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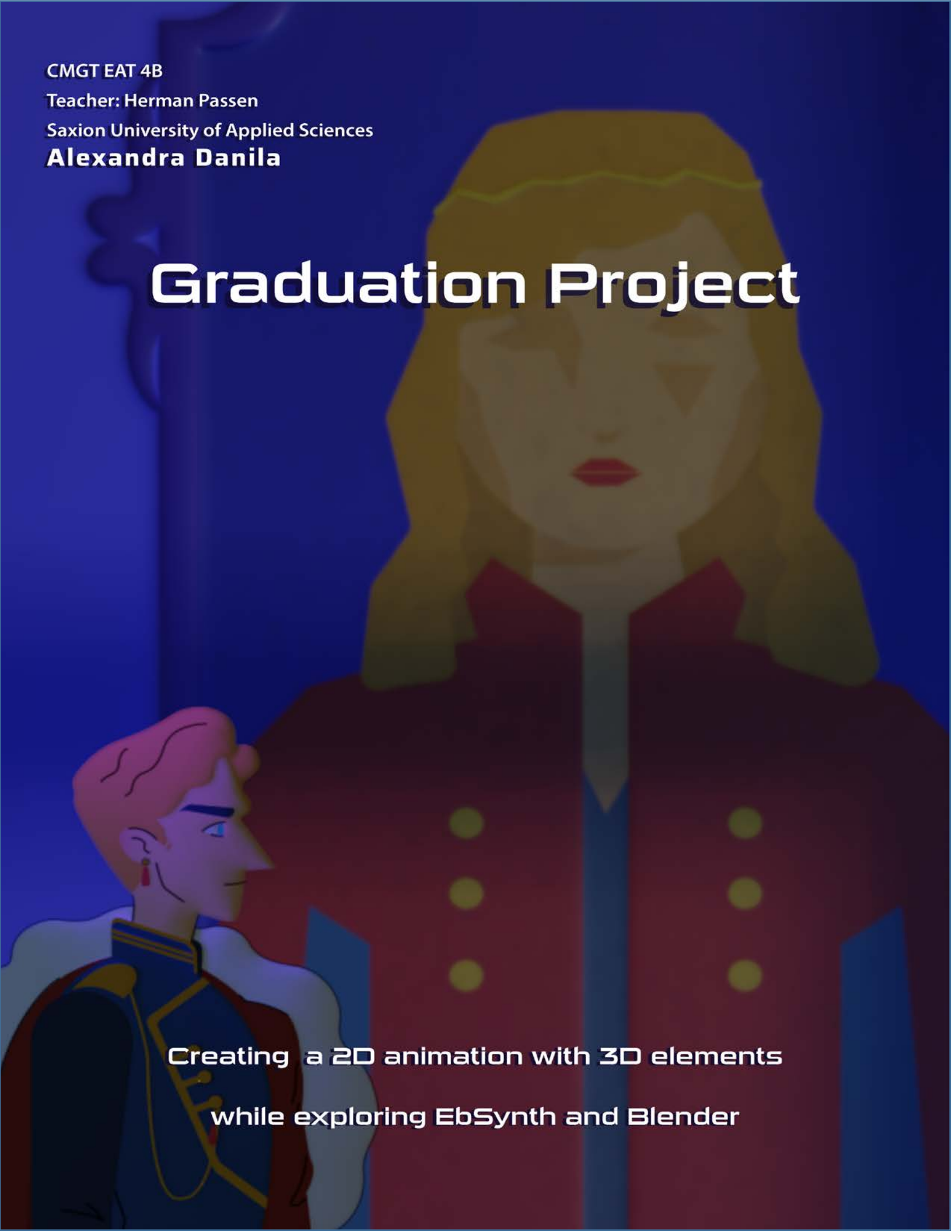
Graduation Project



Creating a 2D animation with 3D elements

while exploring EbSynth and Blender

Information

Creating a 2D animation with 3D elements, while exploring EbSynth and Blender

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Preface

I would like to thank my work supervisor, Ivan de Wolf, for providing me with so much support and enthusiasm ever since the beginning of the graduation assignment. In addition to that, he always provided me with feedback and any necessary help, which made me feel more confident about my graduation topic, especially since it involves 3D - an area I am not very familiar with.

Special thanks to Allan Parker, 3D Generalist, for assisting and guiding me with the lighting technique pipeline when I lacked the necessary technical knowledge.

I would also like to thank my graduation company, Newframe, for giving me a lot of freedom and full control over the graduation project.

Abstract

Newframe is a 2D animation studio, which mainly focuses on commercial animation. The company uses 2D vector-based animations for content creation. The studio is very open to new animation techniques or software which could contribute to the company's workflow and improve their productivity.

The purpose of this research is to allow a 2D animated character to interact with volumetric light in a 3D space. A similar technique has already been applied by SPA studio in the Klaus animated movie. Their method permitted adding and controlling the light onto moving images. The animation style was achieved with LAS, SPA studio's in-house software, and involved a tedious and time-consuming process.

Newframe is interested in an alternative lighting method, which could help them obtain the desired results in a short-time period. Therefore, the following main question was addressed:

'*How can 2D animation studios replicate the results in style and lighting technique that was used in Klaus animated movie with different methods?*'

To answer this research question literature study and qualitative research has been conducted in the form of interviews, secondary research, and prototypes.

The alternative tools the paper covers are EbSynth and Blender. EbSynth (beta version) is an open-source tool used for style – transferring: propagating an art-style onto a video footage with only one keyframe. The company is interested in the software's potential, usability, and limitations as well as possible creative applications aside from style – transferring.

Multiple tests were applied with EbSynth to determine its efficiency with the following topics:

- Style Transfer
- Save Rendering Time
- Motion Graphics
- Video editing
- Klaus style

Despite showing potential on an animation conceptual stage, EbSynth does not understand lighting and cannot achieve the desired stylized look. Blender is the second tool the research covers; it is used to generate real–time lighting and give a 2D character volume by using 'Normal' maps.

The working prototype had various iterations to establish any possible limitations and fix them, guaranteeing an elaborated set of steps for the company usability.

The technique has indeed proved itself feasible and useful for creating a stylized lighting effect while preserving the 2D look. The explored method can be used by a company like Newframe for mixing 2D animation with 3D lighting.

A more elaborated experimentation phase would help sell an animation using the lighting technique to potential clients.

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1.Introduction

This document provides the preliminary information required to execute the goal of the graduation project, followed by initial research on the related topics, and a detailed description of the problem, solution and approach.

1.1 Graduation Assignment

The graduation assignment explores a method which could enable a 2D animated character to interact with volumetric lighting in a 3D space. A similar approach was already applied by SPA studio in the Klaus animated movie, allowing the artists to manipulate the light onto the moving images. However, the tool SPA studio used, LAS, is not open to the public, therefore substitute software will be investigated such as: EbSynth and Blender.

The research focuses on a technique which could successfully achieve a stylized look and enable light interaction of a 2D vector character with 3D light within the given timeframe. Aside from that, the paper also follows on how EbSynth could be implemented in a company's workflow and what added value can it bring based on all the research findings. The results will be documented in a separate file: *EbSynth Proof–of–Concept document.*

Besides researching the above topics, a demo–animation will be created, introducing an innovative lighting approach.

1.2 About the company

The main client of the graduation project is Newframe, a 2D animation studio located in Enschede, Netherlands. It collaborates with other small companies, such as TinyGiants, a 3D animation studio.

The company showed attention towards a new innovative lighting technique which would allow 2D animations to interact with volumetric light in a 3D space. In addition, Newframe is also interested in EbSynth's features and whether it could be implemented in the company's workflow. The company is open to the possibilities of introducing AI in their working process.

The project supervisor during this graduation assignment is Ivan De Wolf, Tiny Giants' VFX & Compositing Artist. During the graduation period, one person will be working alone on the project, while receiving help and feedback from the company supervisor. The communication will be held throughout meetings at the company since Newframe provided a workspace at the office.

1.3 Why NEWFRAME

Newframe is mainly focused on 2D vector animations. Though, when introduced to the lighting technique SPA Studio used, the company showed interest in achieving a similar stylistic lighting effect, combining 2D and 3D. Such method would add value to a flat animation and story as well as make future animations stand out.

2.Problem Indication

2.1 Reason for the assignment

Empathise Stage, General description

Producing and enhancing 2D animations using particular 3D techniques related to lighting and implementing 'Style-Transfer' AI methods with EbSynth and Blender Software.

Klaus, an animated movie, came out not long ago and impressed the industry with a unique art style. The production designers made it possible to give flat characters a 3-dimentional look with the use of an innovative 3D lighting technique. It combines CG lighting with traditional 2D animation, allowing the artists to manipulate lighting using 3D control, while maintaining 3D results.

Figure 1. Klaus animation style

While creating this film, SPA studio challenged itself in establishing a new way of storytelling, creating a 2D animated movie with a 3D-like look.

Since the graduation assignment is a personal project, the goal is to replicate the technique SPA studio used to create a short animation. However, since the software is not open to the public, alternative methods will be explored. The technique the studio used involved a very tedious and time-consuming procedure that only high-level craftsmen can achieve.

In order to attempt to create similar levels of quality and style, AI systems might benefit here. Particularly, 'Style-Transfer' system such as EbSynth, and Blender.

'Style Transfer' is a complex automated visual method which involves two or multiple sources (content and style) for input, to produce animations of a given style from only using reference images. In practice,

a user would feed the system several images of style reference, and a low-resolution animatic. As output result, the animatic will be replaced with an animation that fulfills the style provided in the references.

Consequently, the client wants to explore the AI technology as a potential tool while creating an immersive storytelling experience by recreating Klaus' style and feel with an alternative process, which would serve as a demo animation.

2.2 Objectives of The Client

Providing proof of concept on how "Incorporating AI technology in the company's process" will help accelerate Newframe's workflow while pushing creative boundaries. The client has not researched on this topic yet. However, the studio showed interest in the above-mentioned AI technology: EbSynth and how it can change the style of a whole animation with a single frame. The client would like a more in-depth research on how the software would prove itself useful in the motion graphics, video editing and rendering aspect.

Question of the client.

The client is questioning EbSynth's value and the limitations it may encounter before implementing it in the company's workflow. If limitations occur, the secondary tool, Blender, should be able to fix them and help achieve the desired stylized lighting.

Product/services the client needs.

The client needs to determine the most efficient method in making a 2D character interact with volumetric light. This will be done by creating a short animation of 10-20 seconds. The paper is exploring 2 software: EbSynth and Blender.

Concerned parties

The parties concerned are: Newframe and Ivan De Wolf (TinyGiants' member and company supervisor). Since the graduation assignment is a personal project only one graduation student is involved: Alexandra Danila.

What will the company do with the final end-result?

At the end of the graduation, the company would like to use the final product as proof of the EbSynth/Blender's efficiency and decide whether it can be implemented in future projects. Since the Klaus' style turned out to be very innovative in the animation industry, the company could benefit from being able to recreate and apply a similar style in a faster way.

Limiting Factors

Despite enabling a certain degree of creative freedom, there are a few limitations on different aspects:

Software:

A possible limitation is the software's inaccuracy (the software will have a hard time style-transferring if the original footage contains a lot of camera and character movement), which could be fixed by Blender. In order to recreate the Klaus lighting effect, it might be hard to apply 2D stylistic lighting and shading

since EbSynth does not understand how lighting works. Blender could be a possible solution to a character reacting precisely to light and depth.

Moreover, another limitation is whether the AI systems is able to fully understand various 'stylized' imagery in a stable manner.

Hardware:

This is also another possible limitation, as style transferring an entire animation might nonetheless take time to render.

Skills:

The assignment requires a set of skills and knowledge within the 3D field since Blender is a 3D creation suite.

Team size:

The graduation assignment is a one-person project. Therefore, the amount of work and experiments needed to achieve the final product should be kept in account. Thus, the tasks should be kept manageable within the given timeline.

3.Problem Analysis

Newframe's demand is part of a bigger problem: since AI is becoming trendier in the art industry, how can studios like Newframe be prepared when AI technologies become more abundantly used in the animation industry? For example, Adobe: a recent Adobe Sneak Moving Stills project – enables people to turn any photographs into a "live" image. By animating the image in 3D, these become immediately simulated *(Mejia, 2019).*

Introducing EbSynth to the company would help them get accustomed to AI tools, especially since the software has already been used and tested by multiple artists and animators, who testified that this particular software has a high potential in the animation industry.

The client's concern revolves around EbSynth's efficiency and implementation in the company's workflow. In addition, it focuses on the extent to which the software will prove itself useful reproducing the stylized lighting results observed in Klaus animated movie. If the software fails to complete the desired look, Blender should help achieve the lighting technique within the given timeframe.

The possible invisible problem causing the concern is the current lack of a public or affordable software that will aid in replicating the exact Klaus lighting technique within a range of a few months - which is generally the amount of time given to produce commercial animations.

The Klaus lighting technique used by SPA Studio bends the light by breaking it into multiple component layers, such as: direct light, shadow, rim light etc. This raises the question: What alternative software could achieve or replicate a similar process in a short amount of time?

Will the client really be helped when this problem is solved?

The client will be satisfied once the problem is solved since the lighting technique is very challenging and could help bring an immersive touch to future animations (which would use the Klaus style). The company would also benefit from an AI software which could possibly ease any project workload.

With the solution of which problem will the client be most satisfied, and will the client achieve the most?

The client will be satisfied with the currently addressed problem since they do not have any other pressing matters. The final product (10-20 seconds animation) is part of the graduation assignment and will help decide on how efficient the researched method is in achieving a 2D art-style similar to the Klaus art style.

Final definition of the problem:

The Klaus technique is remarkable thanks to its lighting process. The alternative solutions should make the animation (final product) flexible and feasible with the use of AI and 3D software (EbSynth & Blender). As for the client, they need proof of concept of the software's usability in any future project workflow.

Formulation of preliminary problem:

Is EbSynth (AI software) a suitable software to replicate the Klaus style and lighting technique and can any possible limitations be fixed by another tool, like Blender within the given timeline?

4.Theoretical framework:

4.1 AI and EbSynth use in the animation industry

What is Artificial Intelligence (AI)? Artificial Intelligence is a knowledge shown by machines, unlike the common one shown by a human or a leaving creature. In other words, AI is a computer intelligence that tries to mimic parts of the neurological, human way of thinking in order to do tasks that are less 'robotic' and more 'holistic/human'.

Fundamentally, AI works by combining enormous data with the use of intelligent and progressive algorithms. The role of algorithms is to allow the software (machine) to grab knowledge derived from insights, information, patterns present in the data *(Tawvva, 2020)*. AI individually cannot work without Machine Learning and Deep Learning's involvement among other.

Machine Learning: the ML role is to push AI fast forward mode and take it to new levels. It helps AI to focus on developing the capability to improve responses and outputs to any given situation. While Deep Learning is a subdivision of ML, and is designed to analyze data with a logical structure, similar to the human brain, for drawing inferences. In order to do this, deep learning deploys a layered structure of algorithms known as artificial neural network *(Riya, 2020)*. Essentially that makes a more potent learning process than standard ML models.

To sum up: Machine Learning uses algorithms to define data, learn from data, and make informed decisions based on its learning. And Deep Learning uses structured algorithms in layers to create artificial neural networks (ANN) that learn and make informative decisions by itself.

Nowadays AI is used in almost every field like media industry, aviation, cartoons, and animation, and many more *(Riya, 2020)*. Digital technology is expanding day by day and there are numerous technologies introduced to people. Adobe has actually released some of the latest AI technology: a tool that can match up a character's jaws movement with voice recording.

AI is also used in the animation industry. For example, Disney is recognized for using AI to create storyboard animations just from contents by utilizing words, for example: "turn right" and having the animated virtue turn toward that path. However even the Disney discloses that making an interpretation of the text to animation using AI isn't easy. So far AI has been already used in many animated movies.

Source 1

Price (2018) addresses AI's impact on the animation industry and what will it already/ possibly replace. Firstly, he believes that within 10 years Procedural Workflow (Modelling, Materials, Texturing, World Building) will become standard. As an example, he mentioned: Procedural Lake village course given by Anastasia Opera using Houdini. A second leap would be Machine Learning becoming standard in a software, already being used for: denoising, motion capture & animation. It will replace many tedious technical jobs. And the final leap is: Machine assisted creativity – artists will use machine learning to explore new ideas. An example he gave is style transfer applied to both pictures and videos. The researched software is based on style transfer using a texturing algorithm. The conference approaches the idea that in a few years, AI will become a huge part of the animation industries' pipeline and artists should try embrace this change since it aims to ease the excessive workload.

Source 2

Subin (2020) approaches the use of EbSynth as a possible tool in saving rendering time. The artist used 3 high quality rendered frames and one low quality animated sequence of a car. One of the limitations was the odd look of the shadows underneath the car, however the rendering time needed makes up for it. Initially it would have taken 24 hours to render the car rotating, however it took only 2 hours to complete the work with EbSynth and finalizing the composition in After Effects.

Therefore, this could become very useful in the later stage of my project.

Source 3

(How to Automatically Shade Your Animations, 2020) - This source covers the use of EbSynth in shading a 2D animated image sequence. In order to get the best results, it is better to use a frame which shows as much as possible of the character so EbSynth can have enough material to work with. For example, if your character has his mouth open in the footage, it is better to use a frame which shows that so the program could have a reference in applying the style transfer from the stylized frame. Despite a few inaccuracies the result was satisfying, all the intricate details added to that one stylized frame were present in the sequence. The test helped showing how fast it takes to create full shaded versions of previously flat animations. As a possible limitation, EbSynth does not seem to understand how 2D lighting & shading works which explains the odd look the final animation had.

