovington's narrated introduction, both appearing at a larger legible size.

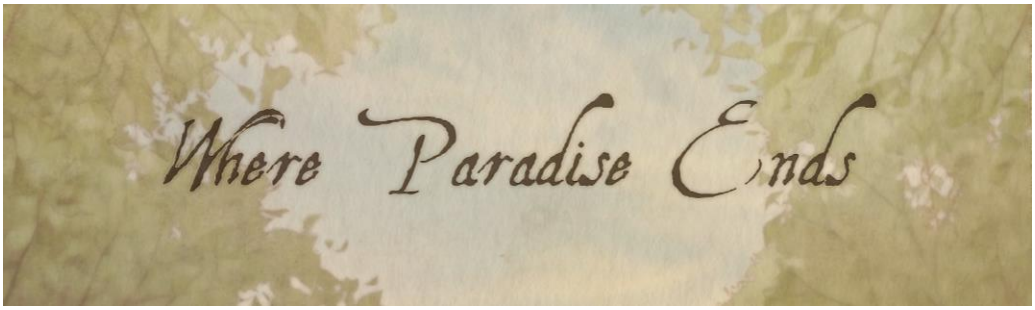


Figure 124 - Title Screen In Cursive Font

The written exposition at the beginning and end of the film is given in the form of small paragraphs that setup the historical context of the animation, these are written in English with Portuguese subtitles appearing periodically as the information is revealed (Figure 125).

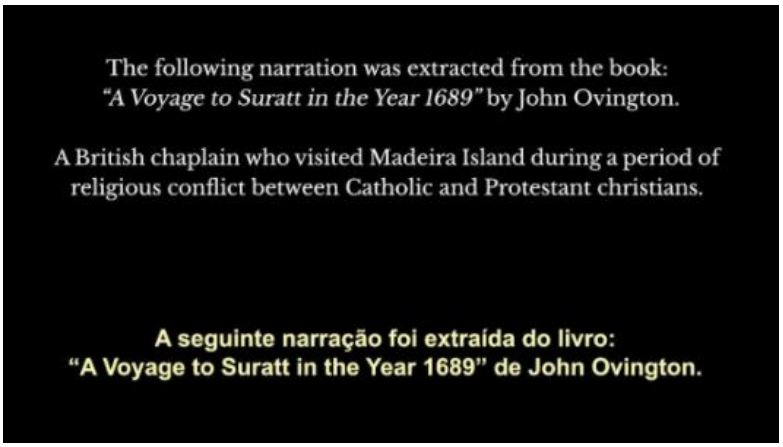


Figure 125 - Exposition Subtitling Sequence

This format also underwent some testing to ensure a pleasing viewing experience, as initial versions featured both languages on screen delivering the same amount of information, filling the frame with excessive reading, and even if only half of it was meant to be read by its respective speaker, the apparent wall of text was evidently off putting and overwhelming right at the start of an animation.

In addition, another option involved creating two separate versions of the short-film: one entirely in English and another entirely in Portuguese. However, this approach was discarded, as having to manage two versions of the animation would complicate its distribution, raising questions for which versions should be shared in different contexts and what factors would determine those choices, before acknowledging that English would oftentimes be the default “safe” option. In the end, the most practical solution for this problem was, in fact, to create a single version which could accommodate both languages.

5.5. Exporting:

With the clean-up complete the film was then exported at its maximum quality, standing at 6:56 minutes long with 5 minutes of actual 3D animation. And can be viewed in its entirety in the following link: https://tinyurl.com/WhereParadiseEnds

The film’s trailer, poster and technical sheet can all be viewed in the first two pages of the annex (Figure 126).

CHAPTER IV - CONCLUSION

6. LIMITATIONS & FUTURE WORK

As of the writing of this dissertation, the film has been submitted to two animation festivals and will continue to be submitted to other events throughout 2026. After its promotional run, the documentary will eventually be published on online forums and platforms concerning NPR and Blender animations to garner an international audience interested in the project's more technical aspects.

Effectively, this project succeeded in creating multiple frames of stylized animation that resemble a 2D artwork, rather than a 3D render or an old photograph, and the final animation features a unique and cohesive style within the stylized 3D animation spectrum. Conversely, while static scenes and screenshots of the film look fairly convincing, the 2D illusion is broken as soon as motion is introduced – be it in the form of character animation, interactive shading, or most notably, camera movements and perspective changes – all of which coincide with the illusion breaking factors studied in the contemporary works compiled in the state of the art. Consequently, a common pitfall while developing this project was, in fact, trying to maintain a foolproof 2D illusion with every shot, even while in motion. This goal set an unreachable precedent, as stylized 3D's ability to emulate 2D animation is, essentially, an uphill battle, in which the time, effort, and technical ingenuity required to create a truly foolproof 2D animation through 3D assets and rendering would, effectively, be better spent in developing a unique 3D style that can take full advantage of NPR, which was ultimately the approach taken in this project.

Evidently, there is no master method for 3D stylization and while some industry trends can be analyzed and emulated, the process of creating a unique visual language proved to be an extremely ambitious and complicated endeavor, resulting in a majority of this project's methodology being taken up by an extensive and convoluted iteration and experimentation process in the lead up to the final style. This fact was especially pertinent given the estimated runtime of 5-minutes, which raised questions throughout the production of whether or not achieving a pleasing visual style replicable throughout more than 30 shots was achievable within the project's timeline. In effect, this was made possible through the extensive optimization efforts applied from the start of the pre-production onwards, as well as the discipline required to let go of low priority objectives and accept the style "as it was", living up to the adage by Leonardo Da Vinci – "*Art is never finished, only abandoned*". In effect, while photorealistic rendering can use real life to define a render's visual accuracy or quality, stylization features no such definitive metrics and demands far greater artistic sensibility to produce satisfactory results, which, in and of themselves, are still subjective and dependent on the viewers' perception, complicating this process.

The development of the procedural material and composition techniques relied heavily on trial-and-error approaches, iterating on the style directly in Blender and Photoshop compositing. Ideally, the visual development process would precede a thorough concept art phase, where every scene and shot from the storyboard would be hand-painted in the animation's intended style to accurately

define their compositions and avoid having to figure out or make up these features “on the spot” for every scene of the animation by making use of the concept art as a clear stylistic reference point.

As the animation’s style was inspired by watercolor paintings – which usually highlighted wide scenic landscapes, rather than individuals or foreground elements – the style naturally performed better in its well-developed wide shots. In its less favorable situations however, the procedural material and the style’s flaws had to be subsequently hidden. While this was achieved through careful compositions, lighting, and prop arrangement, even remaking or removing entire shots to mask these imperfections, this practice often created a trend of “how to hide these imperfections” rather than “how to show off these strengths”, which was a consequence of using procedural materials in an application that prioritizes quantity over quality, when ideally, a visual style should strive for the latter, rather than the former.

In effect, this project’s NPR experiments provided valuable insight on stylization techniques and solidified Blender as the best choice for this kind of independent stylized animation. And while procedural materials have proven to be the most effective method to quickly texture and stylize a multitude of objects in a scene, having every asset share the same material properties can incur less detail in the image overall. Though in the case of this project, this lack of individual detail was exploited to ensure a cohesive visual language across every composition in the documentary and create the animation’s painterly style.

A hand-painted style, which has seen a rise in popularity in recent years with Arcane [32] and many others, could prove more visually appealing and modern, exploiting the attractiveness of this style to further market the short-film to a wider audience through a recognizable style. While this technique would have proved unlikely to succeed within the scope and timeframe allocated to complete this particular animation, further restricted by the limitations of my own artistic ability, it could find success in recreating a more detailed and visually pleasing version of the “dated painting” look that the animation ultimately aimed to achieve.

Additionally, this project raises possibilities to explore 3D stylization in fields beyond animation. For example, the engraving and graphite shaders developed in the pre-production, which worked fairly well with buildings and architectural compositions, could be used for historic games, VR museum tours, or interactive installations, as their use of stylization and non-photorealistic rendering would allow for highly optimized real-time experiences with unique visual styles. Moreover, future iterations of these styles could be customized to fit any country and any era’s visual language.

7. CONCLUSION

In conclusion, this dissertation has detailed the development process of *Where Paradise Ends,* an artistic 3D animated documentary about the Madeira Island of the 17th Century. The themes aborded in this documentary underline the importance of ensuring the highest possible impartiality when representing a cultural event, highlighting faithfulness to a historic source material, even if acknowledging its negative depictions. This boldness is essential to further the understanding of a local and national history, in this case 17th century Madeira Island, and its evolution into present values, as this depiction was meant to contrast the misguided practices represented in the documentary with the welcoming Madeira of today.

