



# Creating a Large-scale Video Mapping Show

Project Development Pipeline for the Tampere  
Film Festival Performance March 4-8<sup>th</sup> 2020

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## **ABSTRACT**

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New technologies can bring new possibilities for utilizing applied art in marketing solutions. The core idea of this thesis is to create a documented pipeline for the projection mapping show production for the Tampere Film Festival.

Having a real-life case study project in the background, this thesis covers the entire process from early planning stages up to the documentation phase. Three visually connected performances were created and conducted the frame of the festival. These shows took place at three different locations on the same date as the festival screenings and were aimed to boost the visibility of the festival in the city.

The study describes the full path of the show development. Like all of the projects, it started with an extensive planning phase and research on technical aspects of the equipment. It was followed by buildings recreation in 3D environment and solving cameras to maintain accurate viewer perspective. The study covers troubleshooting of the projectors and sound set up on location and concluding a project with the documentation stage.

The developed pipeline confirms the necessity of the extensive planning stage and large time investment in 3D modelling before starting the animation process. However, the created workflow is not ultimate and can be easily altered according to the specific project needs.

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Key words: projection mapping, video mapping, cinema 4d, 3D animation, mo-graph, Millumin

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## ABBREVIATIONS AND TERMS

TAMK	Tampere University of Applied Sciences.
4K	a video resolution standard of 3840 by 2160 pixels.
GPU	the Graphics Processing Unit of the computer.
CPU	the central processing unit of the computer
3D	the three-dimensional computer graphics.
HAP	a set of video codecs that performs decompression using a computer's graphics hardware.
H264	most commonly used format for the recording, compression, and distribution of video content.
Video mapping	superimposing static or moving images onto various non-flat surfaces of the physical objects.
Projection mapping	similar to video mapping, commonly used in the United states.
Photogrammetry	the science of making measurements from photographs. The input to photogrammetry is photographs, and the output is typically a map, a drawing, a measurement, or a 3D model of some real-world object or scene.
Lumen	a measure of the total quantity of visible light emitted by a source per unit of time.

## 1 INTRODUCTION

There are plenty of ways to impress the crowd with stunning performance and create more visibility for your brand. Approaching 50th anniversary in March 2020, Tampere Film Festival production crew decided to utilize the power of the video mapping for this purpose. The core idea for this project was to create 3 performances in three different locations, with a united idea of the implementing buildings structures in the developed 3D animation. It took more than 2 months to settle with locations, budget and development schedule. Actual work project process took over 2 months as well including modelling, animation and performance on location. The project went under the name “STRUKTUR”.

Creating video mapping show seems to be a quite straightforward process. A lot of guides and tutorials over the internet are available, but most of them cover only basic projections and simple animation for the buildings. Furthermore, when it comes to the complex structures or not regular projectors setup – there is almost no information, only tiny ideas scattered around. Video mapping shows are heavily dependable on location and building structure and most of the time development process will be tailored to the particular needs.

Thus, general purpose of this study is to combine all information accumulated during research on this particular project together. As a result, this will be a well-documented developing pipeline, based on practical aspects taken into account during the entire process. Like every project-based work, it can be divided into 4 parts: planning, preparation and animation, execution on location and documentation for the portfolio. At the end of this thesis I will share several tips on how to minimize time-consuming tasks and advise on the better timeframe for future projects.

## 2 VIDEO MAPPING. DEFINITION AND BRIEF HISTORY

For the past decade video mapping or projection mapping shows have gained enormous popularity for the public events in the cities. The popularity is based on simple, at first glance, technology to project image or video onto a building and ability to create impressive and even interactive shows without interfering with the object itself. By utilizing this technique artist able to create unseen optical illusions and immersive performances by taking advantages of the building structures, binding existing architectural forms with imaginary elements.

To define the term of projection mapping we can break it into 2 parts: projection and mapping. Both of the words are self-explanatory: projections stand for projecting image and mapping stands for wrapping this image onto a surface. Projection mapping and video mapping have exactly the same meaning; however, video mapping is commonly used in Europe and projection mapping is more popular in the United States. Both of the terms could be defined as superimposing static or moving images onto various non-flat surfaces of physical objects. Maniello Donato referencing to several other architects describes video mapping also as “Architectural Dressing” (Donato 2015, 15). This would be a more artistic approach to interpret public spaces and architectural elements as a stage for the emerging media theatre, where urban fabric being utilized for storytelling.



PICTURE 1. Haunted Mansion ride in Disneyland 1969. (Jones, 2014)

First experiments with video mapping date back to the opening one of the rides in Disneyland in 1969 (Picture 1.). For the dark ride were created optical illusion projecting filmed singers onto busts of their faces. (Jones, 2014) In the '80s took

place one of the first architectural projections by Mario Mariotti. He projected some drawings from the famous artists onto the facade of the Florentine church of Santo Spirito (Donato 2015, 27-28). Perhaps at this time point, we can state the birth of the large-scale video mappings, although for that performance was used a film projector.