In conclusion, EbSynth has the potential of greatly reduce the amount spent in shading, lighting and coloring department.

Source 4

Warlick (2019) follows the use of NVIDIA's GauGAN (AI technology) which allows you to transform simple paintings into photo realistic landscapes. GAN is a type of type of deep learning which reduces the amount of human work required to train an AI to complete a task. After playing around with this GAN, Jon tried to make a realistic video sequence out of a bunch of simple images. His first idea involved generating a small scene and animating a camera view of the scene in After Effects. The final product was quite trippy looking since GauGAN is not made to generate videos, as there was no consistency between each frame. His second experiment involved creating another video with added depth complexity (a 3D journey). His second scene was quite weird looking since he had objects popping out, however the mood and vibe were much richer. He used AI to create something beautiful and bring his vision to life.

Source 5

Mariot (2019) is experimenting with EbSynth accuracy. The results show that using only one frame can make the final animation break since the software does not have enough information. When applied to a character head turn, the results are not that bad, the movement of the shirt turned out pretty good while part of the hair disappeared in the process. Moreover, EbSynth interpretation of the character's mouth closed, open and showing teeth was overall looking good as well. Another result is that when adding an extra eye and stretched muscle, the elements get ignored since there is no equivalent landmarks in the original footage, thus there is no 2D motion for them to be tracked to.

When applying the stylized frame to a footage containing a lot of character movement, far more areas are observed where the animation breaks since it was provided with only one frame. However only one frame showed the potential EbSynth has.

With this information it can be deducted that there will be professional uses for this type of software on animated footage in the very near future.

4.2 Blender

Source 6

Pantoja (2020) achieved the best results resembling the Klaus style look. The pipeline used to achieve the animation started from the 2D animation done in TVPAINT, while the final compositing was done in Blender. The lighting was done real time and automated. The character's depth was possibly achieved by using its color values to create a bump map. However, that led to a couple of subtle artifacts where one of the eyes and part of the fur is sticking out briefly. A better and faster way of creating a more accurate bump map would be recoloring the character in grayscale using values that correctly reflect the depth of every surface on the character's body.

To conclude, this test is one of the most successful experiments which came close enough to the Klaus style.

However, after speaking with Ivan, my company supervisor, he advised on researching procedural displacement, normal maps and displacement maps, since they are more efficient.

Source 7

Ashwitha and Shenuka (2021) present the breakdown of an animated project created in Blender. The artist imported her flat layers as planes in Blender. She later layered the planes since they cast shadow

due to the light source. She also uses an interesting approach: extrudes the faces of the wall tiles in order to create depth, for example she gave edges the counter and pulled them down to create a sense of depth.

To conclude, her method can be very useful and applied at a later stage of my project as a way of building the environment.

Source 8

Bucci (2020) follows the use of basic 3D modeling and texturing techniques to turn a 2D flat painting into a 3D environment. The artist separated all the layers of the painted background in Photoshop and imported them to Blender as planes. He adds edge loop cuts to the image and pulls the ground of the layer he imported, giving the 2D painting an actual 3D depth. He also avoids extreme camera angles when animating the camera movement to sell the 3D effect.

The most impressive part in his work is the sunlight effect, with a detailed walk-through all the steps he took to achieve that.

To conclude, this source will be very useful at a later stage of the graduation assignment, for both building environment and adding lighting effects to it.

5.Problem Statement

Define Stage

The 2D animation medium offers more freedom for experimentation with a personal style, which can be observed in the Klaus animated movie. The film uses stylized lighting and texturing, which contributes to the unique look and feel of the story. This makes the movie different in contrast to Disney and Pixar works.

Pushing a personal animation style comes with a risk, which some animation studios might be afraid to take on, especially since latest cartoons have fallen into the standardized version of CGI. However, SPA Studio attempted something completely different: combine CG features with traditional animation. Thus, 2D animation studios should explore beyond art-styles they are comfortable with and challenge themselves with new tools and technologies.

The aim of this study is to determine what existing software/tools can be used to recreate the Klaus lighting technique. The project aims to explore an unconventional method that will create an immersive experience for the client's targeted audience. This paper aims to investigate particular AI methods and whether the Klaus style can be achieved by using them. Certain tools such as Blender will be addressed to further explore this.

After researching on AI's influence and its use in the animation industry (as mentioned earlier), it can be deducted that in the nearest future, AI will oversee most of the tasks in animation. And rather than stealing artists' work, it will help mechanize animation duties, such as repetitive and tedious work. Companies like Newframe should embrace AI technologies and slowly implement them in their workflow. EbSynth is a good start since it requires a creative use.

6.Problem Definition

The client aims to deliver a new storytelling experience by combing new and already-existing technologies. The main goal is to increase the immersion of the client's targeted audience in each story. To do so, they need to research what tools can be used and what is the best workflow to follow to achieve the final product with a smaller budget and timeframe than what SPA Studio had.

6.1 Main Question and Sub-questions

How can 2D animation studios replicate a similar result in style and lighting technique that was used in the Klaus animated movie with different methods?

The following sub-questions will help answer the main-question.

Sub-question 1:

What alternative tools/techniques can be applied in the commercial domain that offer the same result as the Klaus animation?

Sub-question 1a:

Can EbSynth guarantee a high accuracy when delivering the final product?

Sub-question 1b:

Can knowing the limitations of the AI software be fixed with another tool?

Sub-question 1c:

Does AI qualify as a good approach for lighting purposes?

Sub-question 1d:

Will AI techniques help in assisting the recreation of Klaus technique?

Sub-question 2:

Can the Klaus stylistic shading be achieved in Blender?

Sub-question 3:

Are there any companies that demand the Klaus art-style?

Sub-question 3a:

How to implement Klaus style in a way that adds value to companies like Newframe?

7.The Approach of Your Graduation Assignment

7.1 Methods

1. What alternative tools/techniques can be applied in the commercial domain that offer a similar result to the Klaus animation art-style?

To answer this question, a mixture of literature study and desk research. Websites and research papers will be used as main resources. The obtained data will be summarized and explained in short. In addition, a Proof–of–Concept on EbSynth's usability document will be linked. Along with that a series of technical experiments will be executed and evaluated. The method was chosen because it gives a clear understanding of which potential software could help achieve the wanted look and how can it be applied.

2. Can the Klaus stylistic shading be achieved in Blender?

For this question, desk research will be applied by gathering information on how to achieve a shading network in Blender and following a Blender course in getting familiar with the interface and basic knowledge. The followed Blender tutorials are: A Blender donut tutorial series covering the interface and basic information by Blender Guru *(Blender Beginner Tutorial – Part 1 2019)* and a demonstration on using masks in Blender by Allan Parker *(Parker, 2021).*

Secondly, the collected theory will be tested through a series of tests. One of the methods also involves reaching out to experts in the 3D field (Allan Parker) that can help with any valuable input. This process will give a clear understanding on how a shading network works with 2D image sequences and its suitability in the final product.

3. Are there any companies that demand an art-style similar to the Klaus-art-style?

For this question, desk research will be used to answer it. The topic will be addressed with a few company colleagues through an interview. This method was chosen because an interview will provide the research with insight on the above question.

7.2 Scope

As final product, a short animation will be provided along with an EbSynth Proof-of-Concept document. Therefore, not many methods and techniques can be researched, mainly because of the time constraints. The final demo-animation involves a short character animation. However, this assignment does not focus on character design or color theory since it is beyond the scope of this research. The paper's main interests are EbSynth and Blender and which of the software can offer the best solution on the research questions.

The graduation assignment is a one-person project thus the team is very limited, which might become an issue when executing the final product, especially within a short period. Moreover, the graduating student does not have much experience with the 3D aspect of the assignment. This issue might create complications in achieving an innovative lighting technique with a 3D software. Aside from that there are also hardware constraints since the machine being used lacks in comparison to a high-grade computer.

8.Graduation Results

Ideate and Prototype Stage

What alternative tools/techniques can be applied in the commercial domain that offer a similar result to the Klaus animation art-style?

In order to respond to this question, the student will go through a list of sub-questions:

- What is EbSynth and can it guarantee a high accuracy when delivering the final product?
- Can knowing the limitations of the AI software be fixed with another tool?
- Does AI qualify as a good approach for lighting purposes?
- Will AI techniques help in assisting the recreation of Klaus technique?

EbSynth is a new software which has the potential of replicating the Klaus' art style. Aside from that, the company is interested in its usability and possible application in a company's workflow. In order to prove that a series of tests and desk research was conducted on the following topics:

- Style transferring
- Saving render time
- Video Editing
- Motion Graphics
- Klaus style

The following information is covered in-depth in a EbSynth Proof-of-Concept document containing all the experiment results. The paper represents an overview of EbSynth's creative application.

The link to it can be found in the Appendices: **Appendix A. EbSynth Proof–of–Concept** section.

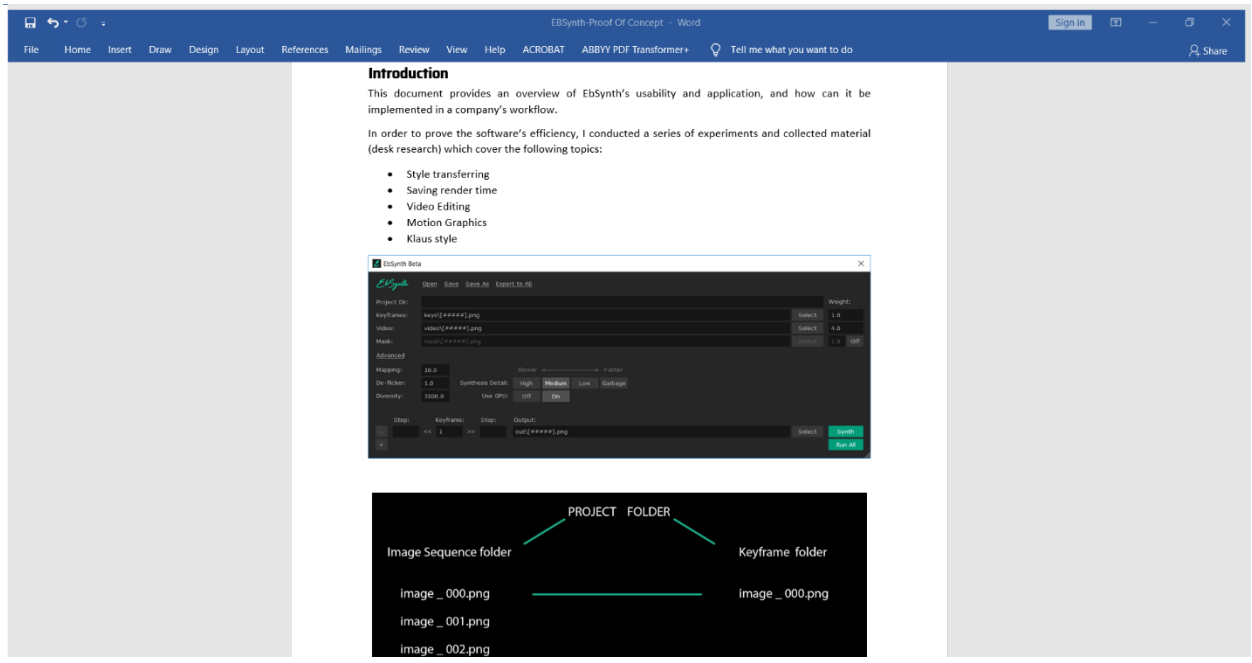

Figure 2. EbSynth Proof-of-Concept by Alexandra Danila

EbSynth works by feeding it one or multiple stylized images (**Keys/ style-frames**) and the footage on which the style will be transferred onto (**Video**), and as the final **Output**, the algorithm propagates the given style onto the remaining video keyframes.

Style Transferring: On this aspect it is determined that for the software to do a good job, the keyframe/style-frame should be very precise compared to the original frame in order to avoid unwanted irregularities, such as jittery camera movement or spill. The software has a hard time generating a style onto the original footage if there is no sufficient information. When choosing a frame which will eventually become the base of the style-frame (Keyframe), it should contain all the information needed for a precise result. Therefore, it is better to use a few more keyframes for the software to render.

Saving Rendering time with EbSynth: After conducting desk research, it was discovered that EbSynth could save a big amount of time by rendering a scene with only a few high-quality render Keyframes and a low-quality image sequence render. The original experiment was managed by *Subin (2020)*, who was able to save 20 hours of rendering, finishing the project within 2 hours. A personal experiment is also carried out by using a low-quality render with Eevee (rendering engine) of a 3D character as input video and 3 high-quality rendered frames of same model: front and side profile with Cycles, Blender. EbSynth fails to propagate the style when there is insufficient information in the original keyframe. Therefore, when the original footage contains camera movements and rotations, it is best to use multiple keyframes for higher efficiency.

Video Editing: On the aspect of object removal and de-aging technique, EbSynth proved itself useful. The tool has a hard time generating a style when there are drastic angle or lighting changes in the original footage. The software can be used for creating Luma Mattes. However, it has encountered problems rendering semi-transparent files due to the lack of defined boundaries.

Motion Graphics: so far, EbSynth has shown the worst performance within this aspect. The software proved itself useless with basic color changes causing color spill and flickering. However, it showed amazing results for style – transferring the Starry Night style.

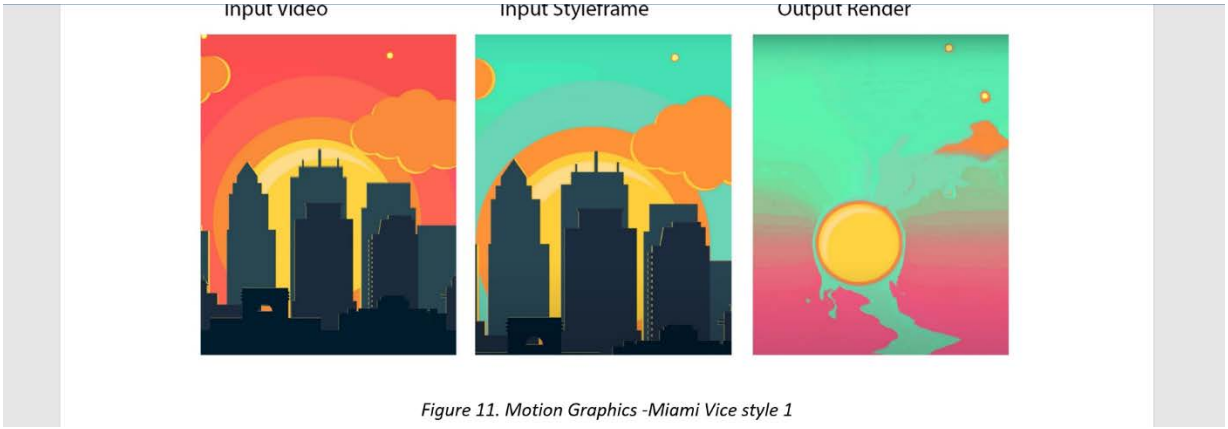

Figure 11. Motion Graphics -Miami Vice style 1

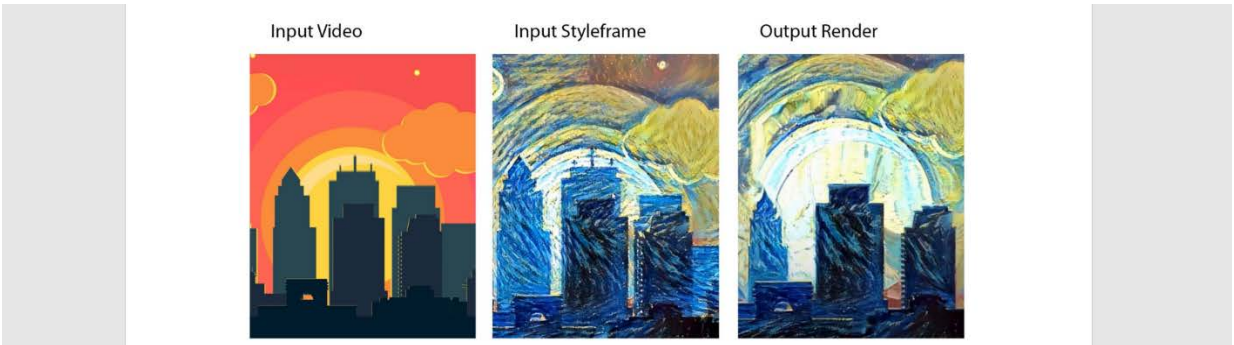

Figure 3. Motion Graphics – Color Change & Starry Night style

Klaus Style: On this aspect, EbSynth was able to carry the painted style – frames, along with the shadow and tint effect very well. However, one downside is that badly lighted surfaces made it hard for the software to generate the hand – drawn style onto the original frames. If multiple style – frames are used, the style – frames should be consistent otherwise the final output will lack accuracy.

EbSynth's biggest limitation is that it does not understand how lighting works ending up disregarding the original illumination setup. Unless the original footage contains shadows as reference the final output might end up with odd or unnatural looking shadows. This particular approach is not feasible due to time constraints and the above-listed limitations.