Effectively, *Where Paradise Ends* demonstrates both the possibilities and the challenges of producing an independent stylized 3D animation with a unique visual language, and has proven successful in creating multiple frames of stylized animation which resemble traditional paintings, rather than conventional 3D renders. Ultimately, while 3D stylization remains a complex and arduous endeavor with limited precedent, the research on the state of the art, the experiments performed and the eventual final result, stand as a contribution to the field of stylized 3D as a powerful form of artistic expression, capable of a multitude of styles beyond conventional realism.

8. REFERENCES

[1] A. Aragão, *A MADEIRA VISTA POR ESTRANGEIROS. 1455 - 1700*. Funchal: Secretaria Regional da Educação e Cultura. Direcção Regional dos Assuntos Culturais., 1981.

[2] M. Aragay, *Books in Motion: Adaptation, Intertextuality, Authorship*. Amsterdam, NY: Rodopi B.V., 2005.

[3] T. Strothotte and S. Schlechtweg, *Non-Photorealistic Computer Graphics: Modeling, Rendering, and Animation*. San Francisco, CA: Morgan Kaufmann, 2002.

[4] N. Heydari, "The Battle of Realism vs. Artistry: How Stylized Animation is Revolutionizing the Industry," Dream Farm Studios. Accessed: Apr. 27, 2024. [Online]. Available: https://dreamfarmstudios.com/blog/stylized-animation-is-revolutionizing-the-industry/

[5] J. Ovington, *A Voyage to Surat in the Year 1689*. New Delhi, IN: Asian Educational Services, 1994.

[6] A. Sousa, "Igreja Inglesa da Madeira – English Version," DRABL. Accessed: Jan. 11, 2025. [Online]. Available: https://abm.madeira.gov.pt/igreja-inglesa-da-madeira-expo_eng/

[7] A. Lake, C. Marshall, M. Harris, and M. Blackstein, "Stylized rendering techniques for scalable real-time 3D animation," in *Proceedings of the 1st international symposium on Non-photorealistic animation and rendering*, Annecy France: ACM, June 2000. doi: 10.1145/340916.340918.

[8] A. Beane, *3D Animation Essentials*, Sybex., vol. 1. in Serious Skills, vol. 1. Canada: John Wiley & Sons, 2012.

[9] "Transmedia 202: Further Reflections — Pop Junctions," Henry Jenkins. Accessed: Dec. 14, 2024. [Online]. Available: http://henryjenkins.org/blog/2011/08/defining_transmedia_further_re.html

[10] "Walt Disney Animation Studios - Visual Development," Walt Disney Animation Studios. Accessed: Dec. 03, 2024. [Online]. Available: https://disneyanimation.com/process/visual-development/

[11] W. Cottrell, D. Hand, and W. Jackson, *Snow White and the Seven Dwarfs*, California, US: Walt Disney Animation, 1938.

[12] A. Honess Roe, *Animated documentary*. Hampshire, NY: Houndmills, Basingstoke, Palgrave Macmillan, 2013.

[13] W. McCay, *The Sinking of the 'Lusitania*, California, US: Universal Pictures 1918.

[14] B. Nichols, *Introduction to documentary*. Bloomington, Ind. : Indiana University Press, 2001.

[15] F. Luz, "Animation Documentaries and Reality Cross- Boundaries," *Int. J. Film Media Arts*, 2016.

[16] I. Takahata, *The Tale of Princess Kaguya*, Tokyo, JP: Studio Ghibli, 2013.

[17] D. K. Welchman and H. Welchman, *Loving Vincent*, Poland, United Kingdom: BreakThru Films, Trademark Films, Silver Reel, 2017.

[18] M. Kamen, "Studio Ghibli's Isao Takahata on animating his final film," *Wired*. Accessed: Sept. 07, 2025. [Online]. Available: https://www.wired.com/story/isao-takahata-interview/

[19] Loving Vincent, Loving Vincent - Making Of, (Marc 30, 2017). Accessed: Sept. 12, 2025 [Online Video]. Available: https://www.youtube.com/watch?v=QE9Q_7bfHsM

[20] J. Lasseter, *Tin Toy*, California, US: Pixar Animation Studios, 1988.

[21] J. Lasseter, *Toy Story*, California, US: Pixar Animation Studios, 1995.

[22] Ultimate History of CGI, *Monsters, Inc. - CGI making of (2001)*, (June 18, 2019). Accessed: Sept. 07, 2025. [Online Video]. Available: https://www.youtube.com/watch?v=XzLp5GQ9AnE

[23] R. Clements, J. Musker, and D. Hall, *Moana*, California, US: Walt Disney Animation Studios, 2016.

[24] J. Bush, B. Howard, and C. C. Smith, *Encanto*, California, US: Walt Disney Animation Studios, 2021.

[25] C. Buck and J. Lee, *Frozen II*, California, US: Walt Disney Animation Studios, 2019.

[26] P. Charrue, A. Delord, *Arcane: League of Legends*, Paris, FR: Fortiche Production, 2021.
[27] J. Crawford and J. Mercado, *Puss in Boots: The Last Wish*, California, US: DreamWorks Animation, 2022.
[28] G. Chen, W. Wu, *Marvel Rivals*, Huangzhou, CN: NetEase Games, 2024.
[29] J. Kahrs, *Paperman*, California, US: Walt Disney Animation Studios, 2012.
[30] B. Persichetti, P. Ramsey, and R. Rothman, *Spider-Man: Into the Spider-Verse*, California, US: Columbia Pictures, 2018.
[31] Vox, *How "Spider-Verse" forced animation to evolve*, (Sept. 10, 2022). Accessed: Sept. 07, 2025. [Online Video]. Available: https://www.youtube.com/watch?v=l96IgQmXmhM
[32] League of Legends, *Arcane: Bridging the Rift | Part 3 - Killstreaks Meet Keyframes*, (Aug. 18, 2022). Accessed: Nov. 15, 2024. [Online Video]. Available: https://www.youtube.com/watch?v=Qd1rOtu4SMI
[33] G. Zilbalodis, *Flow*, Latvia: Dream Well Studio, 2024.
[34] B. Foundation, "blender.org - Home of the Blender project - Free and Open 3D Creation Software," blender.org. Accessed: Jan. 10, 2025. [Online]. Available: https://www.blender.org/
[35] "EEVEE - Blender 4.5 LTS Manual." Accessed: Sept. 07, 2025. [Online]. Available: https://docs.blender.org/manual/en/latest/render/eevee/introduction.html
[36] "style noun - Definition, pictures, pronunciation and usage notes | Oxford Advanced Learner's Dictionary at OxfordLearnersDictionaries.com." Accessed: Sept. 07, 2025. [Online]. Available: https://www.oxfordlearnersdictionaries.com/definition/english/style_1?%EF%BB%BFq=style
[37] D. (Diane E. Lyons, "Regionalism of Dorset art style: a comparative analysis of stylistic variability in five Dorset art samples," 1982, *University of Calgary*. doi: 10.11575/PRISM/19201.
[38] O. Menis-Mastromichalakis, N. Sofou, and G. Stamou, "Deep Ensemble Art Style Recognition," in *2020 International Joint Conference on Neural Networks (IJCNN)*, Glasgow, United Kingdom: IEEE, July 2020, pp. 1–8. doi: 10.1109/IJCNN48605.2020.9207645.
[39] "Definition of STYLIZE." Accessed: Nov. 04, 2024. [Online]. Available: https://www.merriam-webster.com/dictionary/stylize
[40] P. Docter and K. Powers. *Soul*, California, US: Walt Disney Studios, 2020.
[41] N. Bruno and T. Quane, *Nimona*, California, US: Annapurna Pictures, 2023.
[42] C. Dubosc, G. Gorisse, O. Christmann, and S. Richir, "Consistency of Virtual Human Faces: Effect of Stylization and Expressiveness Intensity on Character Perception," *ICAT-EGVE 2023 - Int. Conf. Artif. Real. Telexistence Eurographics Symp. Virtual Environ.*, pp. 63–71, 2023, doi: 10.2312/EGVE.20231314.
[43] P. Perifel, *The Bad Guys*, California, US: DreamWorks Animation, 2022.
[44] B. Howard, R. Moore, and J. Bush, *Zootopia*, California, US: Walt Disney Animation Studios, 2016.
[45] B. Bird, *The Iron Giant*, California, US: Warner Bros. Animation,1999.
[46] B. Studio, "Cowboi: Level up your NPR," Blender Studio. Accessed: Sept. 07, 2025. [Online]. Available: https://studio.blender.org/blog/cowboi/
[47] T. O'Hailey, *Hybrid Animation: Integrating 2D and 3D Assets*. Massachusetts, US: Taylor & Francis, 2010.
[48] "Cel shading," *Wikipedia*. Sept. 04, 2025. Accessed: Sept. 07, 2025. [Online]. Available: https://en.wikipedia.org/w/index.php?title=Cel_shading&oldid=1309580066
[49] Still Watching Netflix, *The Art Of Nimona | Netflix*, (June 30, 2023). Accessed: Nov. 06, 2024. [Online Video]. Available: https://www.youtube.com/watch?v=iADtotJt198
[50] J. Kahrs, *Age of Sail*, California, US: Google Spotlight Stories, Chromosphere, Evil Eye Pictures, 2018.