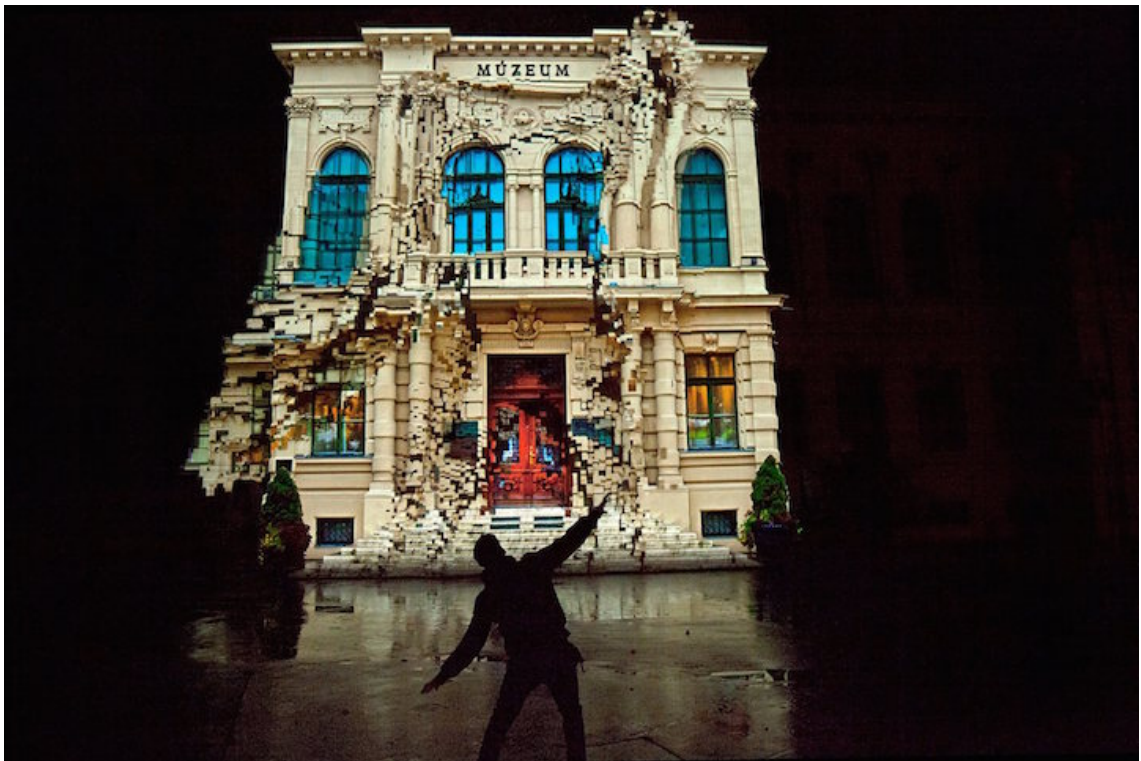
PICTURE 2. Sheikh Zayed grand mosque projections. (leigha db, 2011)

But only with developing computer technologies video mapping became more of its modern meaning. In 2001 five developers from MIT published an article about their invention Shader Lamps – using projects to animate real-life objects with 3D graphics. In this experiment video was placed onto Taj Mahal model and several small objects, 10 years later Obscura Digital created an impressive performance in Abu Dhabi (Picture 2) where approximately the same technique was used on a real-world large monument.

About 20 years since the MIT publication passed and technology developed has developed a lot. During this time artists have developed numerous shows, shared knowledge and inspired future artists on projection mapping and light art festivals such as Lux Festival in Helsinki or GLOW Light Art Festival in Eindhoven. How-

ever, this is merely about pre-made visuals and pre-rendered videos. Dramatically wide perspectives could be open with implementing interactive features and real-time rendering into the show.

Interactive projection mapping goes beyond traditional viewing experience transforming the viewer into an active participant of the art creation. One of the most interesting works in this field would be an interactive projection mapping and sound installation by Klaus Obermaier "Dancing House" (Picture 3).



PICTURE 3. Dancing house at Biela Noc, Kosice, Slovakia. (Obermaier, 2014)

Having several iterations across Europe during the past 8 years, Klaus was utilizing the same design approach on different building structures. The idea behind is simple: allow visitors standing in front of the building to distort or crumble it and simulate the sound of the wind by moving their hands back and forth. (Yoo, 2015) For this installation artist used a combination of the parsed point cloud from the depth sensor of the Kinect and transforming a simple 3D model of the building in real-time with Cycling '74 Max app. The same application was also used to generate sound effects for the show.



This installation is a good example of modern interactive art that has been performed in different locations for several weeks each time. Furthermore, with cheapening projectors production costs and developing LED light technologies we could start thinking of blending in interactive video mappings into regular urban cityscapes on a permanent basis.

Despite the general idea of video mapping as an art performance, nowadays we can surely talk about the usage of this technology in marketing as well. During past decade advancing rendering techniques and modelling software that allows blending together realistically looking artificial elements with real video big companies starting to bring new narratives onto the city surface.

For instance, fashion giants such as H&M and Ralph Lauren (Picture 4) have created fashion shows with animated building structures and therefore utilized projection mapping technology to boost brand awareness and attract new customers. But this advertising approach is not limited to just one particular location and a small number of viewers. Since most of the people have social networks creating an impressive show will definitely have a viral effect and reach more potential customers, creating a positive brand image.



PICTURE 4. Ralph Lauren 4D Experience. (Ralph Lauren, 2010)

Inspired by these possibilities in the autumn of 2019 group of 3 TAMK students approached the Tampere Film Festival crew with the proposal of developing several shows tailored specifically for the organisation. This led to the creation of the several video mapping shows under the name STRUTUR.

### **3 PLANNING AND REQUIRED STEPS**

The starting point of any project would be benchmarking, evaluation and planning future work. In cooperation with the Tampere Film Festival producers has been reviewed several potential buildings that can be used as the performance stage, timeframe and discussed possible limitations in autumn 2019. Production group also brainstormed some potential ideas on visuals according to planned buildings almost a half a year before the performance.

#### **3.1 Developing schedule and production plan**

During November and December 2019 production crew was working on evaluating buildings and budgeting. Original idea was to use following three buildings for the entire festival week performances: Finlayson area (projector setup was provided by Varma) to have mapping running on the loop every day during festival week, Tampereen Tuomiokirkko one day show on the 6th of March 2020 to support mute aim screening inside the cathedral, and Raatihuone on the 4th of March to support official reception for the city authorities and important guests. Another possible venue was Tullikamarin Klubi (Tullikamarin Aukio) – on 7th of March to support screening inside Pakkahuone. Since most of the screening was during the evening time, producers agreed on estimated starting time at twilight at 18:00 and run performances on the loop until 23:00 (sound volume to be reduced after 22:00).