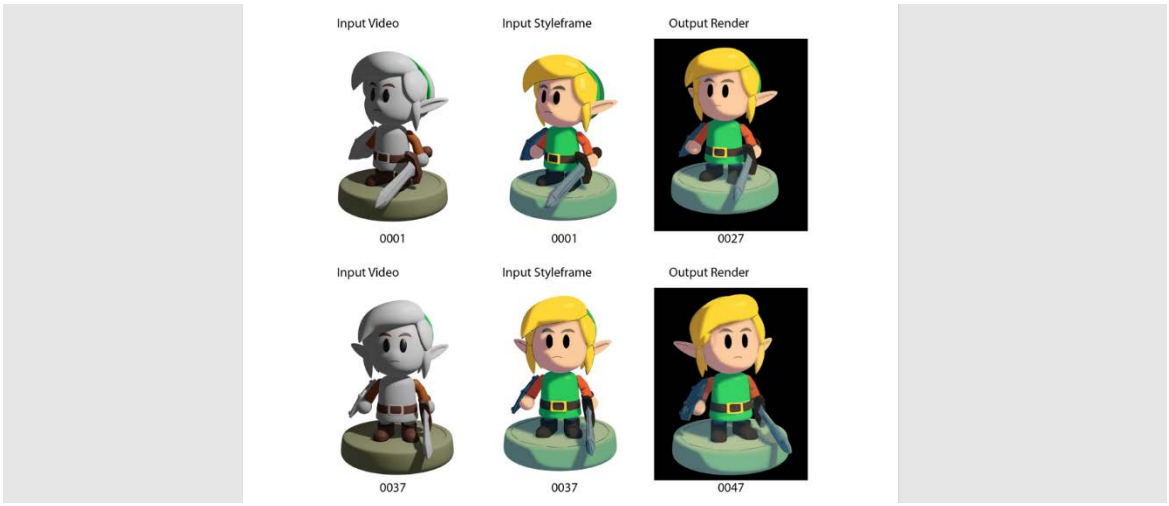

Figure 4. Klaus Style Test

AI for Lighting Purposes

StyLit *(Jakub et al., 2016)*

Even if EbSynth encounters problems with artistic light and shadow transfer, there is a tool which is able to perform artistic-style transfer while preserving the illumination of the scene *(Zsolnai-Fehér, 2016)*. This tool enables one to make use of neural networks which perform such operations and force a personal style on them. Previous techniques take in consideration mostly color and normal information which basically encode the shape of an object; however, these techniques lack the understanding of illumination. For example, the illumination on an object should remain untouched.

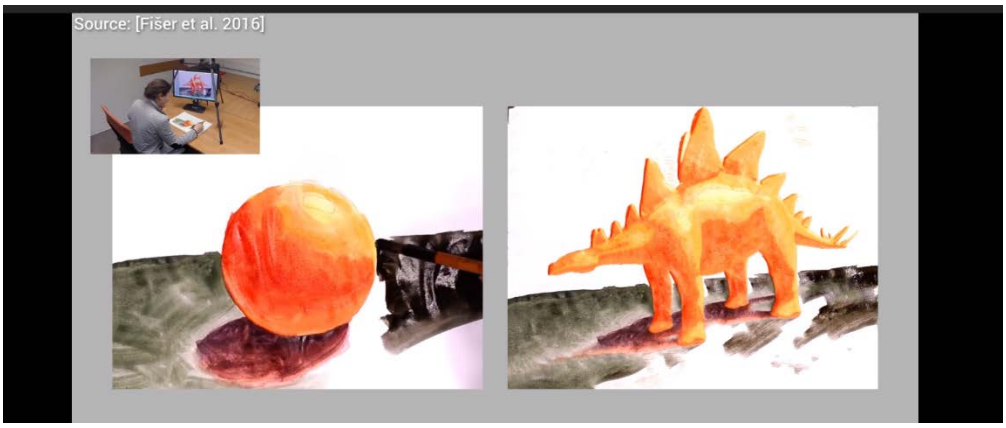

Figure 5. StyLit, Illumination-Guided Artistic Style Transfer/Two-minute paper

In the above image, the artist is given a printed image of a simple object, like a sphere. The image comes from a photorealistic rendering program which is augmented by additional information, like what part of the image is a shadowed region and where the reflections are located. Once the artist applies her own changes, the software knows exactly what the changes are. This pipeline is more elaborated and leads to the illumination staying intact.

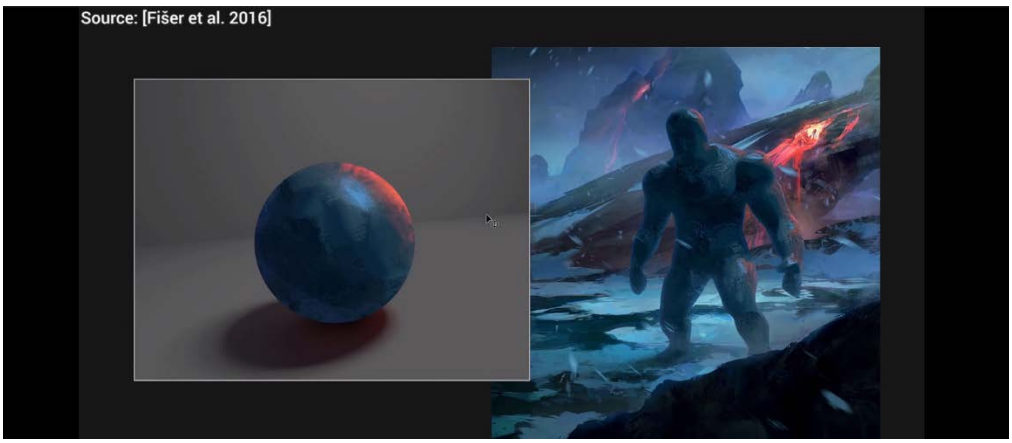

Figure 6. StyLit, Illumination-Guided Artistic Style Transfer/Two-minute paper

In this example, the artist can do the stylization on a simple sphere, while the style is propagated on a complicated piece of geometry almost immediately. However, if applied on an animated sequence, the final output will be affected by flickering and noise. Therefore, the StyLit temporal coherence lacks in comparison to EbSynth.

Generating Digital Painting Lighting Effects via RGB-space Geometry *(Zhang et al., 2020)*

This paper presents an algorithm which can generate digital painting lighting effects from an image only.

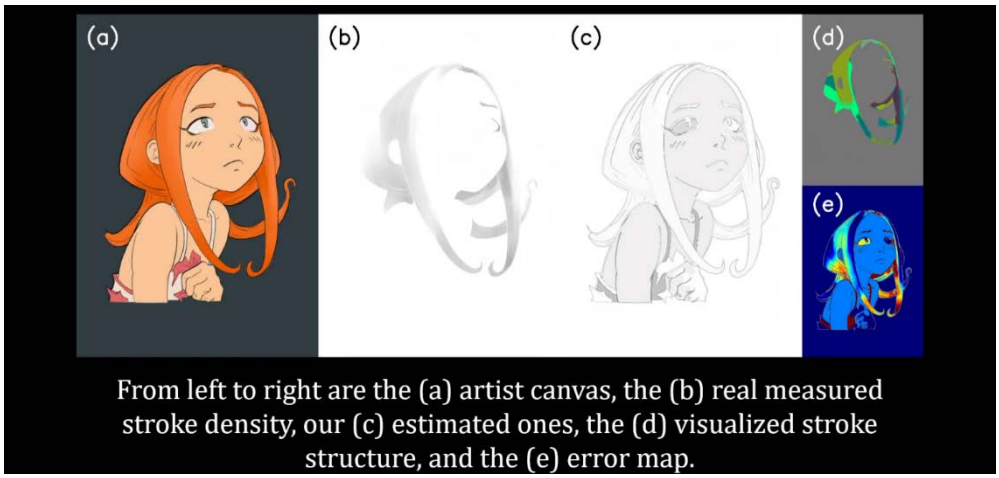

Fig 7. Generating Digital Painting Lighting

(Zsolnai-Fehér, 2020, 0:57) – The input (a) is a painting which represents a collection of brush strokes, which the algorithm is trying to break down into individual strokes. The image (b) is the real number of strokes used to create the painting (a), and the image (c) represents what the algorithm is trying to estimate it with. The colorful image (e) shows the differences between them. The blue color stands for the regions where the brushstrokes are estimated well.

Once all the brushstrokes are collected, the final added assumption is that based on the density of the brushstrokes, the denser regions are more affected by the light than the lesser ones.

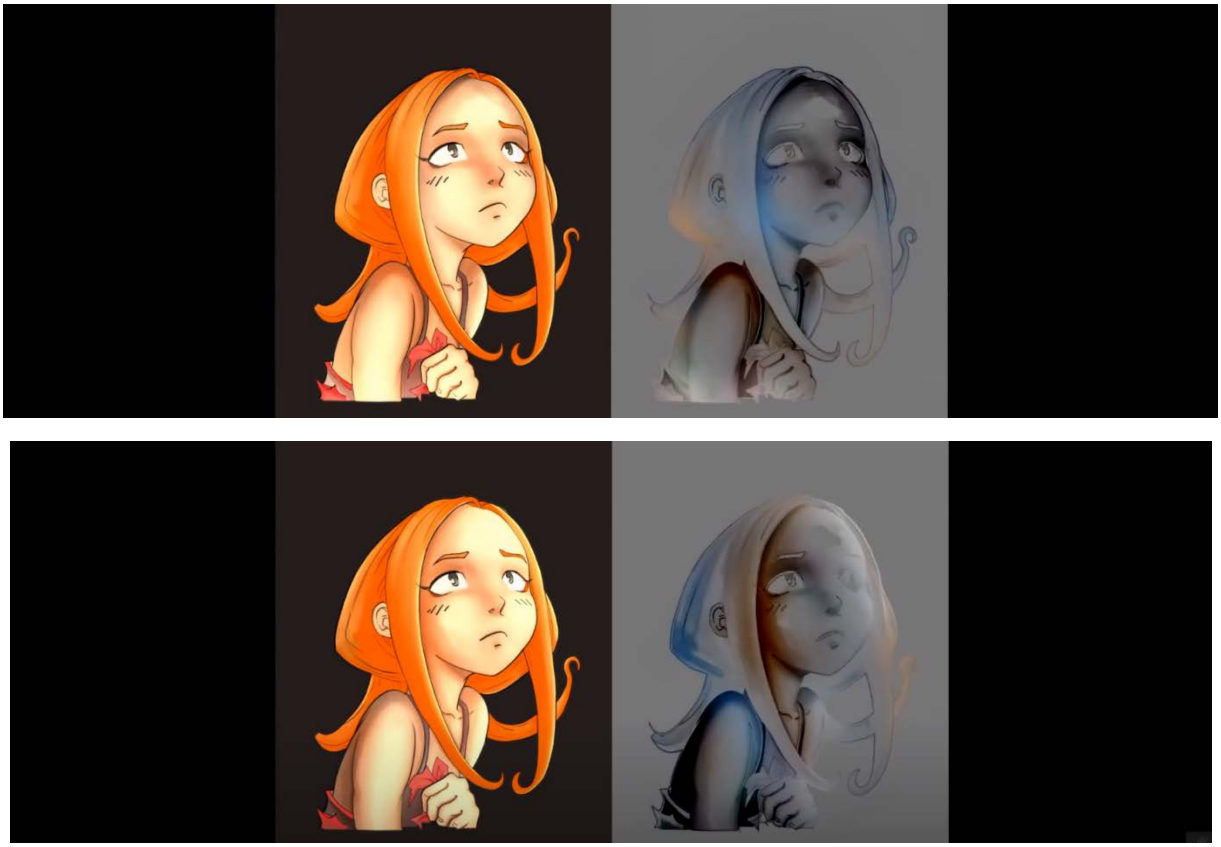

Fig 8. Generating Digital Painting Lighting, algorithm output

This is how the painting changes according to the imaginary light source movement on the left image. The only question is: how practical is this method? To answer this question, an artist was asked to create some light variations of the painting by hand to compare it to the algorithm's output.

Fig 9. Generating Digital Painting Lighting, artist vs algorithm comparison

The algorithm results are very similar to the artist's paintings. The next attempt was done with a picture and the results were surprisingly good as well. The generated lighting effect adapted to the image structure and could potentially become an interactive tool for generating lighting effects for digital and matte paintings. The only limitations are that generated lighting effects may contain irregularities due to hard shadows, complex background object structure or backgrounds that are considerably brighter than the foreground. The algorithm can be applied with photographs and 3D rendered images. However, there is no record on how it would work with an image sequence.

Can the Klaus stylistic shading be achieved in Blender?

The goal of this sub-question is to find out whether it is possible to have a 2D animated character interact with volumetric light in a 3D environment and what method would serve best for such technique.

While doing desk research a few materials were discovered. The videos bring up some aspects the sub-question attends to:

- Importing 2D animated sequences to Blender
- Using Masks in Blender and creating RGB mattes masks

Parker (2021) covers the above points in a few demos on his YouTube channel, *Broke My Pencil*, showcasing a workflow that could help obtain a Klaus stylistic shading in Blender. The process follows masking out particular elements of the 2D drawing completely red (R:25 G:0 B:0) and green (R:0 G:25 B:0) to establish which parts will have a metallic (red) and glowing (green) property. Using the red, green and blue colors as masks will make easier to isolate a shading network in Blender. Additional notes can be found at **Appendix B. RGB Matte Mask import to blender**.

Figure 10. Matting out elements

Using RBG masks can largely affect the character's look, as well as bringing it to life. For the character to have forms and stimulate the impression of a 3D surface, a normal map should be imported as well.

For the sake of obtaining more information on how the artist was able to integrate the 2D character in a 3D environment an expert, Allan Parker, was contacted and interviewed.

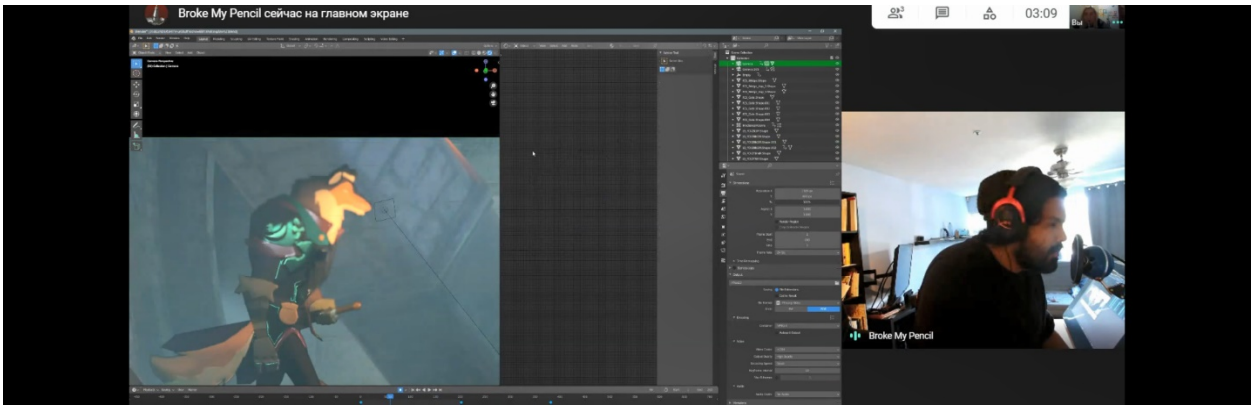

Figure 11. KnygT HunD lighting method explained

Allan's inspiration for this technique came from video games, in terms of using normal maps which he tried to emulate. His main composition is split in a few separate layers: a flat color layer (with no line information), a normal map layer used to interact with lights and a RGB mask layer. His final hand stylized painted look was obtained by adding noise to the normal map, by creating a threshold of a ramp and adding noise texture.

When trying to convert a color map into a normal map, which is based on luminosity, if the linework is kept, the way the light would interact with the knight's eye would end up very undesirable. A great tool for creating normal maps is Laigter. It works by feeding it a depth map to it. It creates a normal map from the greyscale information.

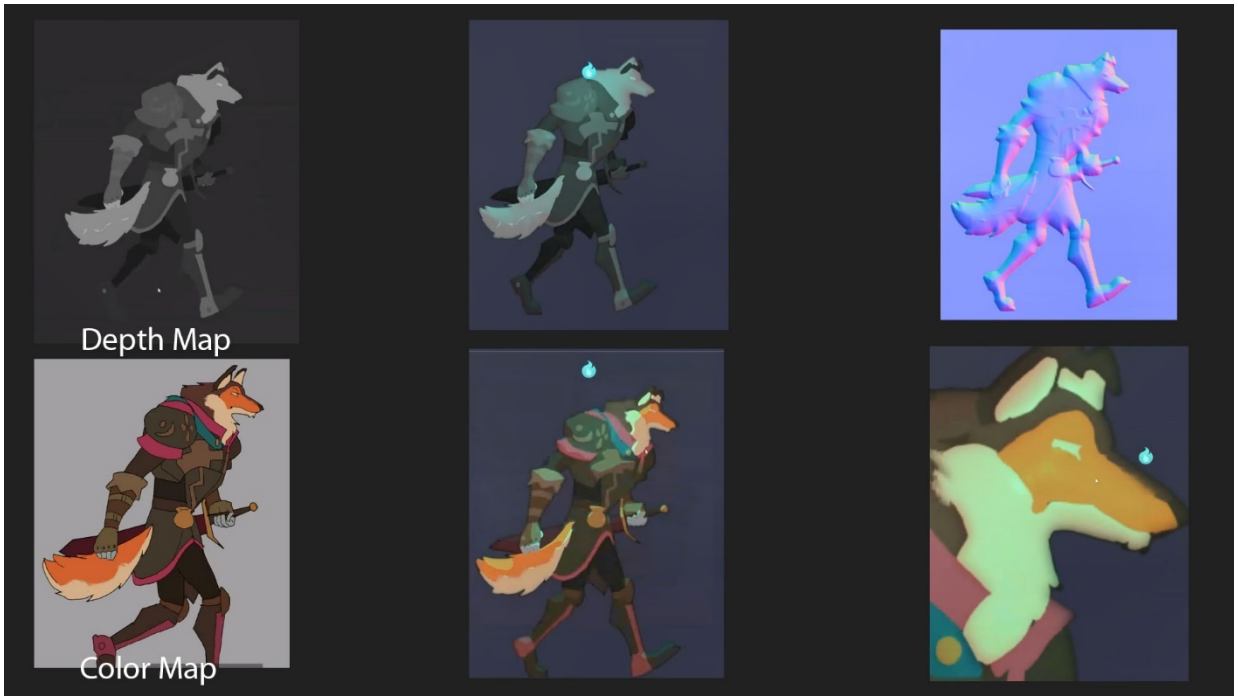

Figure 12. Depth map and Color map difference

When importing images into Laigter, it is better to use depth maps as input. Using color maps may result in weird beveling and unleveled surfaces. For example, the white fur on the color map is on a higher plane

than the brown fur, even though they should be on the same level. In comparison to the color maps, the depth maps offer more accuracy. If the normal map will end up being used for a significant shot, where the audience has more time to distinguish what is happening, it is better to use a custom depth map. The created map would be exported to Blender as a shader.