[51] J. Lu, P. V. Sander, and A. Finkelstein, “Interactive painterly stylization of images, videos and 3D animations,” in *Proceedings of the 2010 ACM SIGGRAPH symposium on Interactive 3D Graphics and Games*, Washington D.C.: ACM, Feb. 2010, pp. 127–134. doi: 10.1145/1730804.1730825.
[52] Diego Gangl, *Creating a watercolor material in Eevee*, (Sept. 07, 2020). Accessed: Sept. 07, 2025. [Online Video]. Available: https://www.youtube.com/watch?v=ZKObDQEPR3A
[53] T. Hill, *The SpongeBob Movie: Sponge on the Run*, California, US: Paramount Animation, 2021.
[54] NVIDIA Studio, *Creating a Stylized Character Animation w/ Bozo Balov | Part 1: Painting in VR*, (Mar. 10, 2023). Accessed: Sept. 07, 2025. [Online Video]. Available: https://www.youtube.com/watch?v=guu_JBTped8
[55] N. Sahgal, “Five Centuries After Reformation, Catholic-Protestant Divide in Western Europe Has Faded,” Pew Research Center. Accessed: Nov. 16, 2024. [Online]. Available: https://www.pewresearch.org/religion/2017/08/31/five-centuries-after-reformation-catholic-protestant-divide-in-western-europe-has-faded/
[56] R. Carita, *História da Madeira Séc. XVII - Volume III O Regresso do Atlântico*, Imprensa Académica., vol. 3, 6 vols. in O Regresso do Atlântico, vol. 3. Portugal: Imprensa Académica, 2016.
[57] A. Bourdon, *História de Portugal*, 3º. Lisbon: Edições Texto & Grafia, 2015.
[58] “Free Text to Speech & AI Voice Generator,” ElevenLabs. Accessed: Sept. 07, 2025. [Online]. Available: https://elevenlabs.io
[59] “1680-1689 | Fashion History Timeline.” Accessed: Oct. 08, 2024. [Online]. Available: https://fashionhistory.fitnyc.edu/1680-1689/
[60] “1650–1700 in Western fashion,” *Wikipedia*. June 18, 2024. Accessed: Nov. 06, 2024. [Online]. Available: https://en.wikipedia.org/w/index.php?title=1650%E2%80%931700_in_Western_fashion&oldid=1229746014
[61] D. Stoop, *Terreiro do Paço*. 1662.
[62] K. H. Carl and V. Charles, *Baroque Art*. New York, US: Parkstone International, 2009.
[63] “Autodesk Maya | Autodesk.” Accessed: Apr. 12, 2024. [Online]. Available: https://www.autodesk.com/products/maya/overview
[64] “Shader Editor - Blender 4.3 Manual.” Accessed: Nov. 12, 2024. [Online]. Available: https://docs.blender.org/manual/en/latest/grease_pencil/introduction.html
[65] “Grease Pencil - Blender 4.3 Manual.” Accessed: Nov. 12, 2024. [Online]. Available: https://docs.blender.org/manual/en/latest/grease_pencil/index.html
[66] Blender Guru, *Beginner Blender Tutorial - Full Course*, (July 25, 2024). Accessed: Sept. 05, 2025. [Online Video]. Available: https://www.youtube.com/watch?v=4haAdmHqGOw
[67] Kevandram, *3 Simple Stylized Toon Shaders for Creating 2D/3D Artworks in Blender*, (Jan. 19, 2023). Accessed: Sept. 08, 2025. [Online Video]. Available: https://www.youtube.com/watch?v=vRALvQSS1vw
[68] SouthernShotty, *EASIEST Way to Make Painterly Animations in Blender 3D (Procedural Shader)*, (Feb. 20, 2024). Accessed: Sept. 08, 2025. [Online Video]. Available: https://www.youtube.com/watch?v=UfSw6428bcc
[69] Toni Mortero, *Blender NPR PENCIL LOOK - Not only a shader (by Toni Mortero)*, (Sept. 06, 2020). Accessed: Sept. 08, 2025. [Online Video]. Available: https://www.youtube.com/watch?v=_reT6PwJRkg
[70] J. Bulwer and W. Westall, *Santa Cruz - Madeira*. 1827.
[71] F. Dillon and T. Picken, *Convento de São Francisco*. 1850.
[72] S. Davies, *Sé do Funchal*. 1779.
[73] S. Davies, *Madeira (1779)*. 1779.

[74] S. Davies, *Funchal Castle Del Oiso, Madeira*. 1779.
[75] "Wiggle bones (a jiggle bone implementation for 2.8) - Coding / Released Scripts and Themes," Blender Artists Community. Accessed: Sept. 08, 2025. [Online]. Available: https://blenderartists.org/t/wiggle-bones-a-jiggle-bone-implementation-for-2-8/1154726?u=peetie
[76] "5.7 million+ Stunning Free Images to Use Anywhere - Pixabay." Accessed: Sept. 08, 2025. [Online]. Available: https://pixabay.com/
[77] "BBC Subtitle Guidelines." Accessed: Sept. 07, 2025. [Online]. Available: https://www.bbc.co.uk/accessibility/forproducts/guides/subtitles/subtitles/

9. ANNEX

Video Link: https://tinyurl.com/WhereParadiseEnds

Technical Sheet

Where Paradise Ends

Synopsis:

A narrated 3D animated artistic documentary based on an English foreigner's factual written account of Madeira Island during a time of religious conflict in the 17th Century.

Trailer: https://www.youtube.com/watch?v=XhZ78szjX1U

Details:

6:56 min. 24 FPS, 3D Animated Artistic Documentary – Portugal 2025.

Part of the Master's Thesis Project: *Where Paradise Ends: An artistic 3D animated documentary about the Madeira Island of the 17th century*, for the International Master of Interactive Media Design, University of Madeira.

Directed, Produced and Animated by Marcelo Mendonça

Music by SamuelFJohanns – Pixabay.com

Narration by John W – Fiverr.com

Video Frames:

Poster:

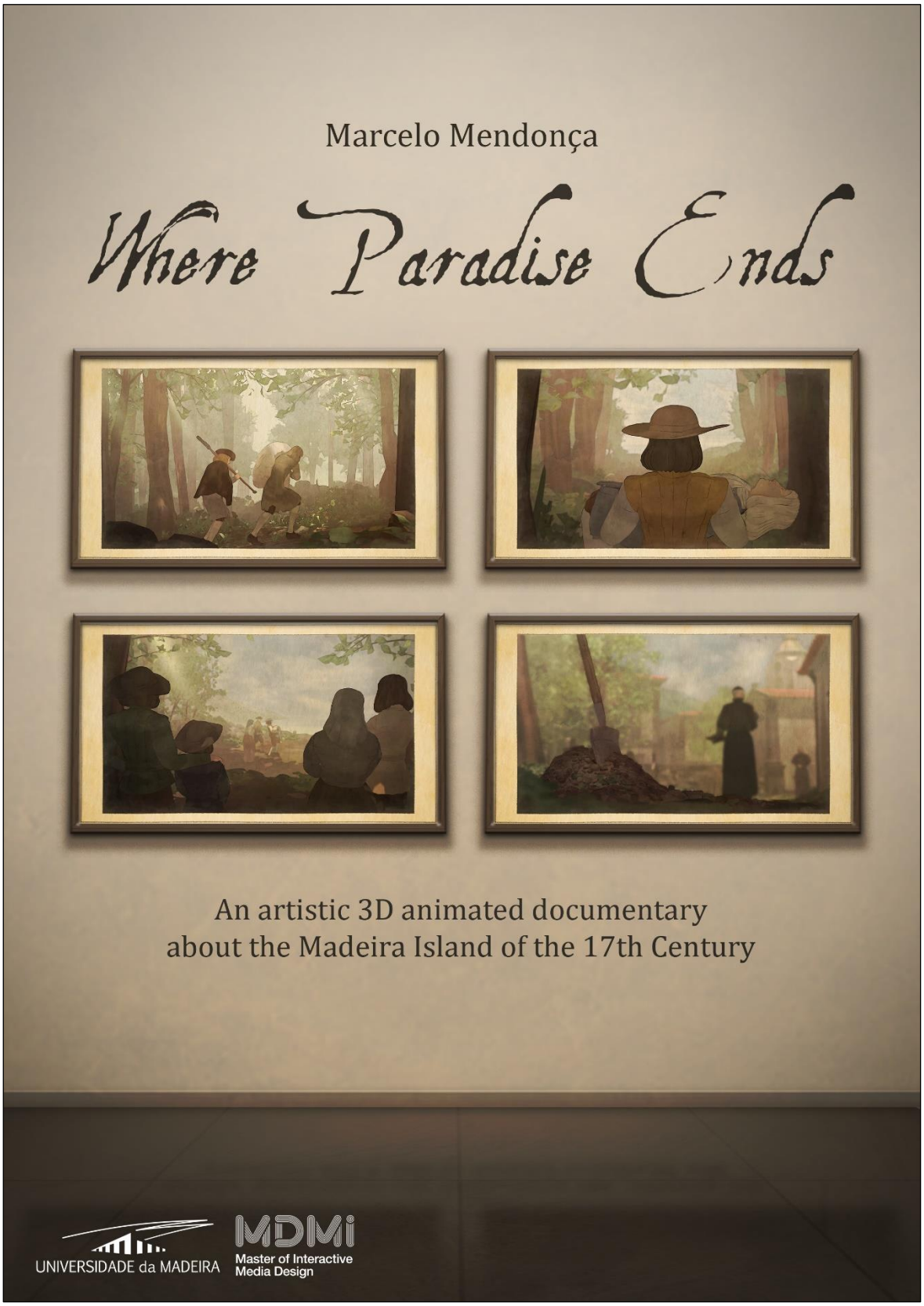
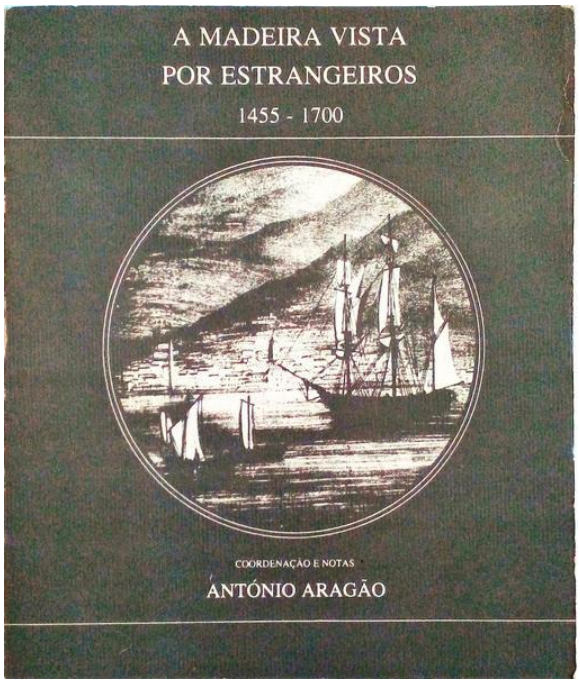


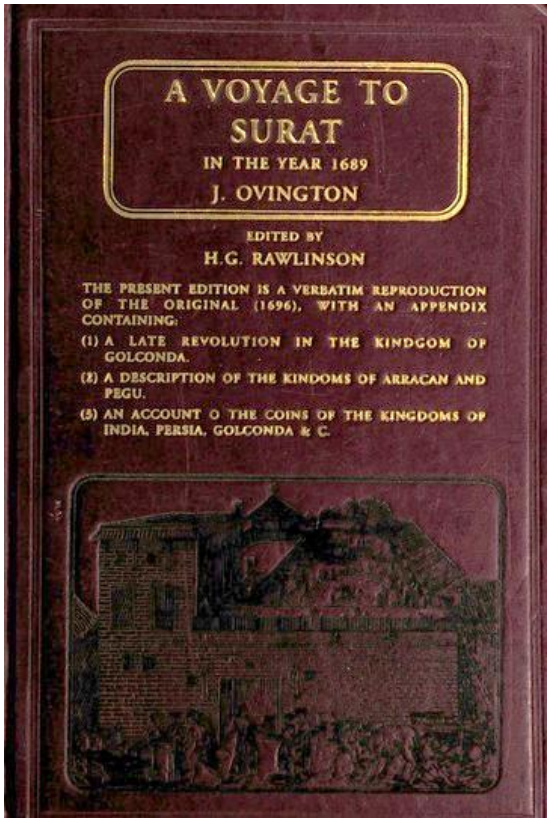
Figure 126 - Where Paradise Ends Poster

Main Books Used:

A Madeira Vista Por Estrangeiros 1455 – 1700 – António Aragão



A Voyage to Suratt in The Year 1689 – John Ovington



Extracted Text In Full:

No burying place allowed to the English. But as their Church allows no Charitable Thoughts to the Souls of Hereticks, so does it forbid all kindness to their dead Bodies, and prosecutes the *English* that die there, with more inexorable hatred, than what they shew to the Carcasses of Beasts and Birds, which may find a resting place on shoar, and quietly remain upon common ground; both which are strictly forbid the *English*, who are cast into the Sea, and committed to the waves. And accordingly an English Merchant falling sick of a sudden Distemper at *Madeira*, was unfortunately carried off by it; which mov'd the rest of our Nation that were there, to contrive for his decent Interment. And therefore, lest a publick Burial might expose him to the Rage of the People, or the Clergy's Indignation, they concluded to deposit him among the Rocks, in order to his better concealment. But the Rocks were unable to shelter him from their Tyranny, which was exercis'd upon him in this barbarous manner, they dragg'd him from the place where he lay, up and down the Island, and expos'd him to the contempt of the Inhabitants, till they threw him into the Ocean.

A dead Child Baptiz'd and Buried for a Summ of Mony. This Inhumanity, which is carried even beyond the Grave, is propagated as far as their Plantations in the *East*; where if any Protestant chance to die among the Nation of the *Portuguese*, no place is allowed for his Reception, nor vile enough for his Sepulchre, but the very Corps of a rank Heretick annoys the Dominions of a Catholick Country, tho' it were buried under ground. And yet a powerful Summ of Mony, which is said to blind the world, prevail'd to open the Eyes of the Priests Intellectuals in this very case; for thus they stated the difficulty concerning an *English* Child, which had been clandestinely Interred there, that if it were immediately taken up, and then Baptized after their manner, and so made a Member of their Church, it might be admitted among their Dead. This Conclusion was approv'd of as Canonical, for the Child was Baptiz'd, Buried after their manner, and deposited where it was taken up.

Narration & Translation:

Their church allows no charitable thoughts to the souls of heretics.
A igreja deles não permite pensamentos caridosos para com as almas hereges.

As it forbids all kindness to their dead bodies…
Pois proíbe toda a bondade para os seus cadáveres…

And prosecutes the English that die there.
E persegue os ingleses que lá morrem.

They do so with more inexorable hatred,
Perseguem-os com um ódio mais implacável,

Than what they show to the carcasses of beasts and birds.
Do que revelam para os esqueletos de animais e pássaros.

Which may find a resting place on shore,
Que podem encontrar um lugar de repouso na costa,

And quietly remain upon common ground.
E permanecem tranquilamente em terreno comum.

Both, which are strictly forbid the English.
Ambos, que são estritamente proibidos aos ingleses.

Who are cast into the sea and committed to the waves.
Que são lançados ao mar e entregues às ondas.

And accordingly, an English merchant,
E consequentemente, um comerciante inglês,

Falling sick of a sudden distemper at Madeira.
Tendo adoecido de uma indisposição repentina na Madeira.

Was, unfortunately, carried off by it.
Foi, infelizmente, tomado por ela.

Which moved the rest of our nation, that were there, to contrive for his decent interment
O que comoveu o resto da nossa nação, que lá estava, a planear o seu enterro decente.

Lest a public burial might expose him to the rage of the people,
Para que um funeral público não o expusesse ao ódio da população,

Or the clergy's indignation.
Ou à indignação do clero.

They concluded to deposit him among the rocks, in order to his better concealment.
Resolveram depositá-lo entre as rochas, para tentar escondê-lo melhor.

But the rocks were unable to shelter him…
Mas as rochas não foram o suficiente para defendê-lo…

From "their" tyranny.
Da tirania "deles".

Which was exercised upon him in this barbarous manner.
Que foi exercida sobre ele, desta forma bárbara.

They dragged him from the place where he lay, up and down the island.
Arrastaram-no de onde estava enterrado, de cima a baixo pela ilha.

And exposed him to the contempt of the inhabitants.
E expuseram-no ao desprezo dos habitantes.

Till they threw him into the ocean.
Até o atirarem ao oceano.

Here, this inhumanity is carried even beyond the grave.
Aqui, esta desumanidade, é exercida até para além do túmulo.

Where if any Protestant chance to die among the nation of the Portuguese.
Se algum protestante morrer na nação dos portugueses.

No place is allowed for his reception, nor vile enough for his sepulcher.
Nenhum lugar é permitido para a sua receção, nem suficientemente vil para o seu sepulcro.