The complication for one of the proposed buildings was early reception time at Raatihuone – 16:00 (at this time light is still quite bright in Tampere, which makes impossible to see the show on the building surface) and required permission from the general city architect. Film Festival producers applied for the show permit, but unfortunately, the reply from city authorities arrived very late, thus the production team decided to go with the Klubi building instead of Raatihuone in February 2020.

Following initial brainstorming discussion, the resulted production plan (TABLE 1.) was made with strict events date in mind, yet quite flexible and “back up” plan in case there would be problems with getting show permit. It can be seen every show preceded with equipment set up and test run the night before the event, which is an important step to have and also creates an impact on the equipment rental price. Finlayson area did not require equipment installation and test run the night before, due to existing permanent projector placement from the advertisement company.

TABLE 1. Production Plan

Date/Month	Step	Location
November 2019	Plan and Budgeting	-
December 2019	Photogrammetry and layout planning. Projectors placement calculations.	
December 2019	3D modelling of the buildings	-
January - February 2020	Animation, Testing & Rendering. Sound Design.	-
4th - 8th of March	Performance evening 18:00-23:00	Finlayson area
Night 3rd - 4th of March	Set up equipment and test run.	Raatihuone
4th of March	Performance evening	Raatihuone
Night 4th - 5th of March	Unmount equipment	Raatihuone
5th of March	Set up equipment and test run.	Tuomiokirkko
6th of March	Performance evening 18:00-23:00	Tuomiokirkko
Night 6th - 7th of March	Unmount equipment, pack and move to Klubi. Set up projectors and sound for Klubi performance. Show test run.	Tuomiokirkko, Klubi
7th of March	Performance evening 18:00-23:00	Klubi
Night 7th - 8th of March	Unmount equipment, pack and return rentals.	Klubi

### **3.2 Equipment, budget optimisation and possible limitations**

Since the Finlayson area has the permanent projector installed, the production team was planning to rent equipment to the rest of the locations. After getting approximate buildings measurements, the team have decided to proceed with two projectors per building, 20000 lumens each. The exact model of the projectors used was BARCO HDX-W20 FLEX with 1:1.4 lens. Keeping in mind that projectors are not weather-sealed, team decided to include to the equipment list a simple trailer with a transparent window to keep projectors “indoors”.

The sound system, used for two buildings consisted of two speakers, two subwoofers and operating console. Video output to both projectors and audio output sound console was from single computer and application Millumin (Mac OS only) with allows to map surface precisely and operate the show playback.

Due hospital placement nearby, video mapping for the Finlayson area was not allowed to be with the sound. Thus, production team came up with an idea of async sound design and use of YouTube live streaming to deliver audio experience. This aspect will be covered more in the following chapters.

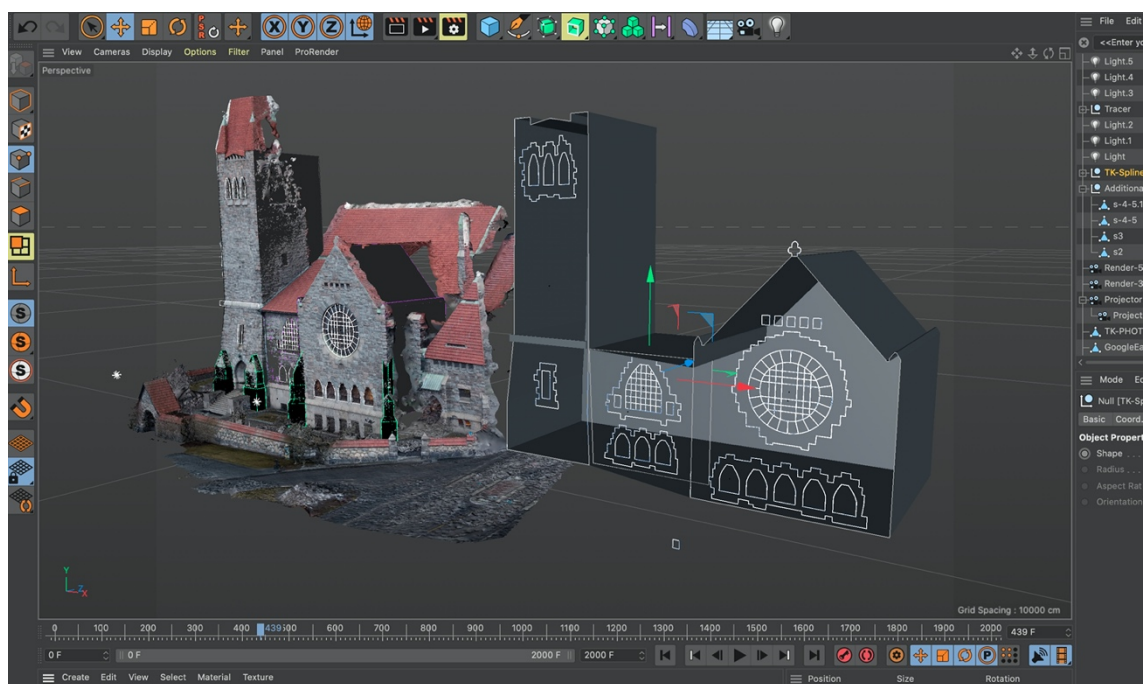
With the Raatihuone cancellation and logistics optimisation team managed to narrow down equipment rental time to three days only and still to have set up and test run the night before for both of the building.