Empathise Stage

Company Interviews

1. Are there any companies that demand an art-style similar to the Klaus-art-style?

To find out the Klaus' art style potential in a commercial aspect for companies like Newframe, the student conducted an interview with 2 companies: *Aart Bakker* from Newframe (2D animation studio) and *Bart Brinkman* from Tiny Giants (3D animation studio) – **Appendix D. Company Interviews**. The interview was meant to establish their position with possibly implementing EbSynth into their workflow, and how could any further future research help enhance the Klaus lighting technique in the commercial aspect.

The interview emphasizes the interviewees' position of introducing a new tool in their workflow, from both a 2D and 3D perspective, as well as help shape any future tests from the EbSynth Proof-of-Concept document more according to the Neframe's main focus points.

Both Art and Bart showed an amount of interest and concern towards EbSynth and its possible implementation in a company's workflow. The main aspects which would make the companies consider this tool focus on how trustworthy, flexible (control parameter) and how much workload would the software unload if being applied. Their opinion regarding the tool's efficiency and its application is pretty positive. It revolves around EbSynth's use in style-transferring, de-aging technique and possible use on a concept art level. The tool certainly has potential and should be explored. (A. Bakker, personal communication, May 4, 2021), (B. Brinkman, personal communication, May 4, 2021)

Regarding the stylized lighting technique, the answers varied between the two interviewees. Both of them showed an interest in it. However, compared to Bart, Aart has higher hopes for it and is confident in the possible style-implementation, which could result in the company standing out among its competitors. Despite being a commercial company, Newframe can already name a potential client they could sell the stylized-look to. (A. Bakker, personal communication, May 4, 2021). Bart however shows more personal interest in the lighting technique. He believes that a production company would benefit more from such a style rather than a commercial one. The style's value could be raised due to a launching partner. However, as any creative technique, once universally applied it will become boring. (B. Brinkman, personal communication, May 4, 2021)

During the pipeline session with Allan Parker, a short informal interview (**Appendix C. Interview with Allan Parker**) was conducted to which he addressed Bart's point of view. He understands his idea, however he doesn't completely agree with it. For example: Spider-man, Into the Spider-verse animated movie was different. Seeing more companies trying to achieve a similar style means that people are willing to experiment. A company which keeps challenging itself with new styles has higher chances to stand out and attract investors rather than one keeping the same identity. (A. Parker, personal communication, May 7, 2021)

Ideate & Prototype Stage

Prototype 1

This stage focuses on applying the gathered information and received tips on a flat character while investigating normal maps.

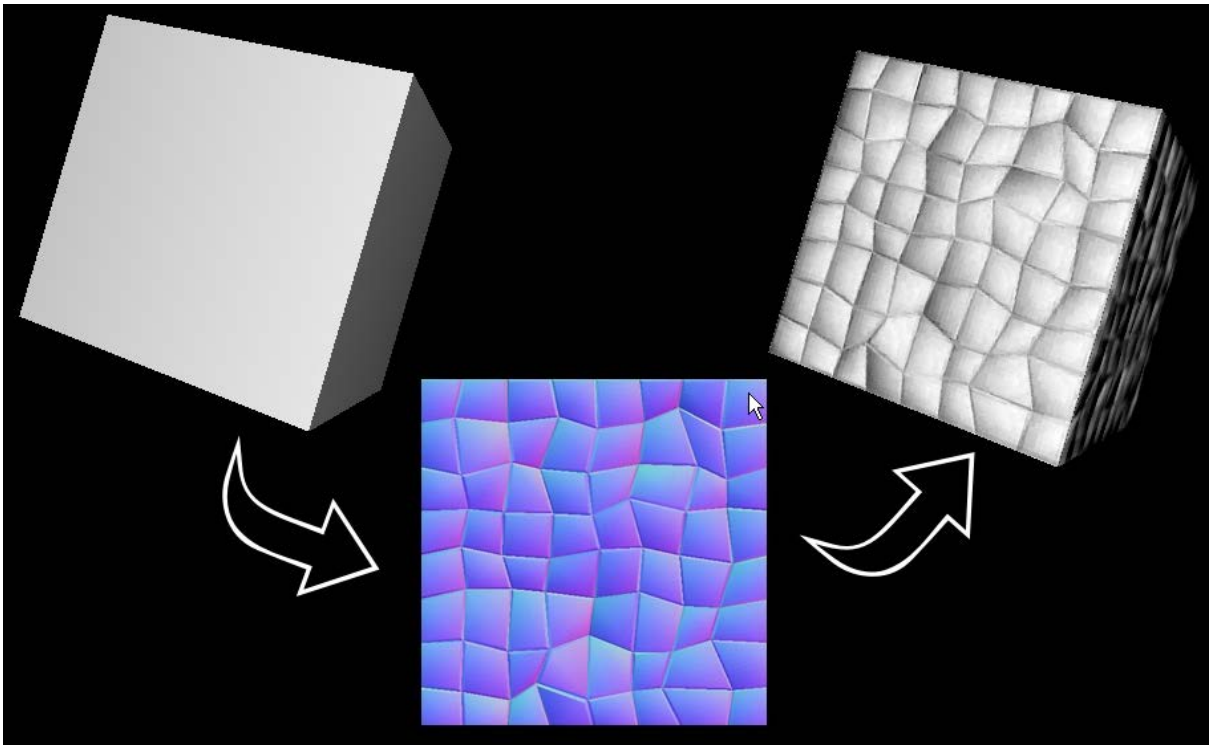

Figure 13. Normal map

The following techniques were used:

- Normal mapping – is a technique used to stimulate the impression of volume and illusion of detail. In the current prototype, normal maps are used so the 2D character could receive light and cast shadows like a 3D character would.
- RGB Matte Masking – is a technique used to isolate all the details which will receive a metallic property or a particular texture.

The normal maps are generated with a third-party tool, Laigter. The normal map used in this prototype was derived from the character's color map containing the linework.

Figure 14. Color map + Linework to Normal map

Normal mapping node structure:

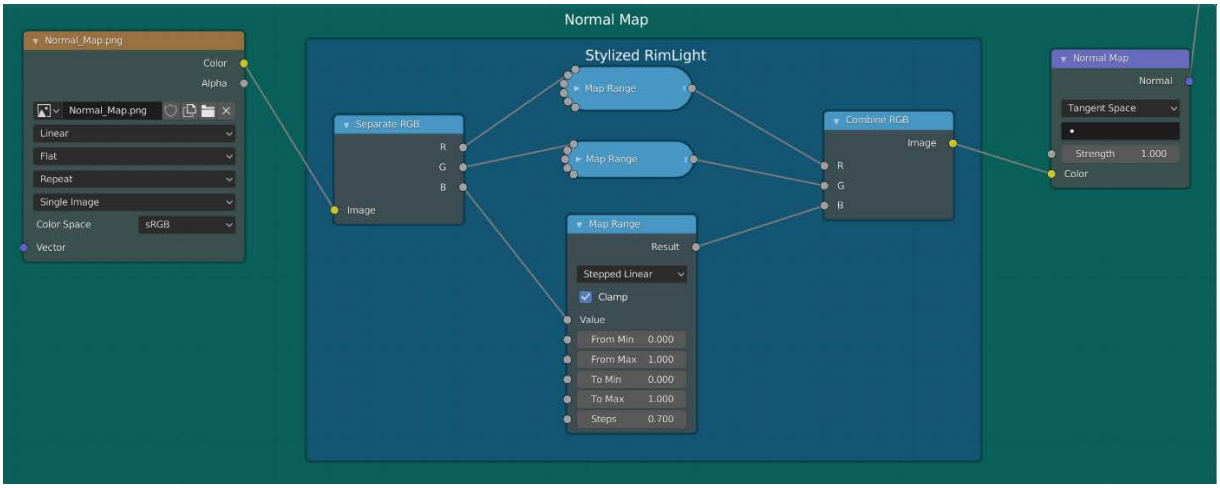

Figure 15. Normal map node structure

The normal map was imported as a plane's image texture and can be connected to a Normal Map node, which gets directly linked to the Principled BSDF Normal setting. The blue section is responsible for the stylizes rim-light effect. The Separate RGB node separates the normal map in 3 channels. The Map Range nodes are used to split up the colors and create a color ramp. The Stepped Linear setting "slices" the gradient, giving the character a more stylized look. More images and detailed analysis can be found at the **Appendix E. Prototype 1**.

The *normal mapping* technique has certainly proved itself very successful in attaining a 2D character interacting with the light in a 3D space while preserving its 2D aspect. Due to the linework caving too much into the normal map, a few irregularities can be observed around the character's nose and eyes.

In conclusion, the above method is very efficient and has successfully achieved a stylized look resembling the one observed in Klaus animated movie. The normal map shader takes on lighting information, therefore multiple light scenarios can be applied to the final animation. The biggest asset this technique adds is: the lighting is done real time and automated.

Prototype 2

The second prototype focuses on importing the line-work separately from the color map. Aside from that, this stage also investigates obtaining a hand-painted stylized look by adding noise.

In the previous prototype it was determined that a better normal map would be produced by a depth map based on the lineless color map. The depth map was created by painting the nearest elements lighter than the farther ones. The linework was imported to Blender as a black outline image texture.

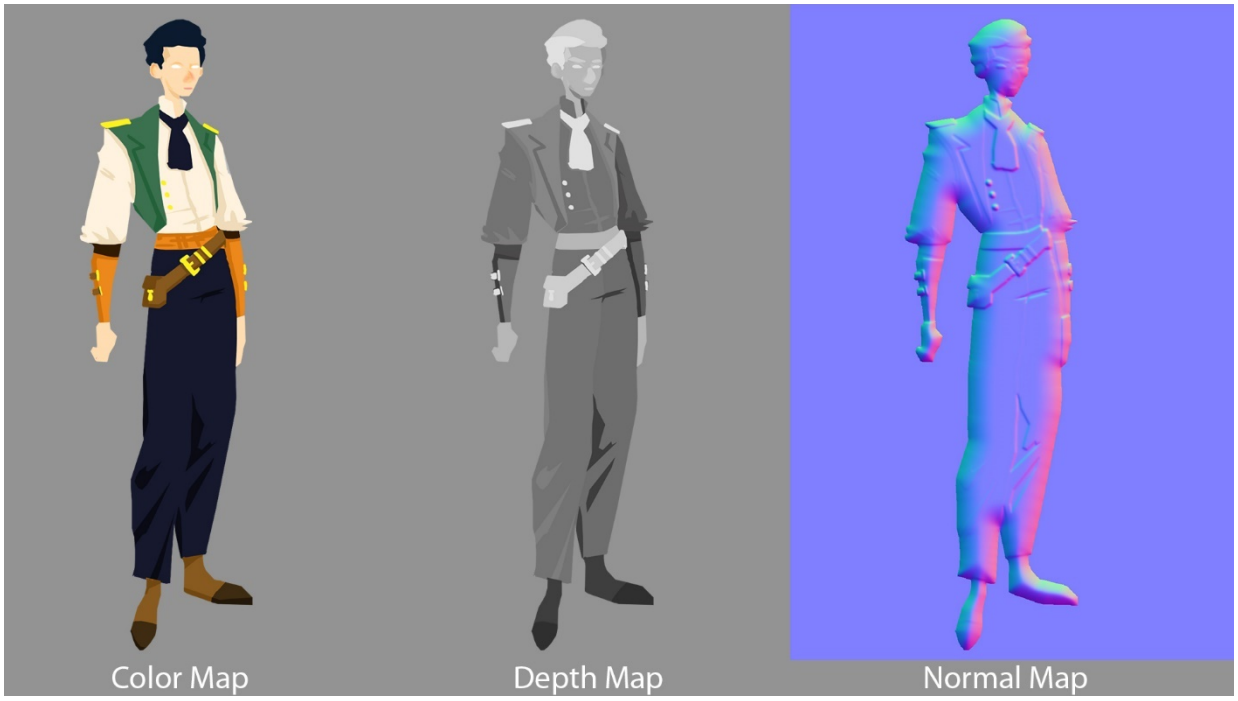

Figure 15. Color Map, Depth Map and Normal Map

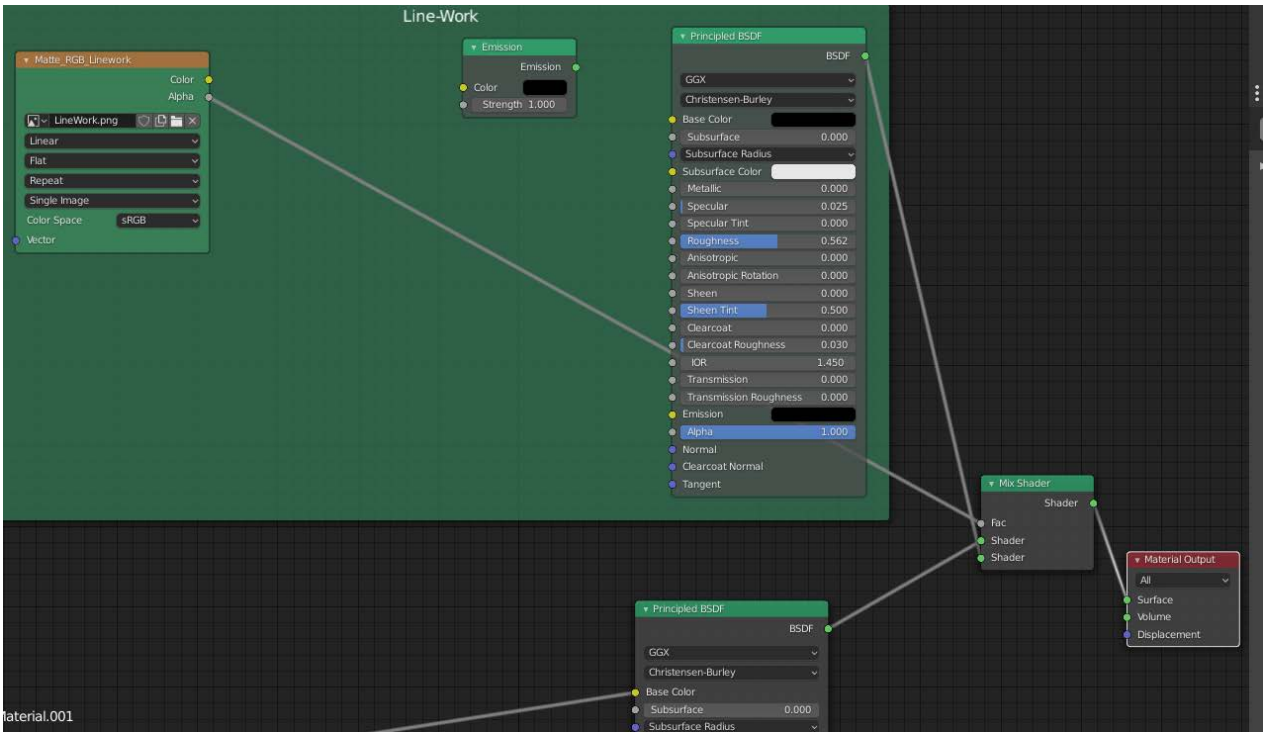

Figure 16. Introducing the line-work separately

The line-work is linked to a Mix Shader node which connects 2 BSDF shaders. One shader contains the color map and normal map information while the other Base color is black (changing the color would affect the character's outline color). The linework alpha is connected to the Mix Shader node as the factor. Doing so makes the linework avoid responding to the light. The same output image can be achieved by using an Emission node instead of a Principled BSDF node, changing the color to Black, as black diffuse absorbs more light ending in becoming less reflective. The results can be found at **Appendix F. Prototype 2.**

The second matter the prototype investigates is a hand-painted stylized look (**Appendix F. Prototype 2**). This can be achieved by introducing a Noise Texture node into the Normal Map node setup.