As the very corps of a rank heretic, annoys the dominions of a catholic country.
Pois o cadáver de um repulsivo herege, incomoda os domínios de um país católico, embora tenha sido enterrado.

And yet…
Mesmo assim…

A powerful sum of money, which is said to blind the world.
Uma poderosa soma de dinheiro, que dizem cegar o mundo.

Prevailed to open the eyes of the priests' intellectuals, in this very case.
Prevaleceu em abrir os olhos de clérigos intelectuais, neste mesmo caso.

Concerning an English child.
Relativamente a uma criança inglesa.

Which had been clandestinely interred there.
Que ali for a enterrada clandestinamente.

The clergy decided, that if it were immediately taken up.
O clero decidiu, que se ela fosse imediatamente desenterrada.

And then baptized after their manner.
E depois batizada segundo o rito deles.

It might be admitted among their dead.
Ela podia ser admitida entre os seus mortos.

This conclusion was approved of as canonical.
Esta conclusão foi aprovada como canónica.

For the child was baptized, buried after their manner, and deposited where it was taken up.
Pois a criança foi batizada, enterrada à maneira deles, e depositada onde fora desenterrada.

Text at start and end of the documentary:

Start Frame 1

In the late c. XVII, the Kingdom of Portugal and the Kingdom of Great Britain, entered into the Treaty of Westminster.

A commercial and diplomatic accord which also guaranteed religious freedom for English subjects, mostly Anglican reformers, residing in Portuguese lands.

However, in reality, for the English who lived and died on Madeira island, as they were not of Catholic faith, only the sea could serve as their burial place.

No século 17, o Reino de Portugal e o Reino da Grã-Bretanha assinaram o Tratado de Westminster.

Um acordo comercial e diplomático que garantia liberdade religiosa aos súbditos ingleses, na sua maioria reformistas anglicanos, que residiam em terras lusas.

Mas, na realidade, aos ingleses residentes na Ilha da Madeira, e nela falecidos, por não possuírem crença católica, só o mar lhes podia servir de sepultura.

Start Frame 2

The following narration was extracted from the book:
"A Voyage to Suratt in the Year 1689" by John Ovington.

A British chaplain who visited Madeira Island during a period of religious conflict between Catholic and Protestant Christians.

A seguinte narração foi extraída do livro:
"A Voyage to Suratt in the Year 1689" de John Ovington.

Um capelão britânico que visitou a ilha da Madeira num período de conflito religioso entre cristãos Católicos e Protestantes.

End Frame

In 1761, after petitions from consuls and British residents of Madeira, the Marquis of Pombal granted them permission to possess their own cemetery.

In 1808, the English Cemetery was constructed, and stands to this day on Rua da Carreira.

Em 1761, após petições de cônsules e ingleses moradores na Madeira, o Marquês de Pombal concedeu autorização para possuírem cemitério próprio.

Em 1808, foi construído o Cemitério dos Ingleses, que ainda hoje se ergue na Rua da Carreira.

Engraving and picture used at the end of the documentary:

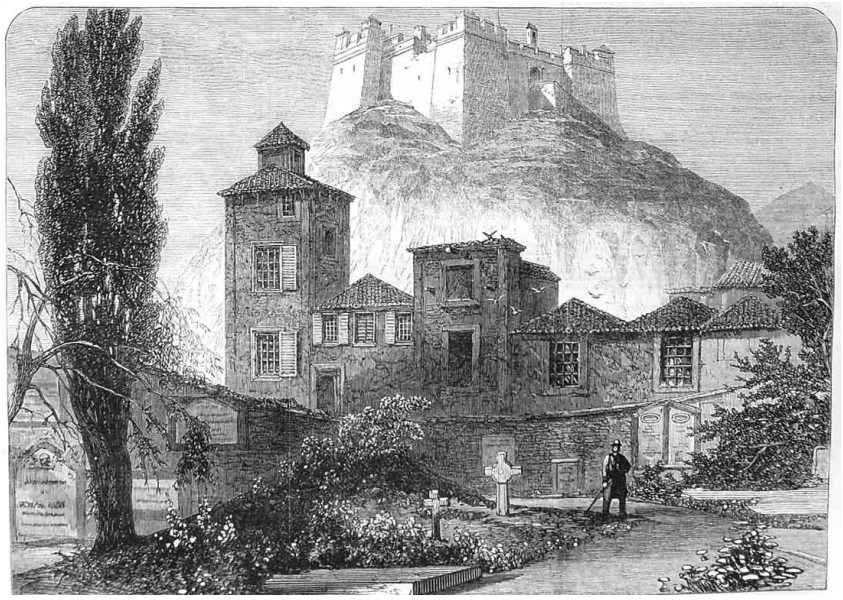


Figure 127- Sketches of Funchal, Madeira - The English Cemetery, The Illustrated London News, 1866

Figure 128 - The English Cemetery Nowadays, Marcelo Mendonça, 2025

2D Storyboard:

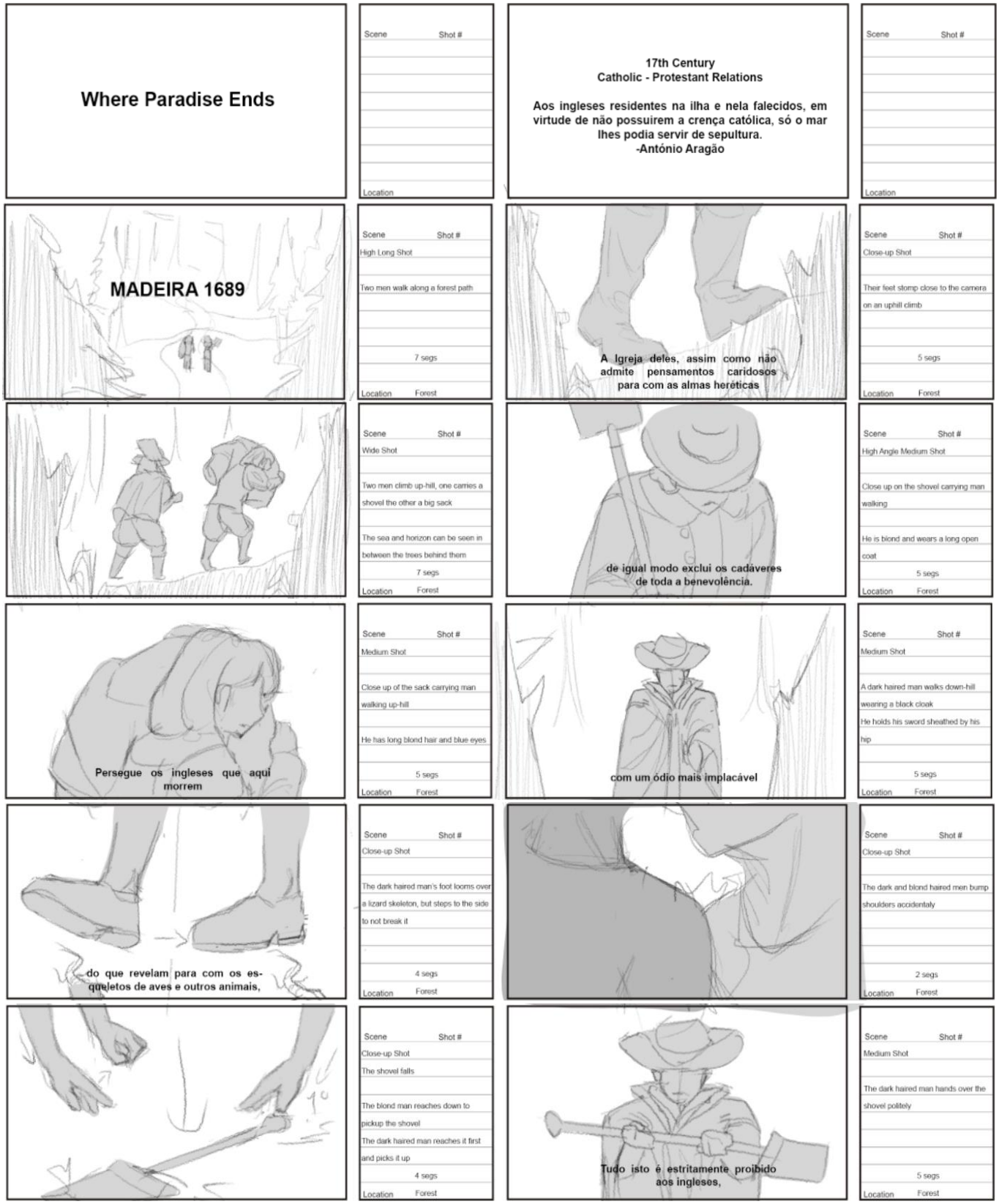


Figure 129 - 2D Storyboard 1

Figure 130 - 2D Storyboard 2

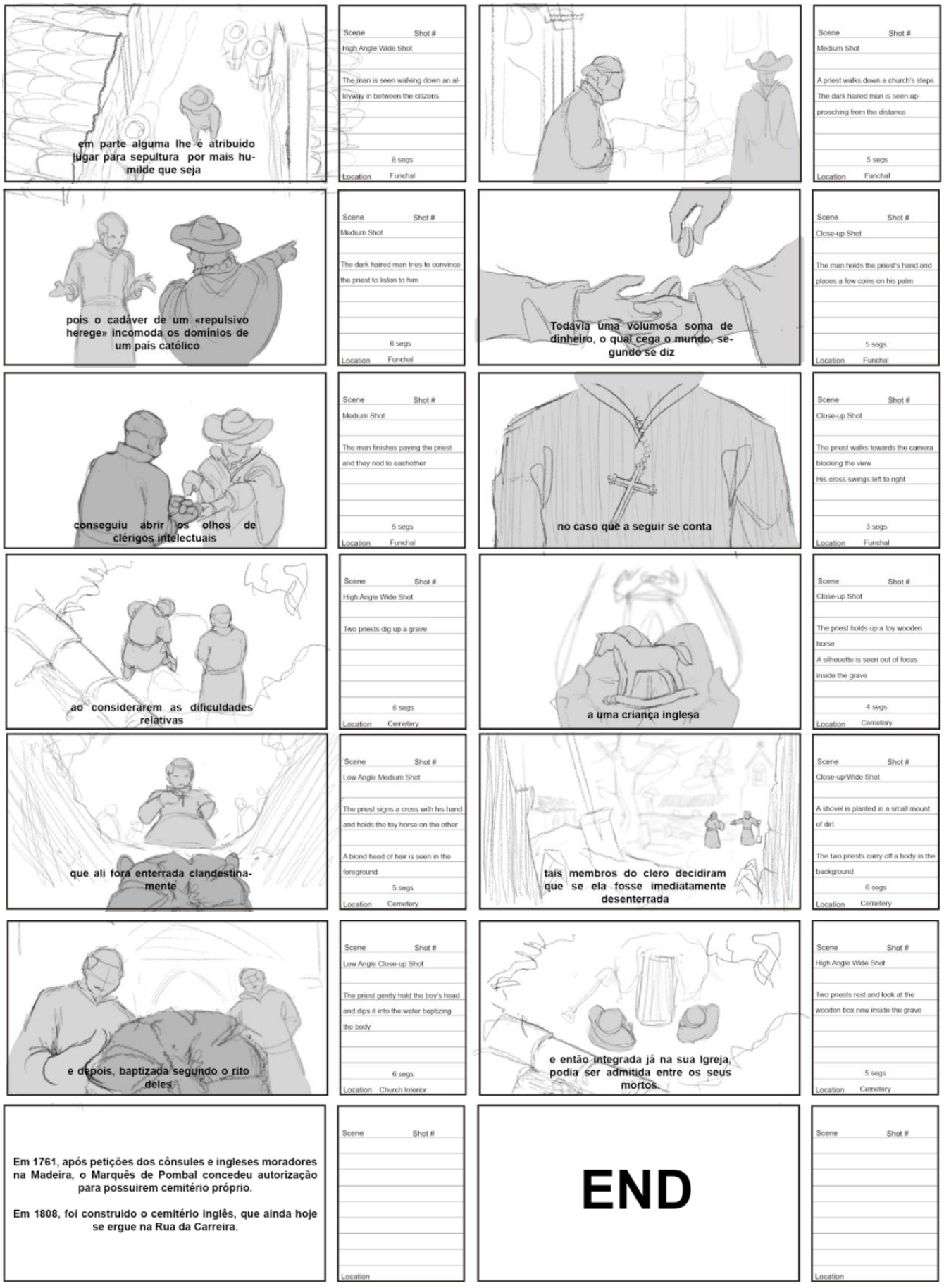


Figure 131 - 2D Storyboard 3

3D Storyboard:

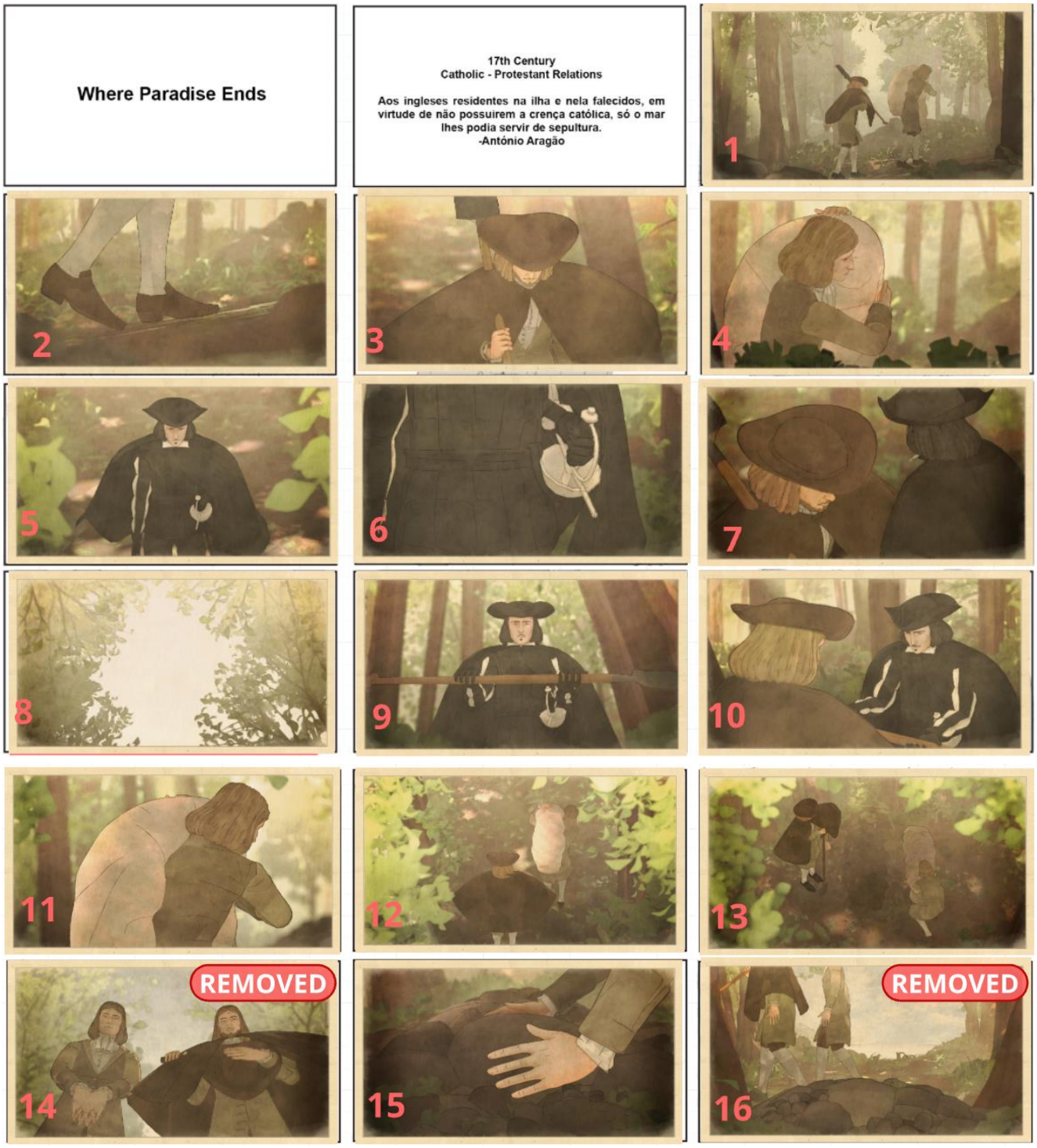


Figure 132 - 3D Storyboard 1

Figure 133 - 3D Storyboard 2

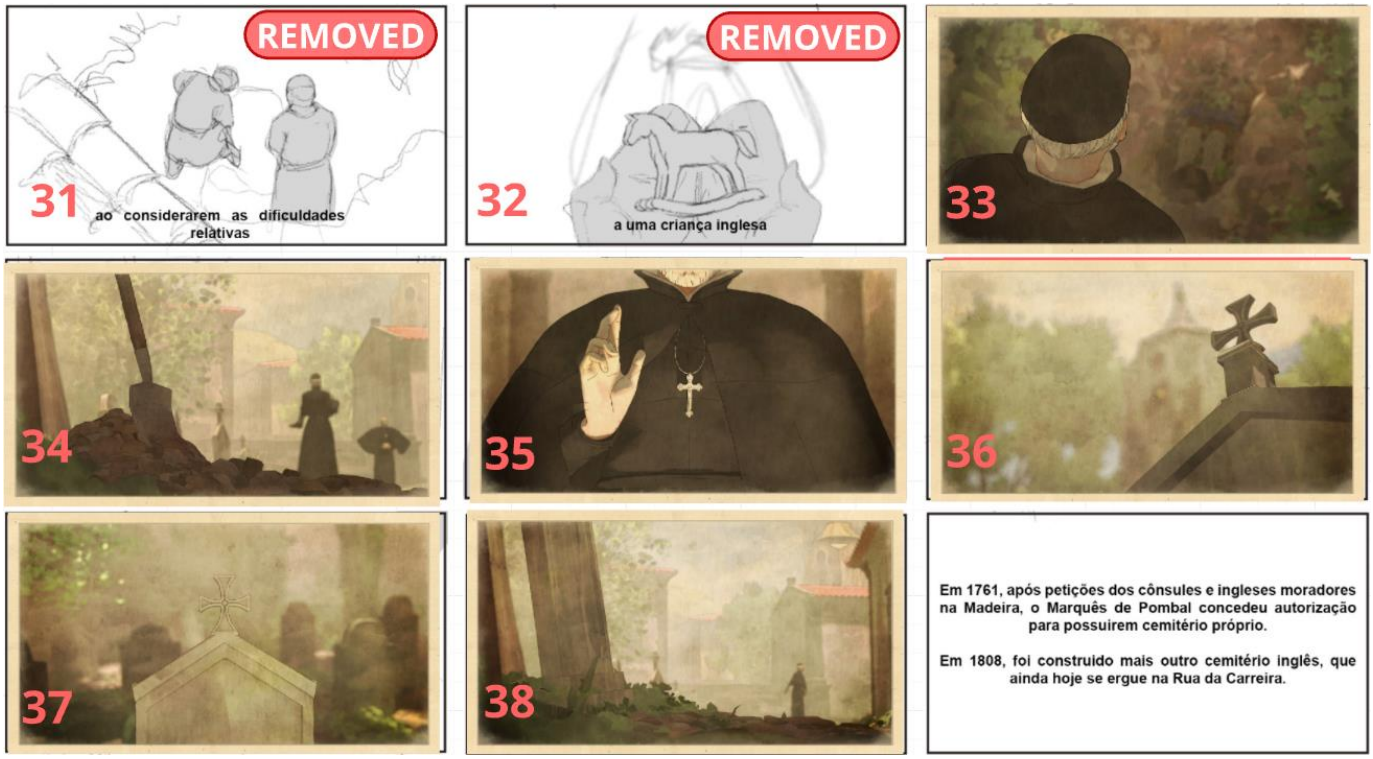


Figure 134 - 3D Storyboard 3

Character Design References:

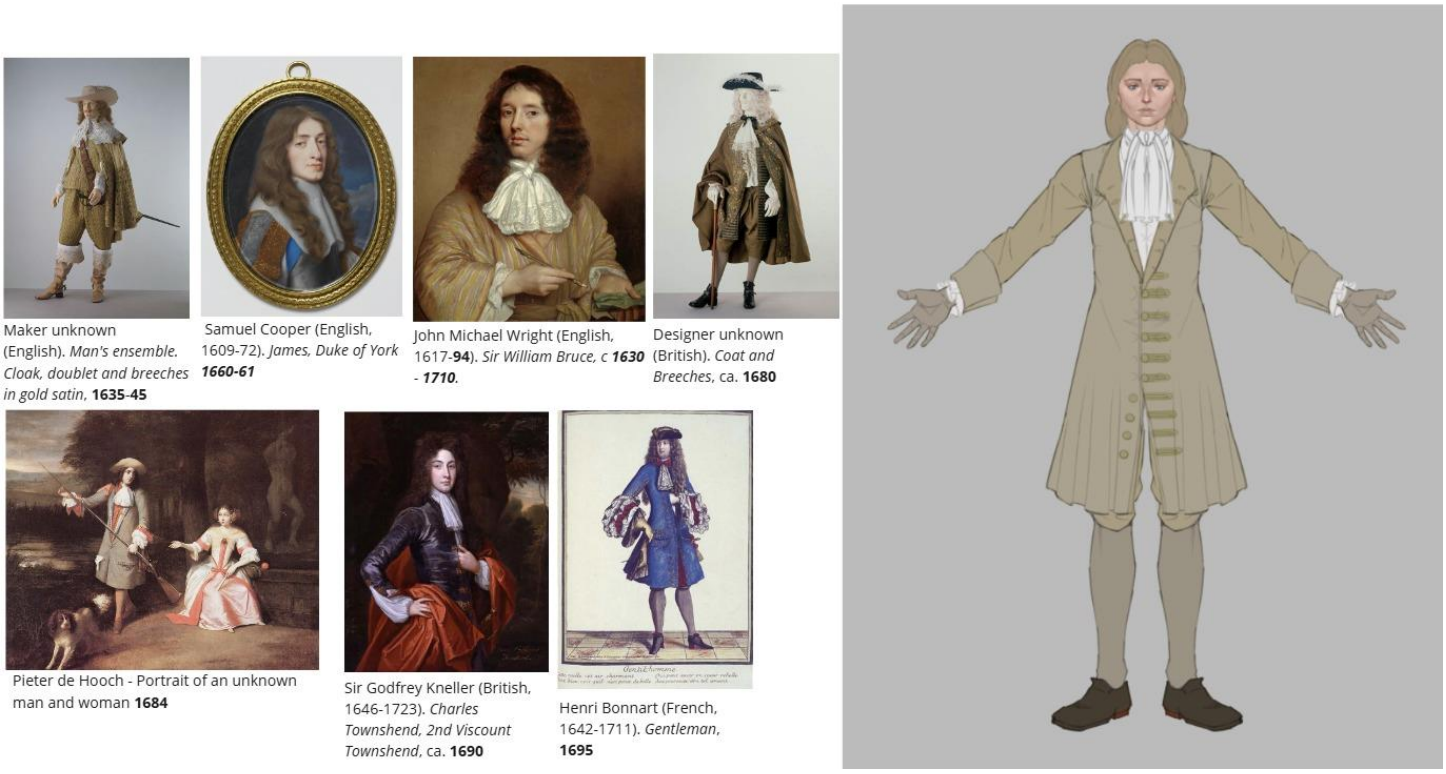


Figure 135 - Merchant Character Design References

Figure 136 - Portuguese Gentleman Character Design References

Terreiro do Paço, Lisboa, em **1662**, Dirk Stoop Museu de Lisboa, MC.PIN.261

Pe. Raphael Bluteau, um estrangeiro "lusitanizado", *Vocabulario Portuguez e Latino*, segunda metade do século **XVIII** Biblioteca Nacional