### **3.3 Creating 3D assets for buildings. Photogrammetry**

If we think about video mapping where a building is not just a stage but an active participant in performance, we will need to have a 3D model of the building in order to animate structure elements. To have this model it is possible to request building architectural layout – this might be a quite complicated procedure. The other option, as suggested it by Donato Maniello is to use photogrammetry to have quite precise high polygon model of the building and then reconstruct the entire building in a 3D editor (Donato 2018, 44-49). To get correct measurement

in this case it would be enough to place some metric object next to the building or take just one, for example, the width of the window.

To get better results I used a drone to capture photos of the buildings. For every single building was taken over 100 photos, assuming recommendations that parts of the object have to appear on at least three photos from batch to create a 3D replica. Taken photos have proceeded with Metashape and team had a high polygon model in about 1-2 days per building. As you can see on the screenshot (Picture 5) the result reconstructed low poly model inherited precise measurements of the high poly model, exported from the Metashape.

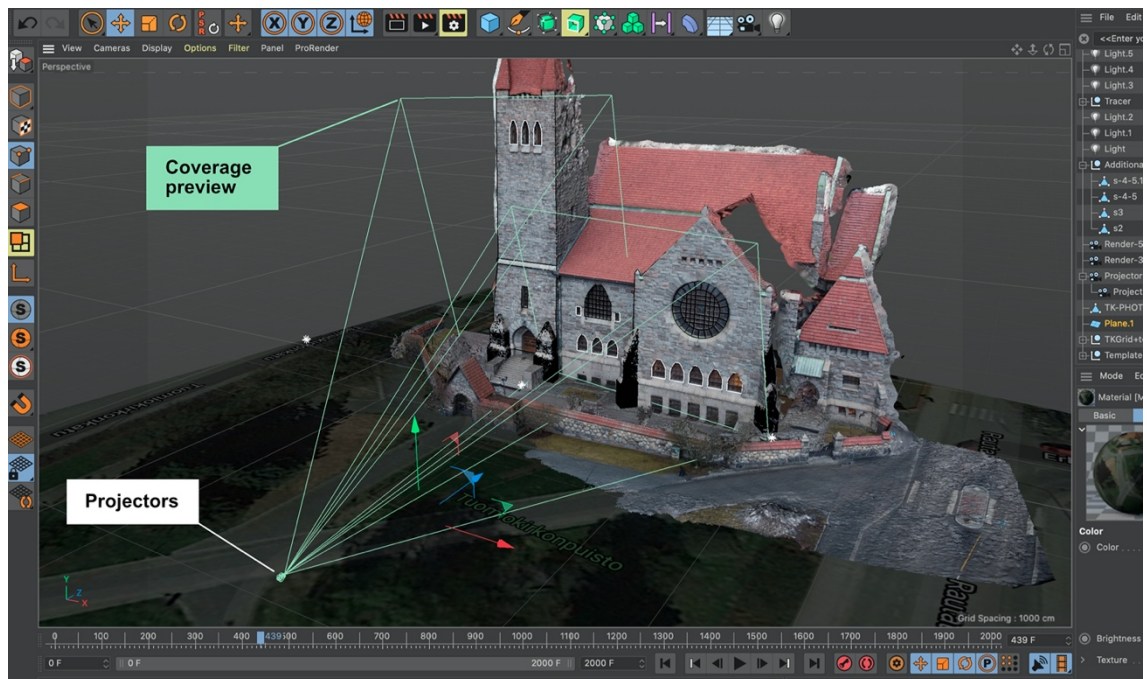


PICTURE 5. Building reconstruction. High and low polygon models.

In the depicted case, resulting model has most of the building elements as an independent object, this makes the animating process more simple and easier to control. The overall shape of the building was made as polygon object and windows as splines with extrude modifier. Having a 3D model of the building ready allows proceeding with layout and projectors placement validation.

### 3.4 Creating area layout and validating projectors requirements

The result high poly model was also used as a measured reference for the equipment layout creation. For instance, to cover Tuomiokirkko building production team decided to place one projector horizontally and the second horizontally, thus projection distance was smaller and projection brightness high enough. In order to validate this theory, the simplified surrounding area was built in Cinema 4D, and cameras with the projectors lenses specifications were placed in the estimated area (Picture 6).



PICTURE 6. Projectors placement and layout.

With cameras placed onto the desired spot – making one of the “projectors” cameras active allows to see through it on the reconstructed building and evaluate the coverage. Thus, even months before and without moving actual quite heavy equipment, the production team had proof of the placement of the projectors and was able to estimate power cables routing from the church outlet.

## **4 DEVELOPING 3D ANIMATION**

With 3D building assets ready it is easy to start the animation process. This process seems fairly easy and quite straight forward but when we think about large scale video mapping it is hard to disregard some crucial aspects. One of the most important is to maintain the correct perspective when working with the facade elements of a 3D building. Nevertheless, it is also quite important is to keep an eye on balanced render settings to archive feasible rendering time.