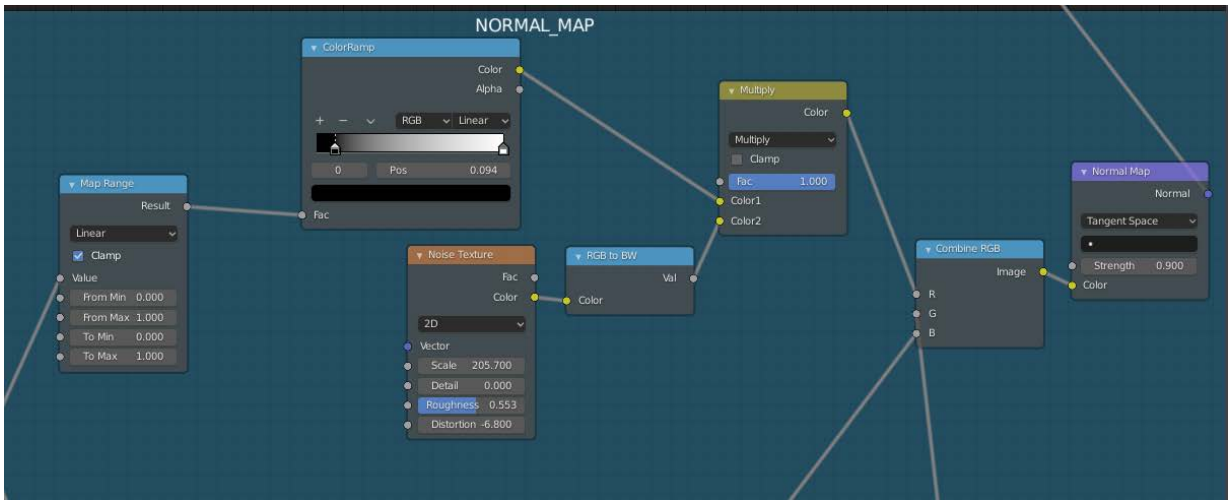

Figure 17. Normal Map + Noise Texture node setup

Generating the character's normal map from a depth map has substantially improved how the output image interacts with the scene's light. Moreover, the noise texture node setup adds a stylized look to the 2D character. A similar approach could be implemented on the character's metallic elements for a bumpy texture.

To conclude, both approaches were effective and provided a range of solutions which will later on be applied in the final animation.

A link to a demonstration of how the normal map helps create depth in the second prototype can be found at **Appendix F. Prototype 2**.

Testing Stage

9.Graduation Products

The link to the final demo-animation can be found in **Appendix G. Final Product**. The Animation pipeline pre-production elements can be found there as well.

During this stage, the knowledge acquired while creating the prototypes helped fix the possible limitations that surfaced when creating the final product. While exploring EbSynth it has been established that the tool was not fit for the lighting technique. However, EbSynth showed great performance and integrity with style-transferring when using multiple keyframes (style-frames). Therefore, it was used for propagating the normal map style-frame onto the character's walk cycle image sequence. The process saved a considerable amount of time since the image sequence consisted of 299 frames. Without this software, the process would have involved manually importing each frame into Laigter, allowing for a limited number of frames to be exported at the same time. The normal maps generating tool would cause constant issues when trying to import the full image sequence at once. For the demo-animation only 3 keyframes/style-frames were used to generate the normal map onto the video source. A few irregularities can be observed on the character's legs. However, they did not affect or cause any issues with the lighting technique.

Figure 18. Normal Map comparison: EbSynth vs Laigter

10.Conclusion & Discussion

To answer the main question, the sub-questions were answered first:

What alternative tools/techniques can be applied in the commercial domain that offer the same result as the Klaus animation?

EbSynth and Blender are the possible tools which could offer the same result as the Klaus' art style. However, during the above research on EbSynth, the software encountered a series of limitations. The main problem is its incapability of understanding how light works. Even if it can be applied in multiple creative approaches, the tool does not cover the main aspect of the research paper: manipulating 3D lighting while preserving the 2D aspect of an animation.

After reaching out and receiving guidance from the expert, Allan Parker, the desired look was achieved using Blender as the main tool. Despite not being used for lighting purposes, the final product involved EbSynth in the production phase for propagating 3 normal maps style-frames onto the video source. The software preformed even better than expected and proved itself worthy of more in-depth exploration on a conceptual level for future research.

Can the Klaus stylistic shading be achieved in Blender?

After contacting the expert Allan Parker, the answer to this question became clearer; The Klaus stylistic shading can indeed be achieved in Blender. Normal maps are the key element allowing a 2D character to fake a 3D look as well as be affected by light.

Are there any companies that demand the Klaus art-style?

The conducted interviews helped gain insight regarding this matter. At this stage Newframe has high expectations of the lighting technique. The prototypes clearly show that the new lighting approach works. A more elaborated experimentation phase would help sell an animation using the lighting technique to potential clients. However, 'selling' this technique would firstly require a series of pipeline testing to make

sure that both EbSynth and Blender can be properly integrated into the company's workflow. During the interview with Newframe's creative director, Aart Baker, a possible client who would show an interest towards it is already named.

Results and expectations:

The final product has successfully incorporated a new lighting technique allowing a flat character to interact with the volumetric light while maintaining the 2D aspect of the animation. The production involved importing the animated color maps, linework, normal maps and RGB mattes derived from the character's walk cycle animation done in AE. The second prototype covered the possible limitations which could appear and made the production pipeline feasible within the time constraints. Integrating this technique into Newframe's workflow does not directly compromise the key values of their production and business. Rather, it helps to elevate their services from an artistic, qualitative standpoint.

11.Recommendation

Recommendation and follow-up research:

Due to time constraints and limited project members, not many methods and techniques were researched. Therefore, it may be very insightful to further explore other techniques which could help achieve the desired look.

Pre-production: When creating the character, it is recommended to keep in mid the possible future lighting scenarios. The character design and movement have an impact on the final animation and the use of normal maps needed to create the illusion of volume and light interaction. It is best to also think of the final scene layout before creating the necessary assets. Therefore, it is more efficient to gather any needed textures for any specific features before assembling the scene in Blender.

Style Transferring: As mentioned before, EbSynth has troubles propagating a style when the original footage contains a lot of camera and character movement. However, a tool which uses AI would be able to fix those limitations. Vyla, a new AI style transferring program could be explored for further research. Compared to EbSynth which uses texture synthesis analysis, Vyla uses AI neural network for style transferring *(Vyla AI, 2020)*. Vyla could generate the normal map style without the irregularities observed in *Figure 18.* So far, there is no much information regarding this tool. A more in-depth research could bring more insight about its efficiency.

Lighting effect: The current lighting technique used 'normal maps' to allow a flat character to interact with the volumetric light and give the illusion of volume. Aside from that, *depth maps* could also help achieve the lighting effect. Another method could explore *displacement maps*. Compared to normal maps, displacement maps create real bumps and wrinkles in the actual mesh *(Displacement, 2021)*. Thus, those distortions can actually cast shadows and occlude other objects. However, this technique would require more vertices (points in 3D space part of a mesh) to work. A more elaborated testing phase would be needed to experiment with multiple different maps.

Software implementation: As already mentioned, introducing both EbSynth and Blender in Newframe's current pipeline would require additional tests and a manual based on them. The main factor the *new software integration* focuses on is its feasibility within Newframe's work process. The pipeline shouldn't become overly complex or take too much time to produce.

The current lighting technique pipeline was established with Blender. However, there are many more stable commercial programs used for 3D content creation. Newframe currently uses Element 3D (After Effects plugin) to combine 2D animation with 3D elements in some of their projects. Further research could explore whether the lighting technique could be accomplished with this plugin and other 3D programs.

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Appendices

Appendix A. EbSynth Proof – of – Concept

Link to EbSynth Proof-of-Concept document:

https://drive.google.com/file/d/15GaIW9VfeJks8flYwDWo7eCY_S2raF4D/view?usp=sharing

Appendix B. RGB Matte Mask import to Blender

By default, when imported into Blender, the 2D drawing is Alpha Blend, the material Blend Mode settings should be changed to Alpha Clip. In order to use the cutout of the 2D character to drive the shadow, the Shadow Mode settings should be changed to Alpha Clip as well.

When importing an image as a Principled BSDF, the surface will end up quite shiny. This can be fixed by changing the specular number. The drawing, with a transparent background will later on be imported as a plane in Blender. When importing an image sequence, the same number of masks should be created and imported as the initial image sequence.

When importing the created matte, the image should be plugged into a *Separate RGB node*, which will separate the mask into 3 channels, which is connected to the Principled BDSF. In order for the character's gun and canister to take the metallic information, the *Separate RGB red channel* should be plugged into the Metallic Shader.

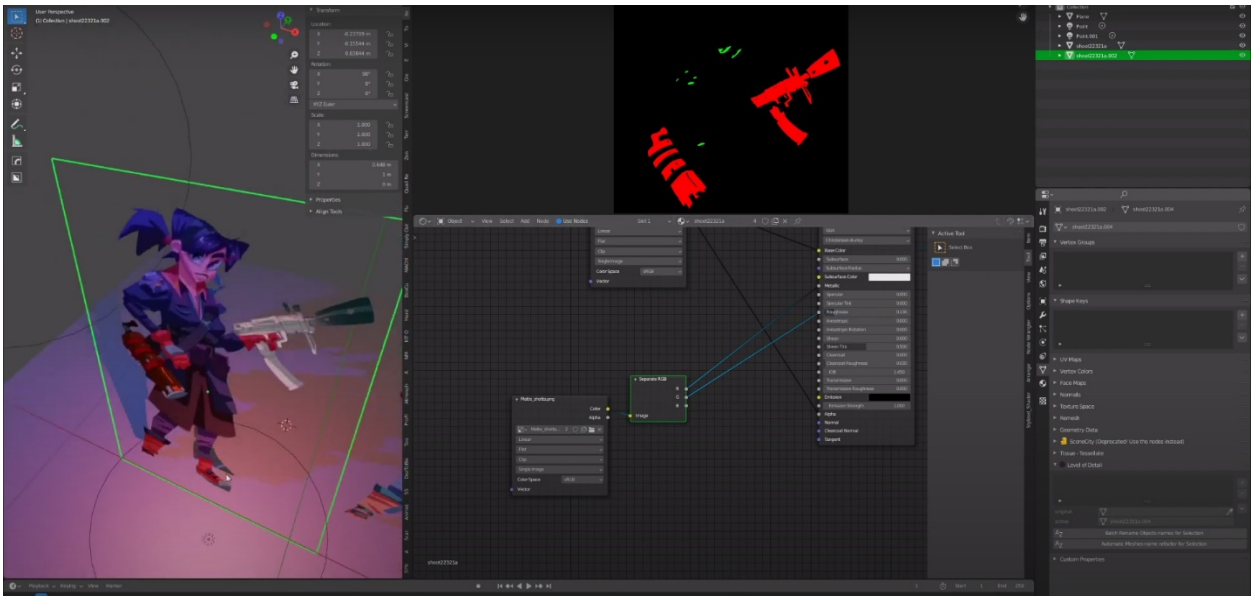


Figure B1. Using a RGB Matte to obtain a metallic property

Appendix C. Expert Interview with Allan Parker

Topics: Unique Lighting Technique

The interviewee had a chance to briefly familiarize himself with the research's topic before proceeding to the interview.

Interviewee: Allan Parker (cinematic artist – Blackbird Interactive Inc)

Question 1: Does the stylistic lighting effect have enough potential to be implemented in a company's workflow?

Allan: Funny that you ask that, I work at Titmouse and I have implemented it already. But it is only for special production […] special scene from a music video. […] It's only for a few scenes that we used this for, I was part of the CG team and we used all Blender for the CG stuff.

Question 2: Would you share your technique with other companies?

Allan: It's an interesting question, let me think for a bit. For companies it's a little bit different but in terms of sharing […] I'm becoming a bit of an idealist. I believe in open source. I wouldn't want a company to keep this to themselves, I'd rather have it public where people can understand how to use it and do something else, because by doing that they can manipulate the technique and do something else. I'm completely fine by people using it and individuals using it, but if companies want to integrate it and make it part of their identity and kind of shut it off then I'm kind of opposed to that.

Question 3: Would the lighting technique lose its value if used in a commercial way? (Becoming a part of its identity)

Allan: I can almost see that point of view. It's kind of like when Spider-Verse came out. […] It's like the wealthy people in the industry see it and are like: I want to do something like that and they keep using it as a reference as supposed to people who are more familiar with the style and technique. […] Basically, there was a strong creating force behind it and they wanted to do something different. I think most people failed to realize that you got to let your creative team be able to express themselves and express different things. It's like putting a wall, let's say: Oh Spider-Verse came out, it's super unique, let's copy it. Why would you want to be a second rate to something else when you can be the first one of a unique voice. But that being said, I think it's great that we're seeing more of that, because people are willing to give more chances to experimental things. […] It is weird but I think it's almost liberating to be the one who came with this idea first. Imagine having to do the same style again and again – you don't have a chance to reinvent yourself. You can almost automate it, where is the creativity in that? For me it's almost liberating if you do something first and everyone starts copying it. Once that happens it's time to reinvent yourself. Your company becomes one that experiments a lot which might attract investors since you do unique things all the time. That is my ideal world at least.

Question 3: Would such a technique bring an impact on the commercial aspect?

Allan: I am not sure how's it there but here in Vancouver, it is very reliant on outsourcing. We outsource a lot of work towards Asia. By doing more complicated techniques, we bring that locally and the response time is faster. It is hard to collaborate with a company across the globe. By doing specialized techniques I think it creates room for collaboration, creativity and could work better for a commercial aspect because you can iterate everything really fast. This is currently what has been happening with the music production video, I just have to sit with the art director and move around the scene directly in Blender and I will already get the scene in the next 30 minutes or one hour.

Appendix D. Company Interviews

Due to corona virus outbreak, I was only able to interview 2 participants from the animation industry. However, their responses ended becoming extremely useful in both the software and the lighting technique's future use.

Both interviewees got a chance to briefly familiarize themselves with the research topic and what EbSynth represents as well as the creative ways it can be applied for various tasks aside from style transferring.

Topics: EbSynth's efficiency, Unique Lighting Technique

Interviewees: Aart Bakker (creative director – Newframe), Bart Brinkman (business strategist – TinyGiants)

Question 1: What is your opinion on using AI in order to help the company's work productivity? (In the future)

Aart: I like the idea but I am kind of skeptical about it. […] AI can try interpret something you don't want, which I think you discovered as well. It is not trustworthy enough for me yet, but I really like what it can do.

Bart: First of all, it can be a great tool on exploration […] I think the best part is that it does not influence the pipeline production fully. On top of that it has its own right for the production pipeline. The trick part is that our pipeline is meant to be flexible at the end of it and this is not, alterations happen throughout

it. I really like that they can do several shots where you can say: that is affected, that is not. It has its risks so to say.

Question 2: To what extent would you consider introducing EbSynth in the company's workflow?

Aart: So far, you've been testing it […] especially the style transferring I would be interested in. For example, saving rendering time is not a high priority to me. Usually, our renders run through the night, I do not care if it is fast or not as long as the second day it's done […] so this aspect is none of my concern but I do like some of the styles you showed me before, that would be interesting. The results you showed me so far look very promising. I am just wondering if it's going to be outclassed by something else.

Bart: I think it's super interesting, especially creatively. That's why I think we should touch it, be aware of it. The same thing applies, this kind of styles that would work are really far away from what the current market and feeling is and therefore is really hard to find that age it is applicable. De-aging is interesting or any type of filter you could apply without an abundance of work. They are super interesting, but they are a gamble right now. [..] That's why in our current pipeline it's not okay yet. But it's super interesting to figure out what is a boundary because it can be applied to any kind of software. […] Ultimately if you know the boundary it's very safe to do. I believe once we know the boundaries it can be used and of course the boundaries will increase. […] Ultimately you get to a solution where you find that you could use this for de-aging, generating random style-shots and so on.

Question 3: What aspects should a new software/ animation technique cover in order for the company to be interested in it?

Aart: I think they would have to be slightly user-friendly and easy to control; it is one of the main things. If you'd look at what we gain at using such a tool, we'd have to spend time on it, which we don't have. The easier it is to use the better. For the technique, If I see others use it then there are more test subjects, so it works well. The main aspect is that it ends looking good. For example, the Van Gogh style, if it can be applied fast and it works well, we would be very interested.

Bart: It should be dependable; you should be able to trust it. That's the biggest thing when using it commercially. You should be able to trust it and once you do you want to be able to control it. […] The control parameter when stylizing, you want to be able to keep stylizing it. The style is not defined, it's not just one click and that's it […] you want to be able to manage it. And of course, Adobe is working on that kind of things which is interesting, but then it becomes part of the mass which is no longer unique. So that is my choice in those three compartments.

Question 4: Would the company benefit from being able to produce a 2D animation with a unique lighting approach? (Similar in style and lighting to Klaus animated movie)

Aart: Yeah, a lot. Just the fact that the fidelity goes up like crazy, it looks amazing and the fact you can fake 3D that way-honestly if we could do that and sell that as a product, we could increase the price of our animations substantially. Of course, it also involves how much workload would it enquire. If there is a software that could do this in a fast way, that would be amazing.

Bart: How I see this technique is like any creative technique. Yes, it is a different game but like had drawing or customer illustration is a creative technique. A creative technique only has a purpose in the creative market, artistic expressions and social […] but it remains that you want to make this custom. However

good is this “Klaus technique” when t’s universally applied and it gets boring, it has zero value. But I think it’s super valuable for me personally. I am interested as soon as possible in making productions that represent our world while taking a bit of distance from it. Usually, 2D would be my goal to since it’s easy to produce. But 2D now is common goods so I wouldn’t be able to stand out with that. What’s interesting is that this type of techniques allows for a similar production time, yet they are still unique and can reframe humans. You can take a bit of distance, without filming or doing 3D, just take that distance and look at it from that perspective. I see that as the biggest benefit.