Retratos Padre António Vieira (**1608-1697**) Séc **XVIII**

Figure 138 - Portuguese Priest Character Design References

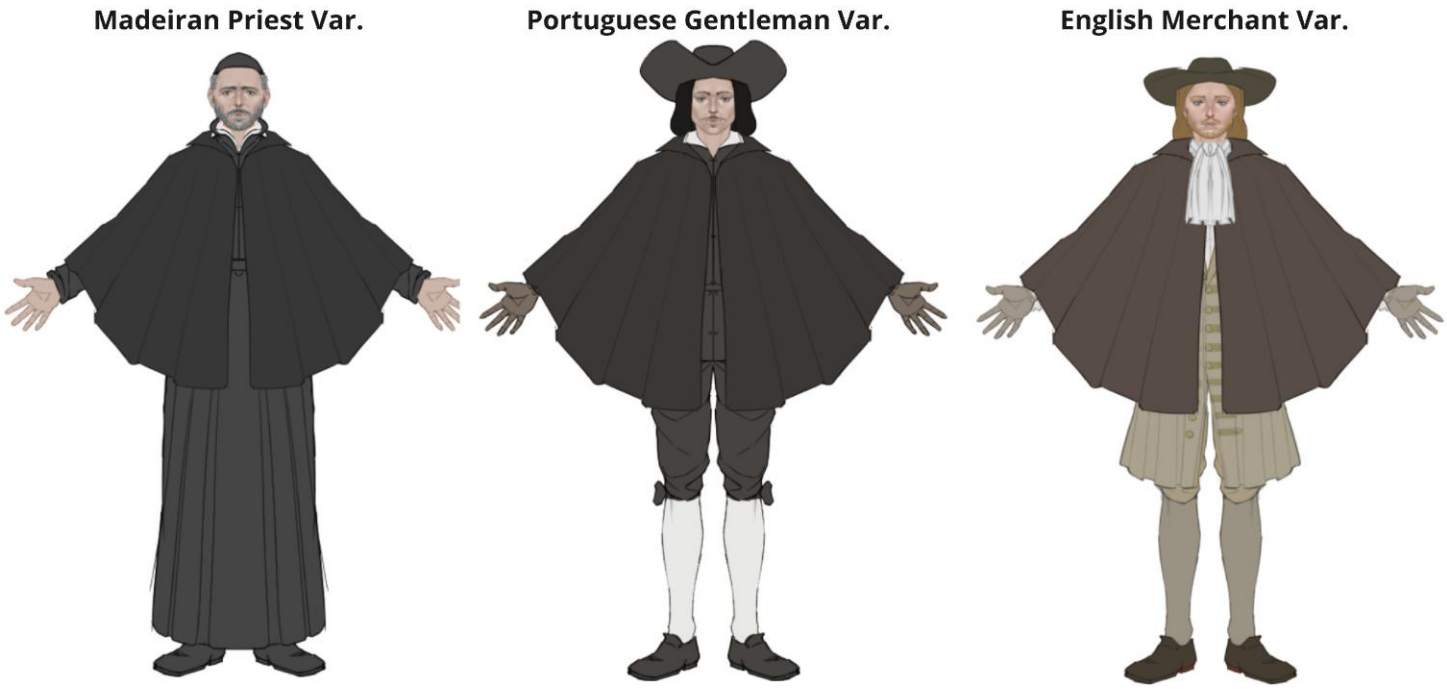


Figure 137 - Char Design Variations

Extra Procedural Material Nodes:

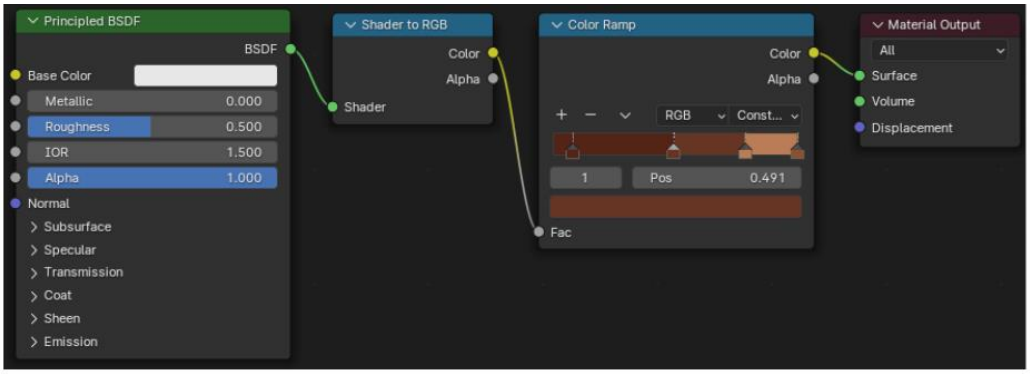


Figure 139 - Full Cel-Shaded Material

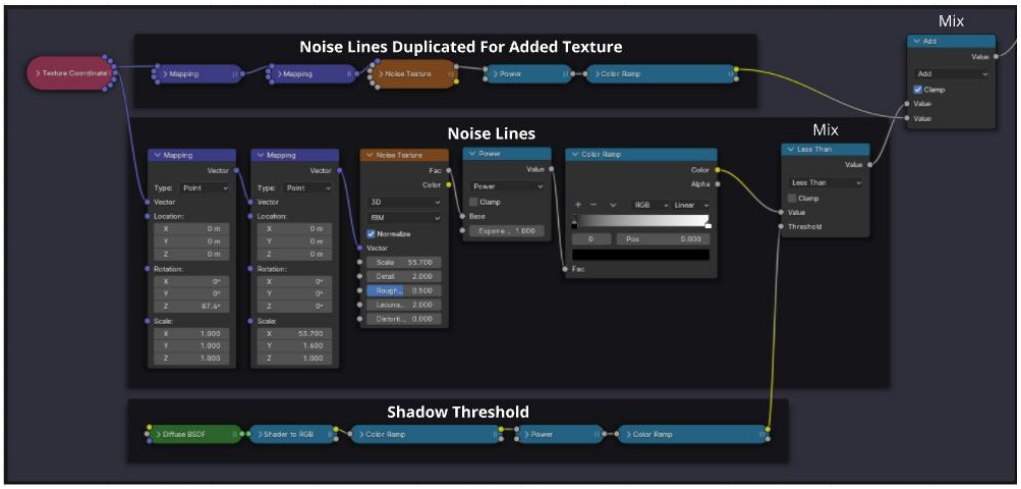


Figure 140 - Cross-Hatching Material Nodes

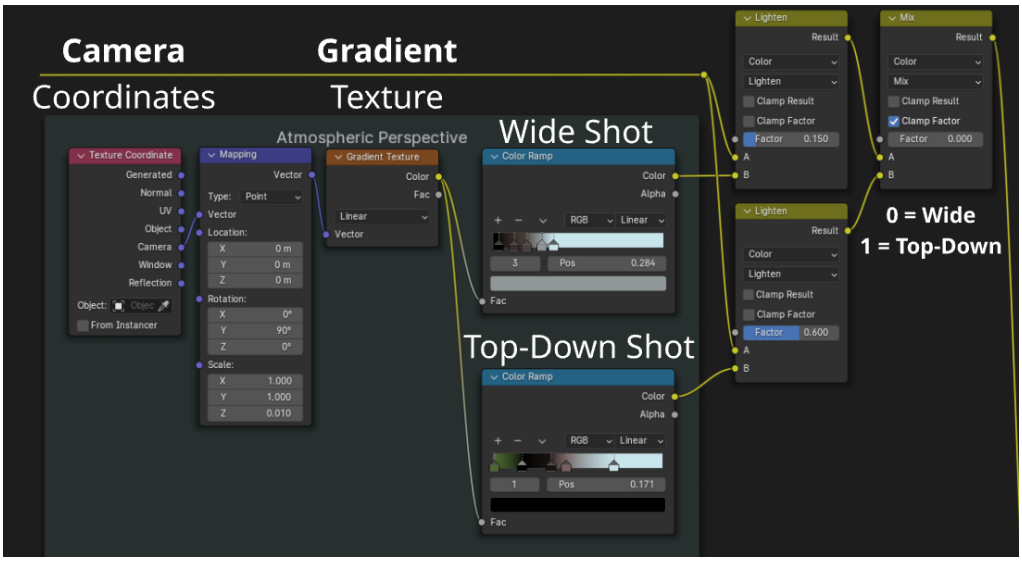


Figure 141 - Atmospheric Perspective Nodes

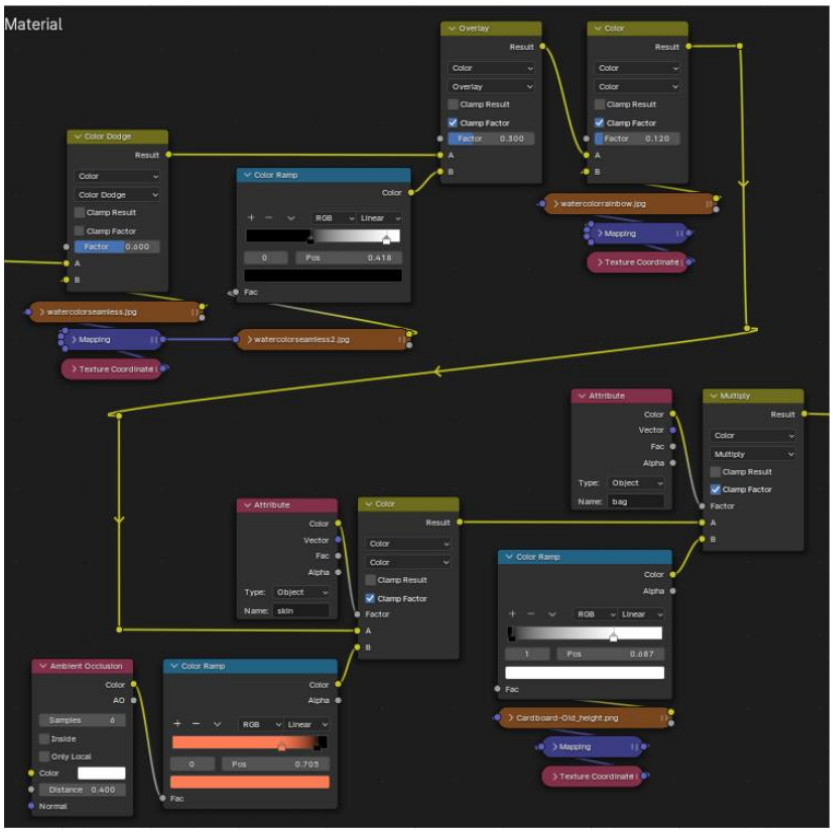


Figure 142 - Character "Add Texture" Node Group

Figure 143 - Environment "Add Texture" Node Group