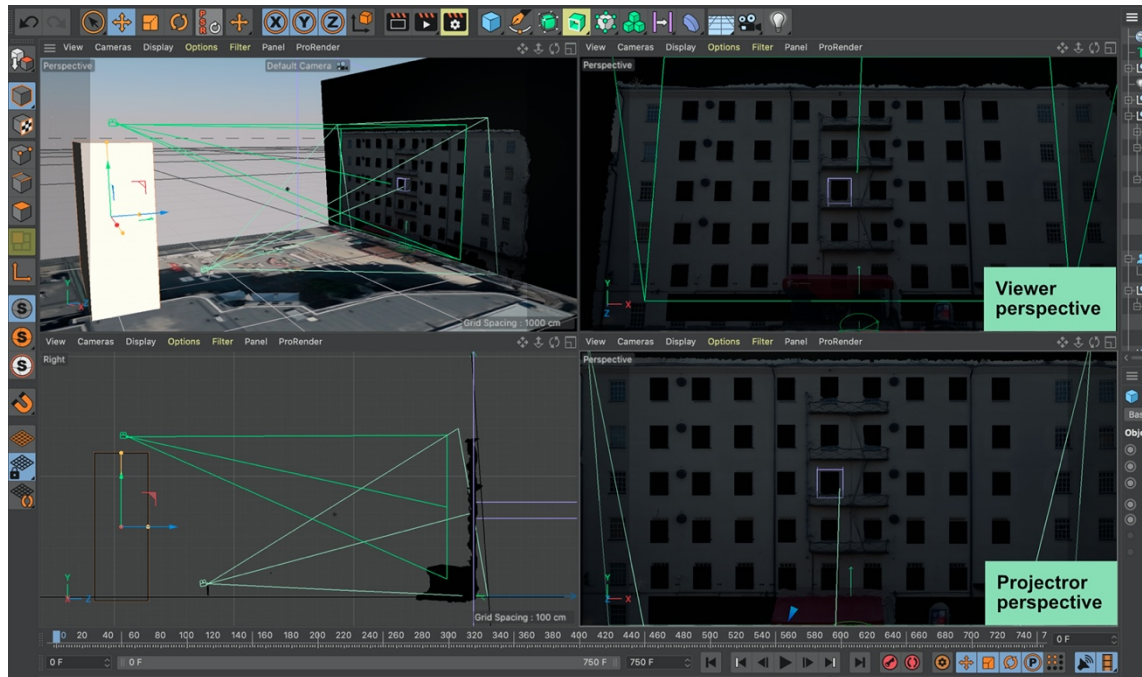
### **4.1 Setting up cameras in Cinema 4D according perspective of view**

Taking into account that the public will perceive the show from a certain point but the projectors will be placed in different spots we might run into the problem with a distorted perspective. If rendering camera is placed at the future projector spot in the 3D space and the projector is high and set aside from the viewer position it will cause distorted image. But what if there are two or even more projectors used? Partially this can be solved during the actual mapping process. Possible another case where the production team might have not proper access to the mapping software to control a projector or distance between projectors and viewer is significantly larger and distortion cannot be easily tweaked.

#### **4.1.1 3D space in software and real world alignment**

For every show production crew had a chance to work on the equipment layout, ability to pick the best spot for the projectors and utilize mapping software to have precise wrapping tweak. Except the one case – Finlayson area. This case is unique: Projector is installed permanently on the rooftop of the opposite building and used for the advertisement purposes. For the period of the festival, it was booked to run a video mapping show every evening. It is fully calibrated and utilizes masks for the windows in order not to cause any disturbance for the office workers (Picture 7). Thus, the production team was only able to send the final video file to the maintenance company. Furthermore, the distance between the

viewer and projector is more than 10 meters – this would cause significant distortion in the optical illusion 3D effect I intended to use for the animation.



PICTURE 7. Projector and viewer perspective.

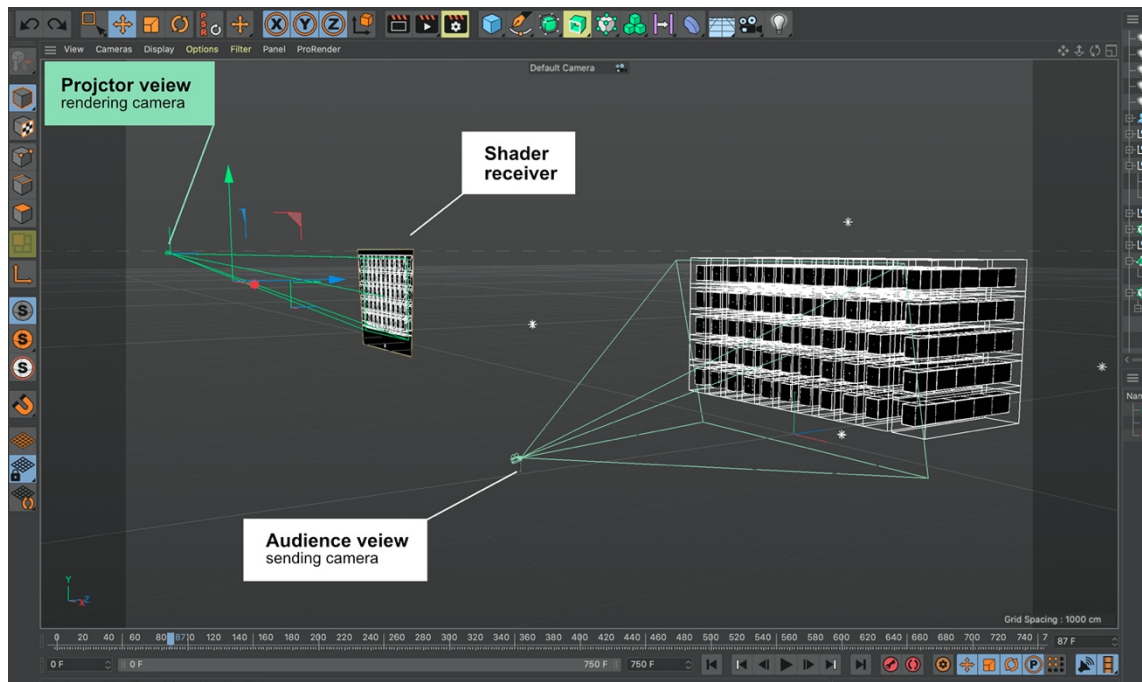
The idea was to create an effect where windows are pushed back towards the building hence to archive better visual impact this extrusion must correlate with the viewer perspective almost perfectly.