Question 5: Would you present the style to the client and do you have potential client which could benefit from it?

Aart: Yes, for sure. I think Possehl could be one, they would like it. There is multiple but I can name this one for sure.

Bart: I think companies like Disney would be more interested in it. Production companies which demand something unique and need to tell a story.

Question 6: Would such a style become a valuable asset for the company in the commercial aspect?

Aart: Yes, for sure. Before that it would require a bunch more shots to play around with before we could sell it. We would make use of your research as a starting point.

Bart For us right now is very hard because who wants to be unique? The big repetitive corporate styles a big company applies, […] are efficient. […] Commercially there is no value in a unique style right now. […] if you find a style that can be carried through several years, then a style might become valuable. At this point people look for a unique style for a specific project. This style would make us stand out if the market realizes that it’s what they want. Let’s take any commercial company that wants to swap directions, for example: Creative Live Stock. Let’s say they are excited about their business, but they want to change it. Then you change the circularity aspect of it making all these productions in this style. Then you have a launching partner and then it becomes valuable. But a style by itself in the market, the market doesn’t know what it does till it sees what it does – it’s not valuable until that moment. Of course, you can decide when that moment happens, but we don’t have the marketing power to make that revolution. I think we would need a launching partner to make it happen.

Question 7: Would you be interested in collaborating with other companies/ artists which are interested in this particular style?

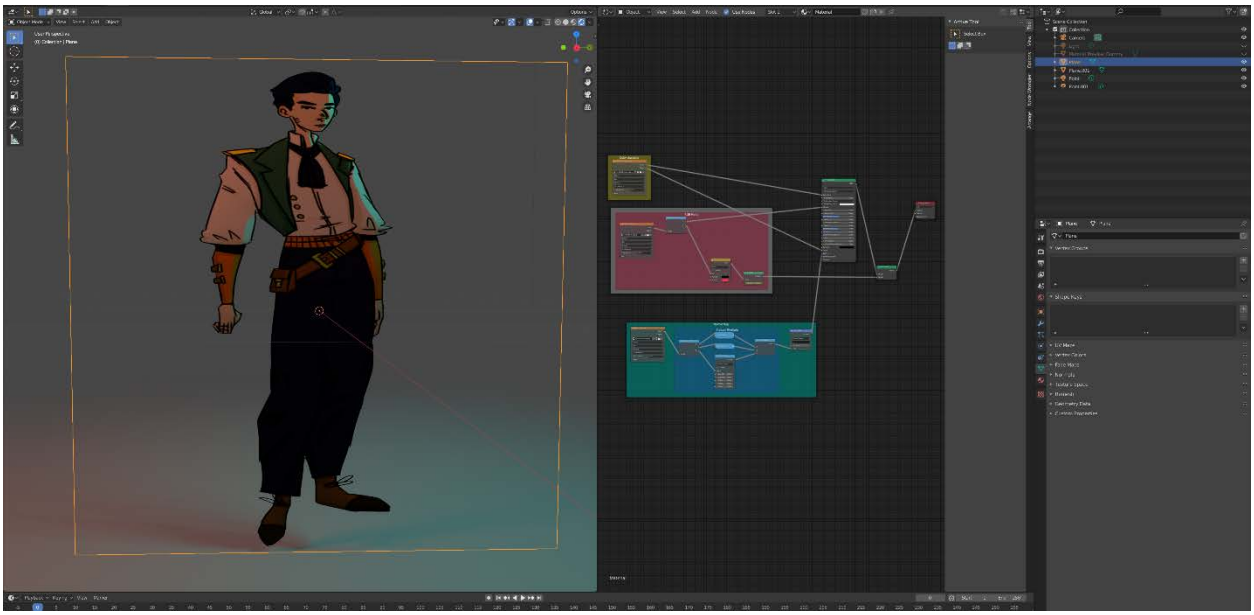
Aart: It depends right? We are very commercial in business. It’s tricky […] in terms of a like a free project, sure. In a commercial aspect, if you spend all your time testing and learning it, you obtain a unique asset. You can sell it to your client. But if you give it to other people, it might not be good for business, that is what I mean with the commercial side.

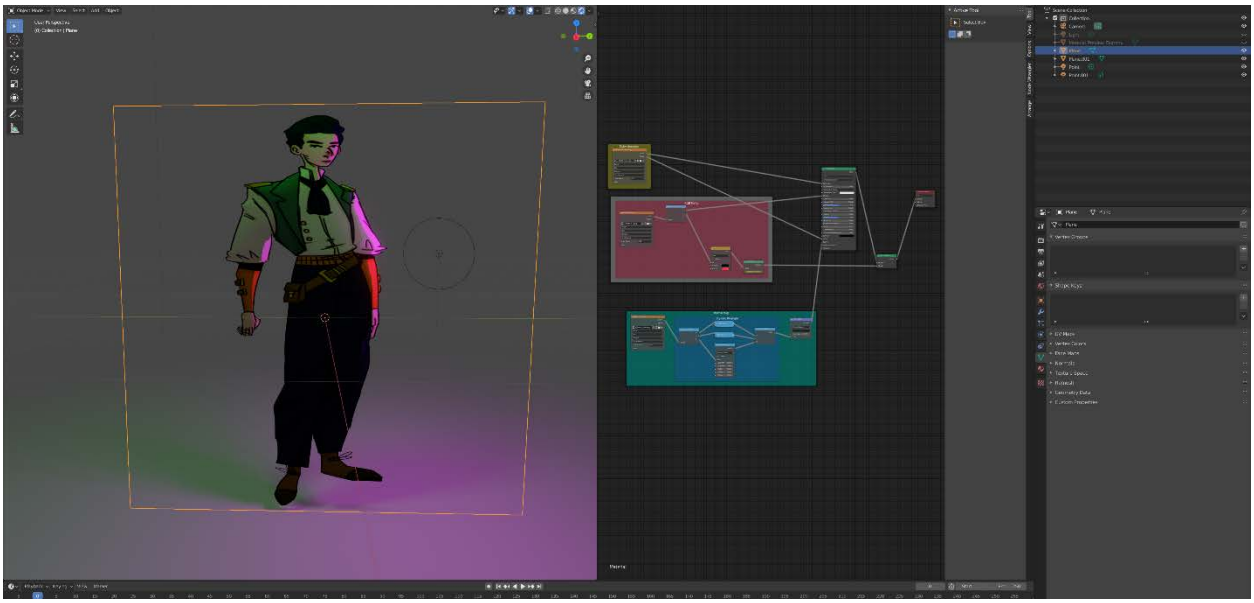
There are a lot of high-end companies looking for new ways to show their animations, maybe not specifically in the Klaus style. Animation is becoming a really big thing. Everybody is using it now so just simple 2D animation doesn’t really sell anymore […] Something like the Klaus animation would be great and unique, at least as a starting point having a 2D character interacting with light like a 3D character would. If implementing this style in our company, we would be the only studio in the region doing it.

Bart: I would push it only if I have a plan for it. […] Whatever this style ends up becoming or variations of it, you'd like to explore it and exploration comes from putting the effort in. This means dedicating more time to it and consider it a full-time production project. […] We are always interested in those things.

Appendix E. Prototype 1

Character interacting with different light scenarios:





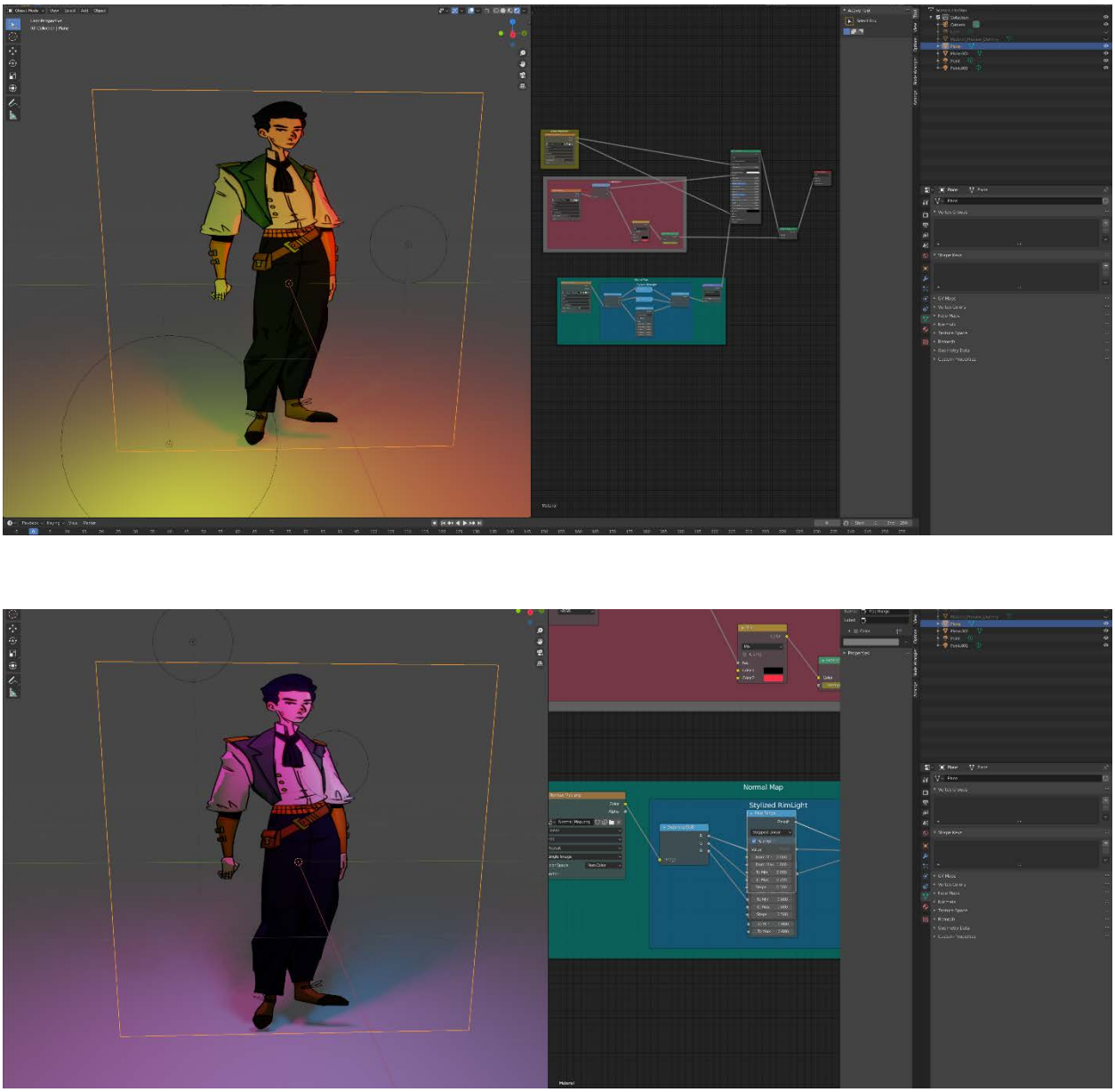


Figure E1. Character interacting with the light

As noticed, the character interacts with the lighting very well. The lower part however does not react properly due to the lack of information in the normal map. The normal map was generated from a color map which results in it acting faulty. This can be fixed by creating a personal depth map (with no linework) for the character which would produce a precisier normal map.

Normal Map Node Structure – each separate node isolated:

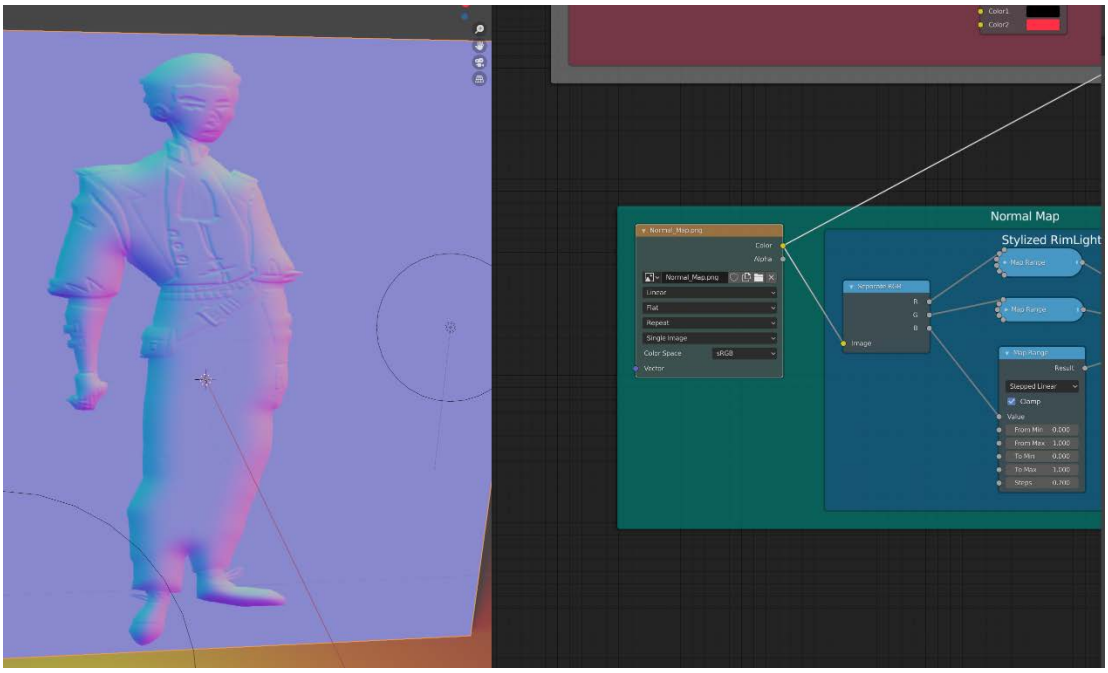


Figure E2. Normal map imported to Blender

The normal map image was imported to blender as an image texture for a plane.

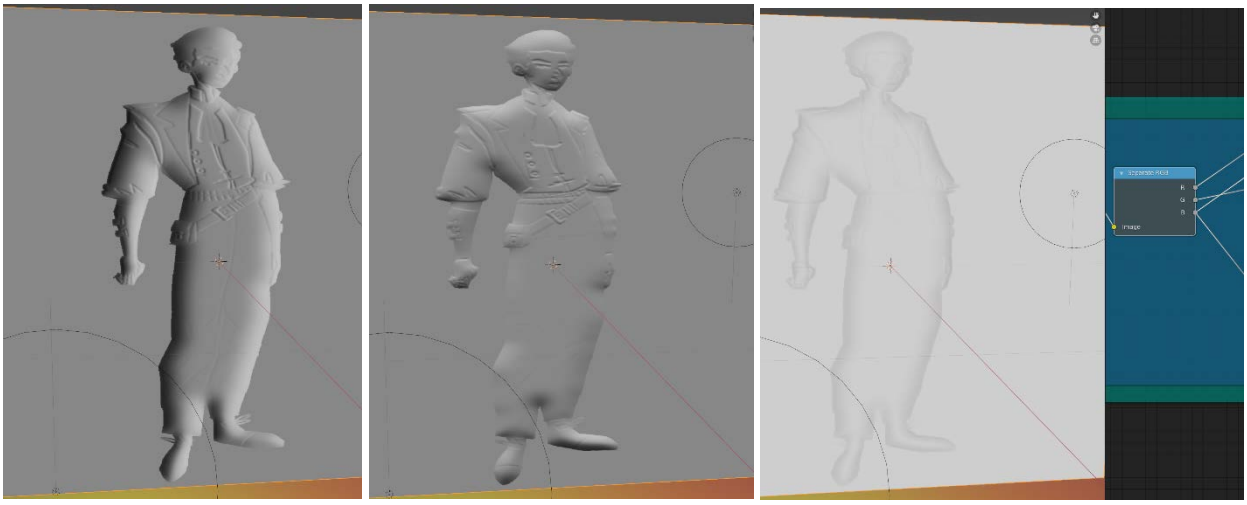


Figure E3. Sperate RGB node isolated

Separate RGB node parts the input image in 3 channels: Red, Green and Blue. This node is used so Map Range could be applied to each channel and make according changes.