#### 4.1.2 Solved camera rig

For the 3D animation I was using Cinema 4D, thus solving the problem with distorted perspective was fairly easy with camera shader and simple camera rig. Camera shader enables transferring footage from one camera onto a flat surface, e.g. plane, in real-time without rendering.

To create perspective rig first step was to create a camera at the approximate best viewer location. This camera was capturing animation with the correct perspective. In the same file, quite aside from the animated elements, we needed to create a plane and another camera. The second camera was an actual rendering camera and projector simulation camera (Picture 8).

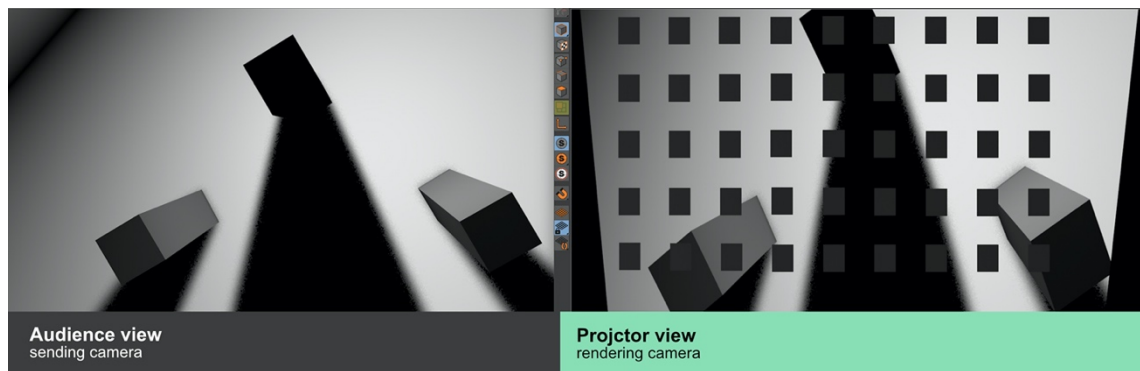




PICTURE 8. Perspective transformation camera rig.

Simon Spencer-Harvey in his video 3D C4D Projection Mapping Rig advised to create the second camera with projector lens settings and place it at approximate projector location (Spencer-Harvey, 10.18). In the given example, Simon Spencer-Harvey clearly shows that this set up can be extrapolated to three or even more render cameras, depending on the planned layout. This verifies necessity to have an equipment layout ready before starting the animation process.

Cinema 4D help (MAXON 2019) describes the following steps quite straight forward: we need to create standard material with only light channel activated. Next step is to place capturing camera as a source into the camera shader in the light channel and set the resolution in appearance panel to “no scale”. When the created material is applied to the plane and activated the second camera as render camera output results will appear distorted, but when reprojected in real life — will be perceived from viewer perspective as intend to be (Picture 9). Here, it is crucial to bring awareness of some existing limitations when using camera shader. In Cinema 4D there are several prebuilt render engines, Standard and Physical renderers are CPU based. Newly introduced, GPU based ProRenderer does not support camera shader yet, unfortunately.



PICTURE 9. Difference between viewers and modified perspective.

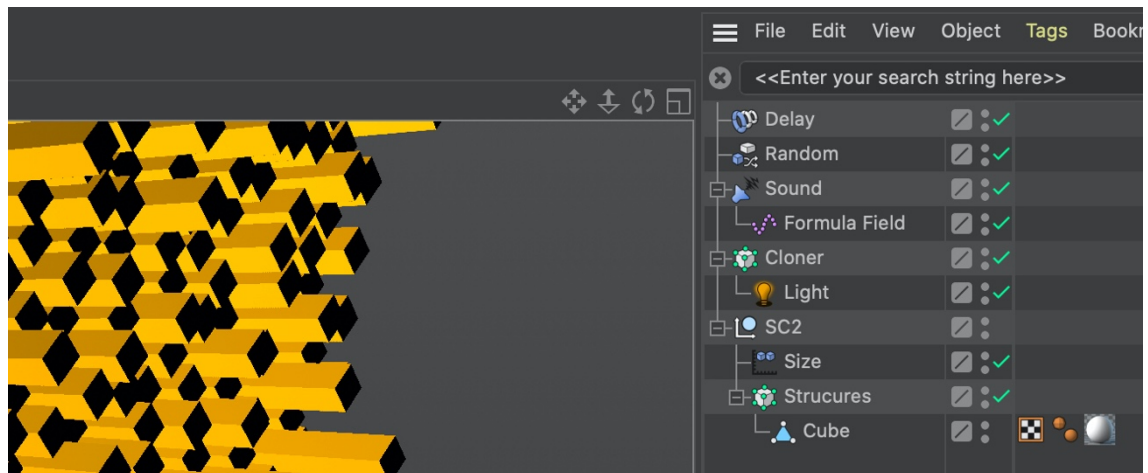
Since the Finlayson area had preinstalled projector, I was provided with the windows mask file and projector resolution specifications. This led to recalculating and manual pixel by pixel fitting set up backwards. Following, motion designer was able to validate solved camera rig on location at early stage in January 2020 and developed camera rig was successfully confirmed and utilized for the future animation.

#### 4.2 Modelling and animation. Mograph tools in Cinema 4D

From the beginning, I came up with a vision to have similar visuals appearing in the video mapping for every building yet have structures of the buildings blended into hence creating individually tailored shows. Other significant note would be an implementation of the identity of the Tampere Film Festival to boost the visibility of the brand in the city and over the social networks. Both goals were successfully reached with the series of video mapping shows under the name: STRUKTUR (Appendix 6).

Besides the classic animation process, it is good to mention that every show was divided into 4 scenes and these scenes were rendered individually and combined in post-production. Moreover, it is needed to highlight the teamwork process from a bit different perspective. Motion designer and sound designer were working together from the initial idea discussion until the end of the project. Quite interesting was this collaboration in setting up one of the main scenes. Utilizing powerful mograph tools, available in Cinema 4D, it was a relatively simple process setting up animation.