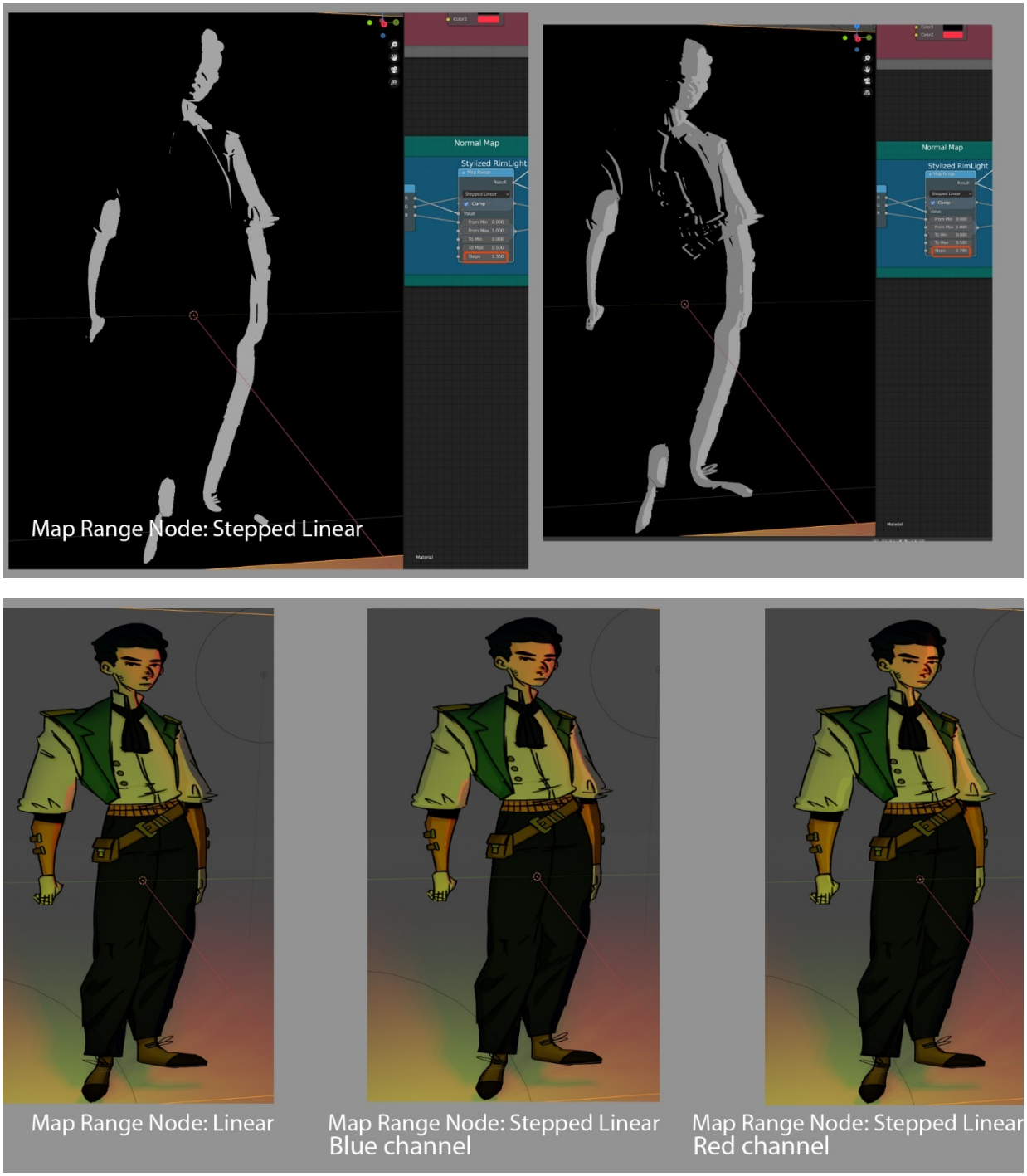


Fig E4. Map Range node isolated

The Map Range node can make changes to each channel accordingly, and as a result a stylized rim-light effect can be noticed on the character.

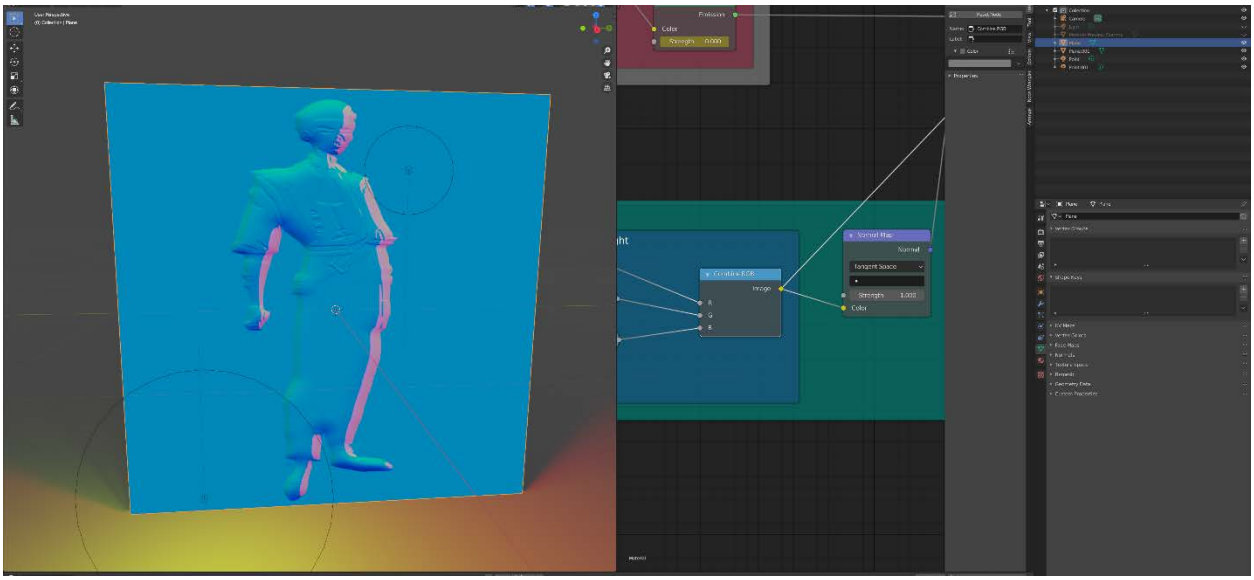


Fig E5. Combine RGB node isolated

The combine RGB node recombines the image from the composited channels (which were affected by the Map Range node).

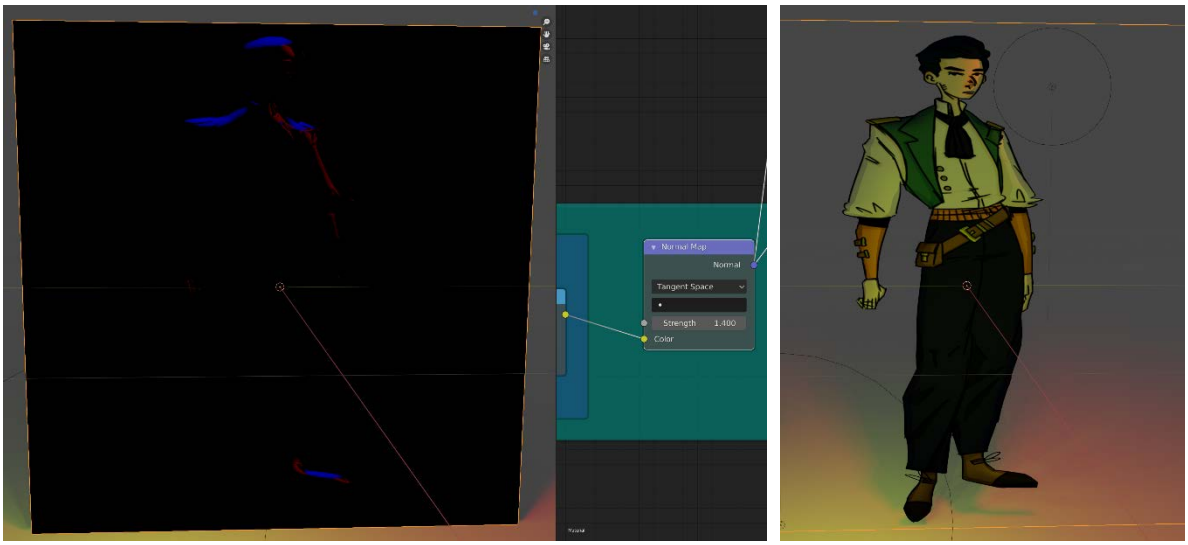


Fig E6. Normal Map node isolated -strengh 1.400

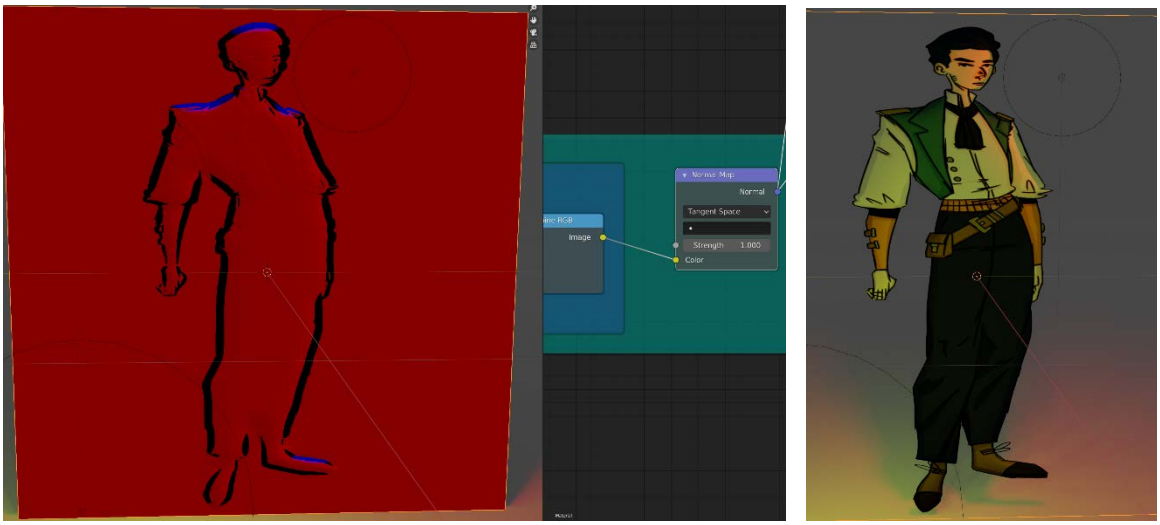


Fig E7. Normal Map node isolated -strengh 1.000

Normal Map node generates a normal from the provided character's RGB normal map image. Changing the strength impacts the normal mapping effect.

Appendix F. Prototype 2

Prototype 1 vs Prototype 2 normal map comparison:

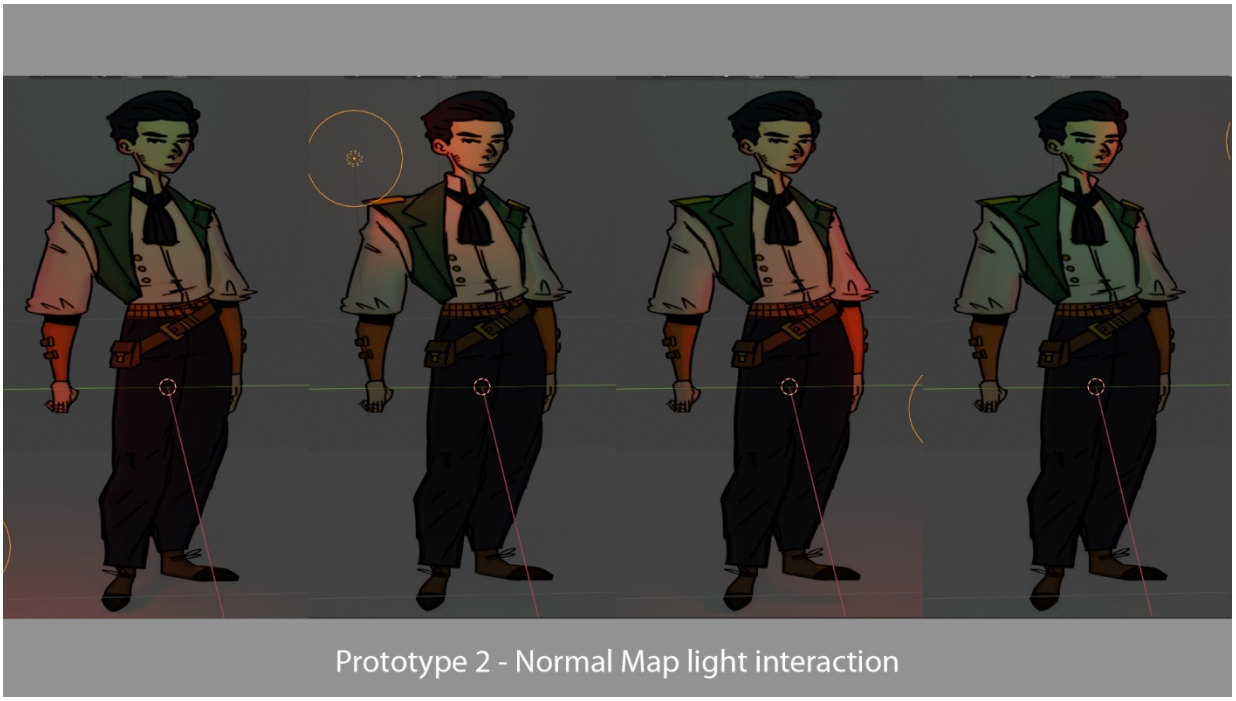


Fig F1. Prototype 1 vs Prototype 2 Normal Map comparison

Impotring the character's line-work separately:

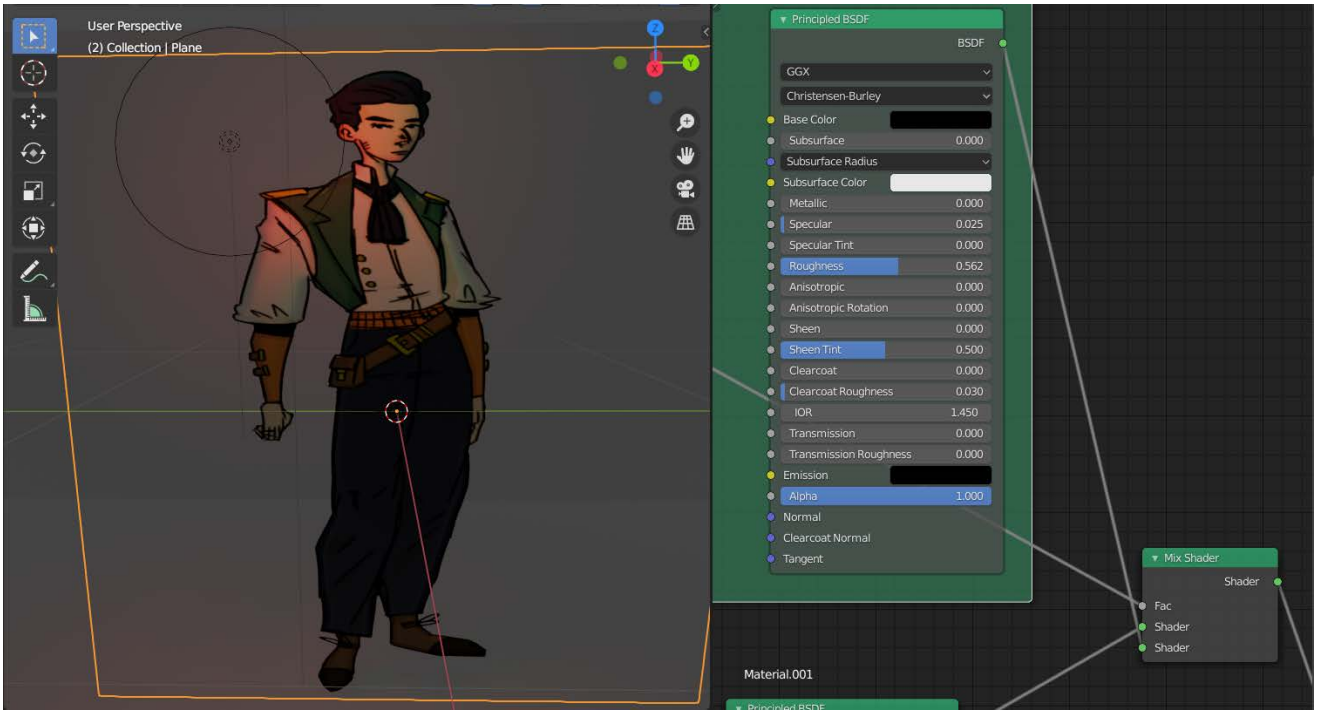


Fig F2. Linework import – using a BSDF shader

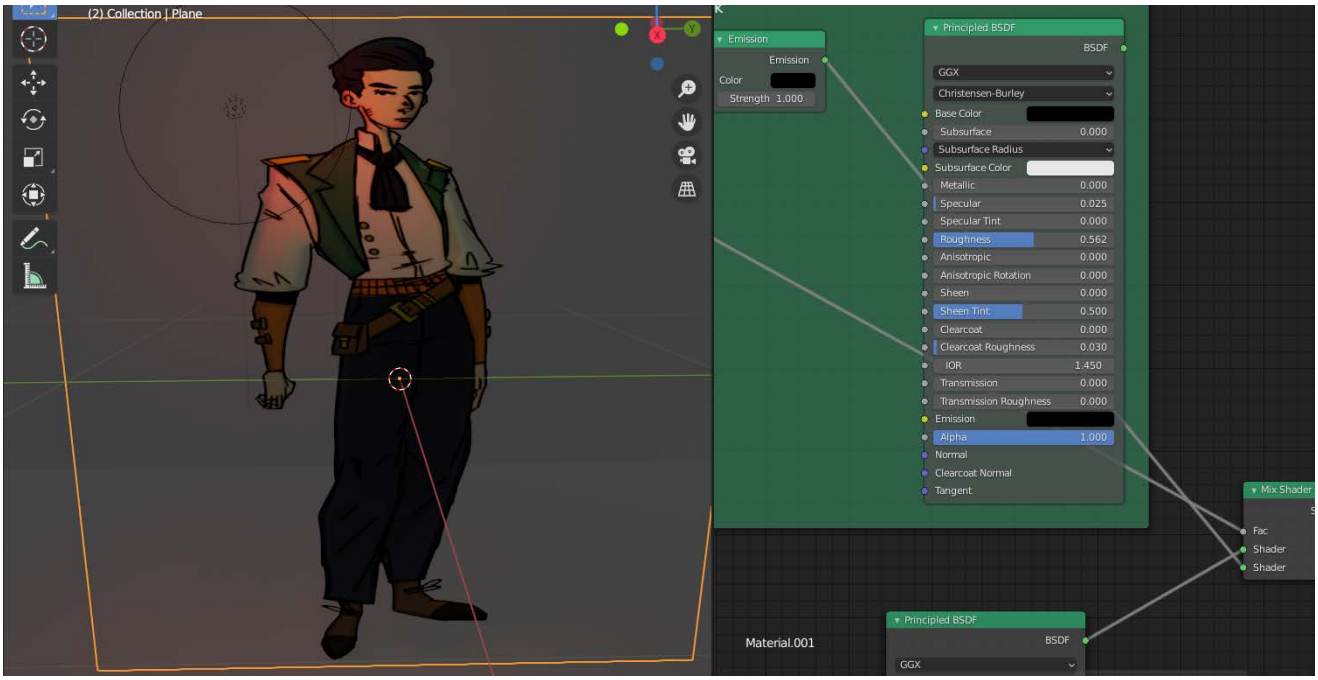
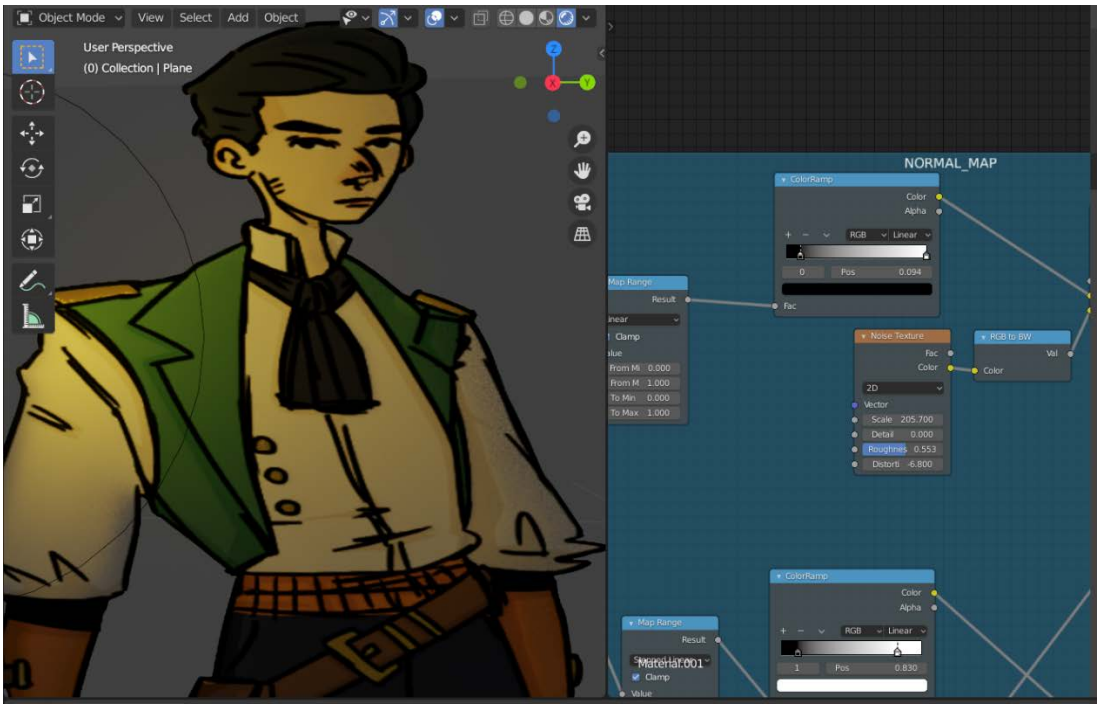


Fig F3. Linework import – using an Emission shader

Both methods produce the same result: the linework is not affected by the light.

Adding a Noise Texture node to the Normal Map node setup:



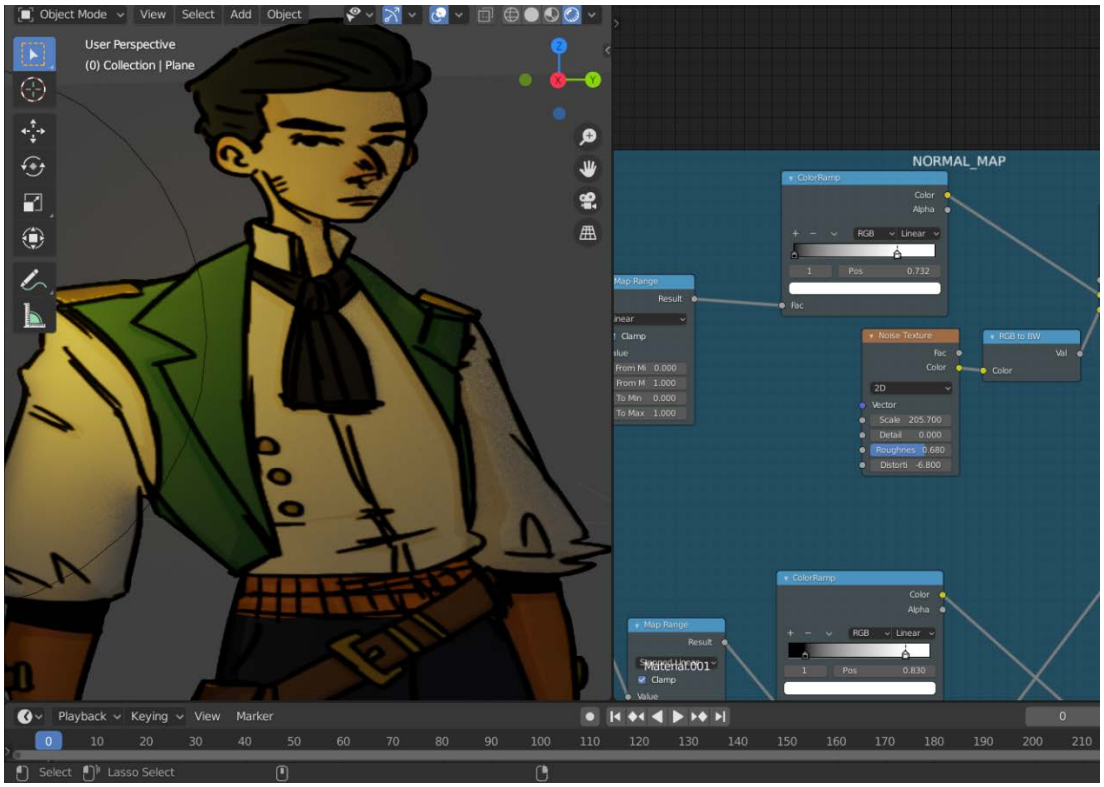


Fig F4. Hand-painted stylized look

Second method in appling a noise texture:

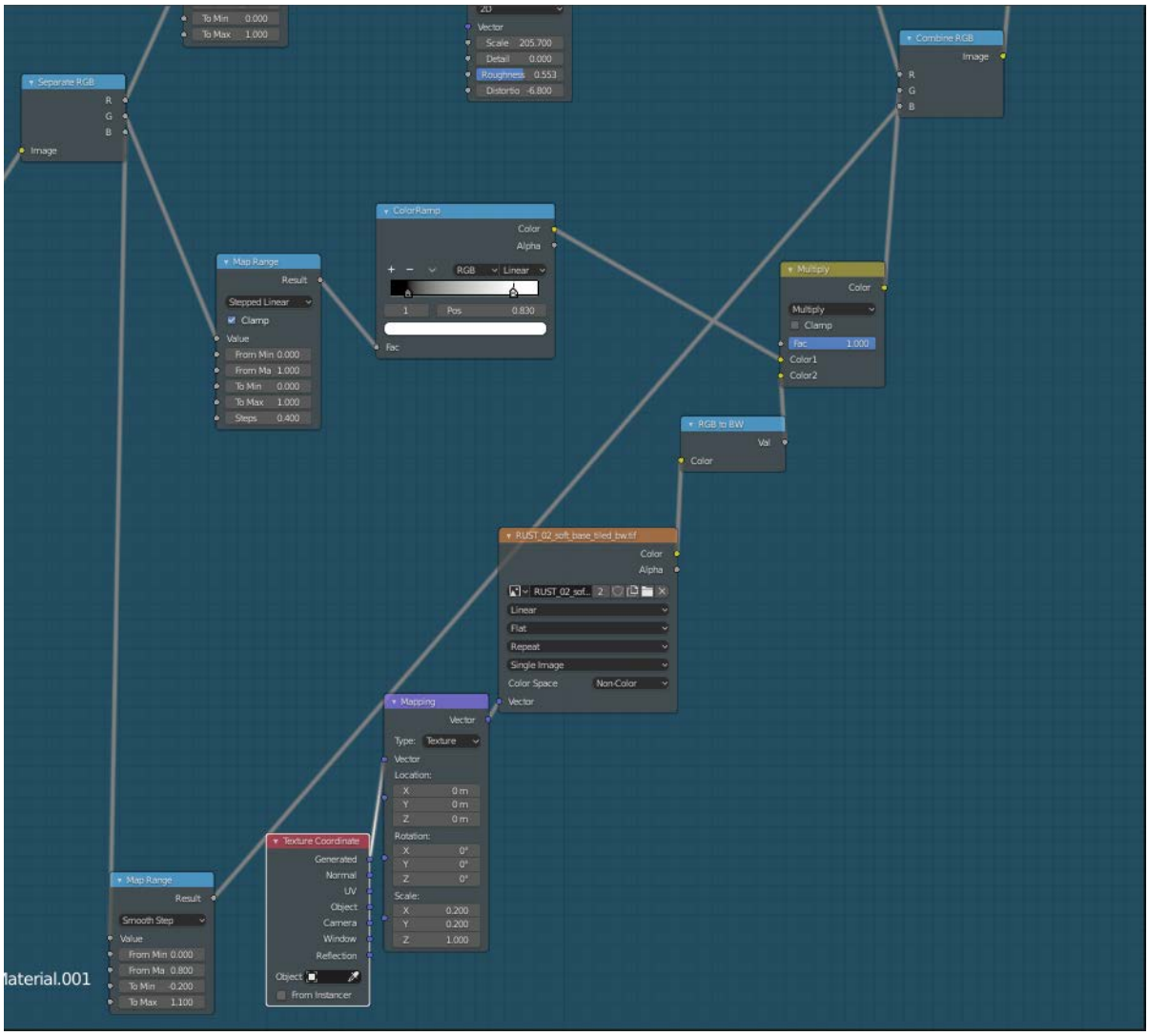


Fig F5. Adding an image texture as noise texture

Prototype 2 short demo:

Link: https://drive.google.com/file/d/1irhQIUANPVLVWt72Zruns3NUGSadxiJA/view?usp=sharing

Appendix G. Final Product

Link to the final product:

https://drive.google.com/file/d/1fGvh-e24mIlHfbI9pxJ3gojOLhwwwHdN/view?usp=sharing

Scene Light Style-frames:

Fig G1. Scene Light Styleframe iteration

The following style-frames were created to determine the best lighting scenario for the animation. The demo-animation focuses on the lighting technique and how normal maps allow the 2D character to interact with volumetric light. The stylized lighting ads value to the story's look and feel.

Pre-production elements:

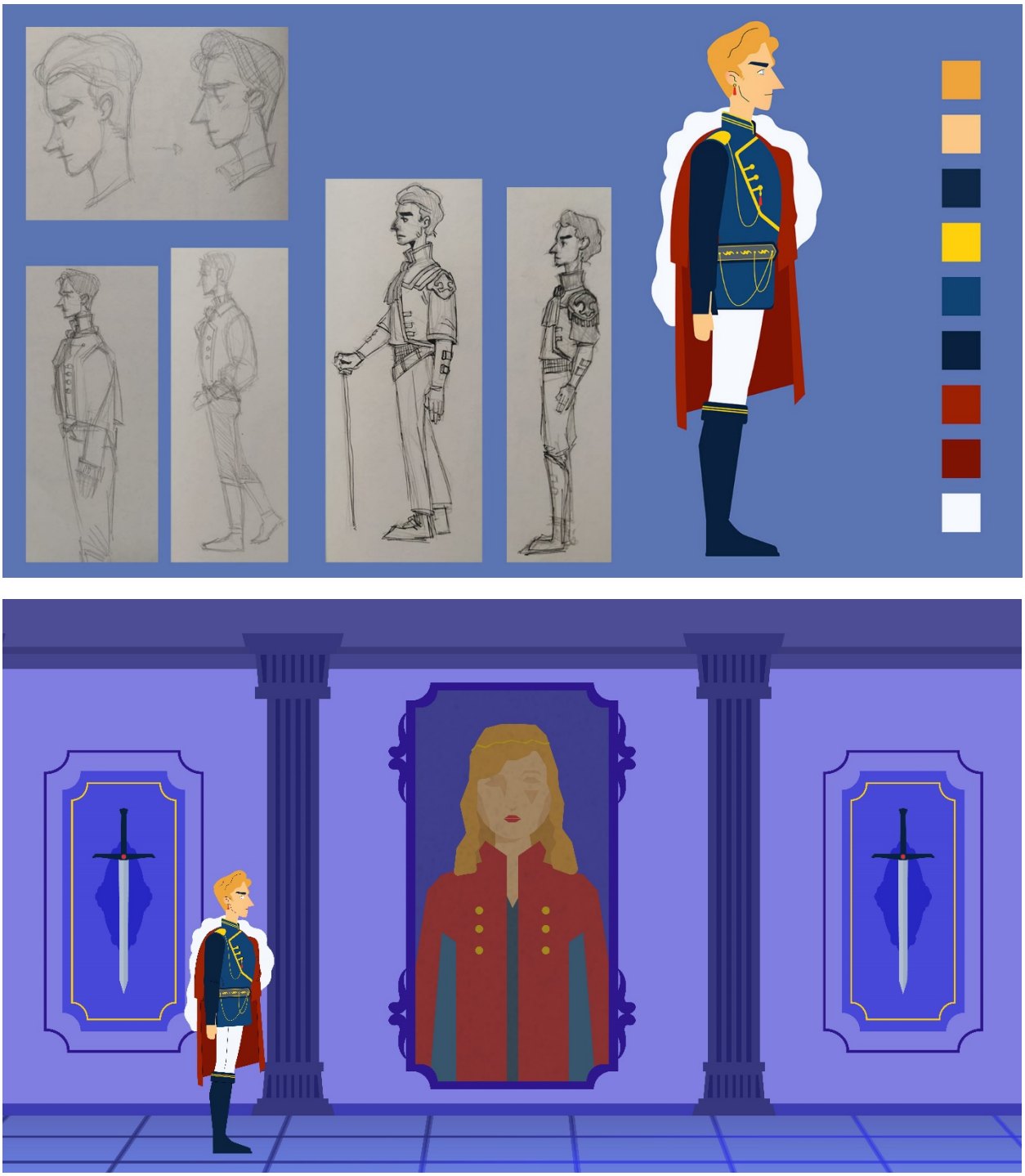


Fig G2. Character and background design

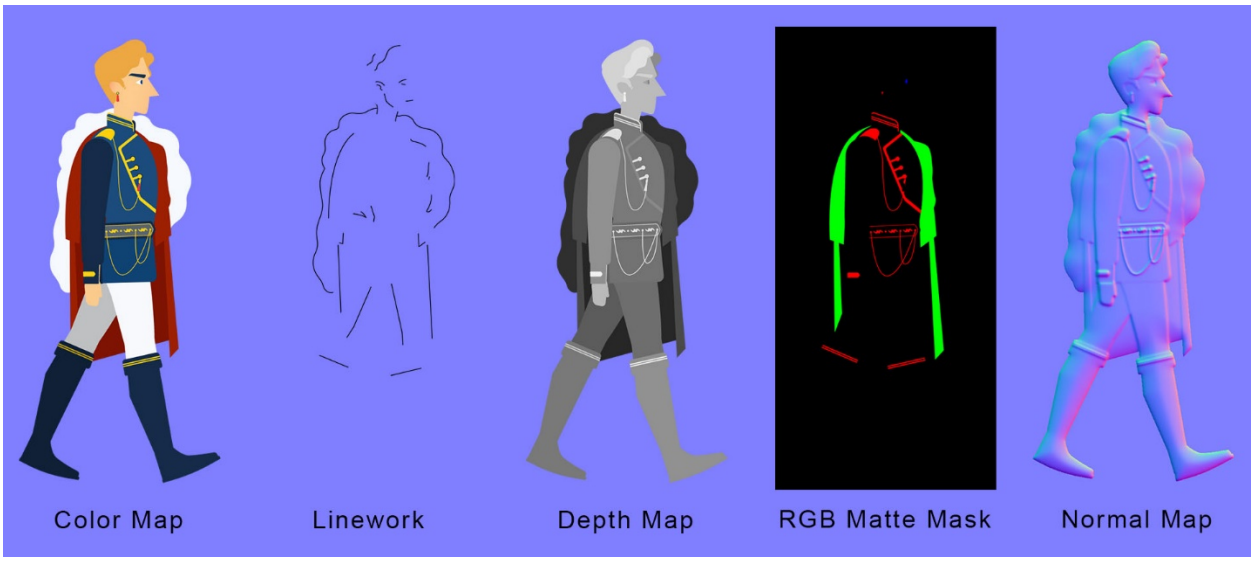


Fig G3. Character Masks and Maps