One of the key scenes' setup (Picture 10) requires additional description due to the fact that usually sound design for comes after the animation. In this case process was different – animation of the structures in the scene was driven by sound.

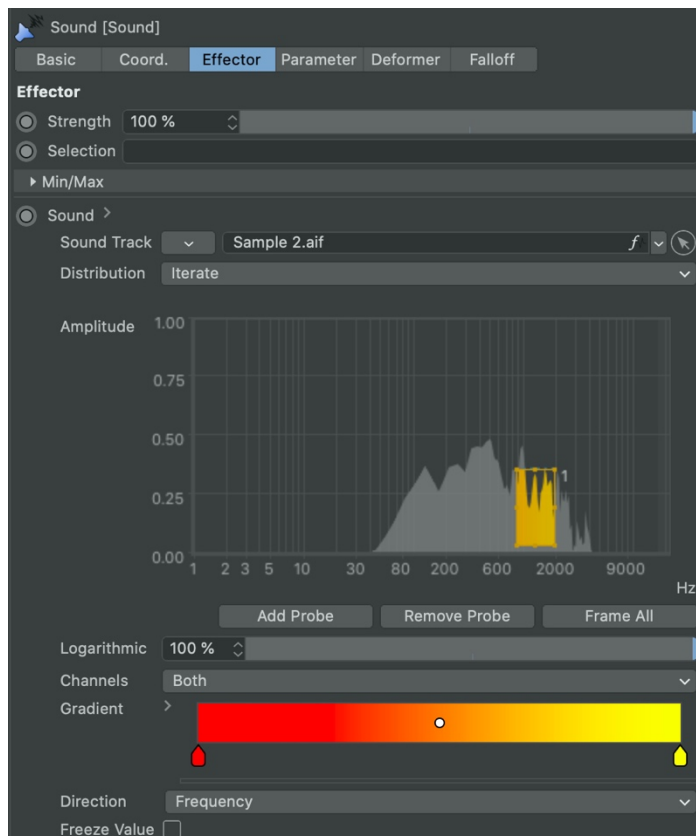


PICTURE 10. Scene elements structure.

As you can see from the screenshot above – this scene consists of just six elements and this set up is completely procedural, which makes any modification extremely easy. Merely this is one cube multiplied with honeycomb array and several effectors connected.

The waviness of the structure created by applying noise filter with large scale and followed by applying the sound effector. The idea behind this combination is to modify the scale of the individual cubes in the cloner array according to the sound clip. The sound effector works by analyzing sound wave from the provided file. Then designer can select frequency and volume range and extrapolate those values to the scale of the individual elements in the cloner array (Picture 11).

Although sound design was more complex for this particular scene, this type of animation simplified the sound syncing process in post-production.



PICTURE 11. Sound effector settings.

If we talk about the building as a stage for the video mapping, there might be challenging obstacles in front of the building. The I faced one of example while working on the Tullikamarin Klubi animation. As you can see on the picture there is a tree in front of the building and almost  $\frac{1}{3}$  of the building is covered by its shadow (Picture 12). Motion designer decided to include the tree as part of the animation, by projection golden leaves onto it. Also, in one of the animation sequences for the Klubi building this tree was mirrored and used to create symmetry effect, with was a nice accent to the entire show. Leaves, in this case, were also created utilizing the mograph cloner tool and only one leaf as animated, rest of are replicated copies with different effectors applied such as scale and random – to remove uniformity and add imperfections.

As we can see from just two examples given, mograph tools in Cinema 4D are very powerful and quite easy to use. Thus, by utilizing suggested tools, we can dramatically speed up the animation process.



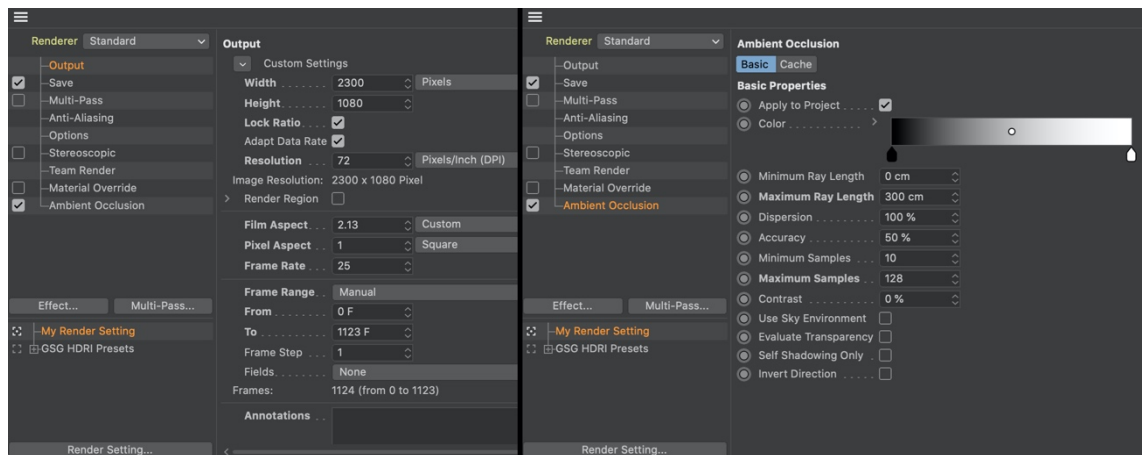
PICTURE 12. Obstacles and animation workaround.

### 4.3 Reducing rendering time with the correct settings. Team render

By virtue of separation scenes, it was possible to shorten work time dramatically. The sound designer had access to an early low-resolution render, thus while motion designer was working on clean final renders – the sound designer was working on the sound.

However, when utilizing 3D animation in the production pipeline it is also crucial to think about rendering process beforehand. While setting up the template files for animation, motion designer was also adjusting render settings to reduce calculation time per frame. First of all, we need to start with the layout determined in the first stage. For all of the setups with 2 projectors motion design used frame size combined from two projectors resolution in order to have a seamless video to wrap it later on location. Hence, there is only one file rendered for both projectors.

Secondly, it is good to consider utilizing simplified not physically correct standard renderer instead of slower, but physically correct render engines (Picture 13). This, depending not the complexity of materials can give up to 2 minutes less rendering time per frame compared to other renderers. Moreover, some of the precious seconds can be saved by utilizing ambient occlusion instead of the real global illumination.



PICTURE 13. Render settings used to create Klubi animation.

Ambient occlusion is a simplified illumination method to archive more or less realistic shadows at desired locations (Maxon, 2020). Another vote for utilizing ambient occasion is projection technology itself. Projectors are not so powerful yet to produce high enough quality picture where views can truly discern rendered physically correct casted shadows over the simulated artificial ones.

The third option to increase calculation speed is to utilize built-in distributed rendering feature in Cinema 4D — Team Render. This option allows spreading rendering load across machines in a network, where one of the computers is a server that transfers tasks between slave computes. When sending rendering task server divides all frames between computers evenly and when frames are renders, sequence files are sent back over the network to the main computer. It is better to utilize image sequence rendering settings instead of full video rendering, thus it will be possible to resume the calculation process if some error occurs.

#### 4.4 Creating and transcoding final video files

Having output files as image sequence requires additional steps to create a video output file. For this purpose, I used Apple Motion to combine result files together with sound into video file. This application also was used to create simple transitions between rendered scenes. To produce output video file was used ProRes 422 codec. For the Finlayson area media server required to use H264 codec with 1920x1200 pixels frame size. For the other two locations I decided to use HAP video file.

Since two projector resolutions combined are close to the 4K video and projectors are generally perceived by playback computer as external display it is better to reduce real-time rendering load to the computers graphic cards and have smooth video playback. Here comes benefits of the HAP Q codec usage: this is a high-performance video codec specially developed for the simultaneous real-time playback of the high-resolution files. On the average file size HAP codecs can be compared to ProRes files but with significant increase of performance.

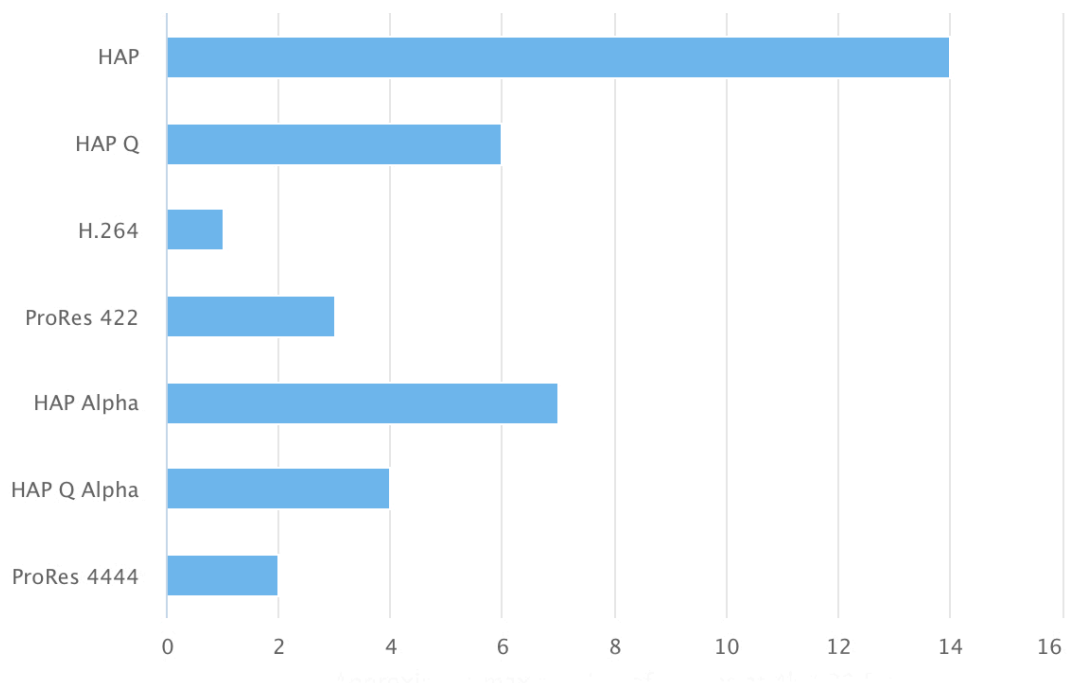


FIGURE 1. Approximate max number of sequences at 4k / 30 fps using single 2.7 GHz Intel Core i7 w/ AMD Radeon Pro 460 (HAP, 2019)

As we can see from the chart provided by the developer (Figure 1) regular HAP codec allows to have up to 14 4K video streams on a regular MacBook Pro without any problem, comparing only 1 to 2 streams if H264 codec is used. HAP Q, however allows get better image quality by sacrificing hard drive space. For example, 5-minute animation file size will be about 2,5 GB size (HAP, 2019).

In a nutshell, HAP codecs utilize standard texture compression formats with a lightweight secondary compressor applied on top of it. During playback HAP demuxing frames from the container and passes decoded data directly to the OpenGL or Direct 3D enabled card (HAP, 2019).

Those codecs can be installed for free from the developer website. Most of the common mapping software and media servers are providing full support for HAP codecs allowing motion designer freedom to choose from different options. It is worth to mention that several of the HAP codec have alpha channel support. Thus, there is another serious advantage over H264 usage – possibility to stack video files as layers with transparency.

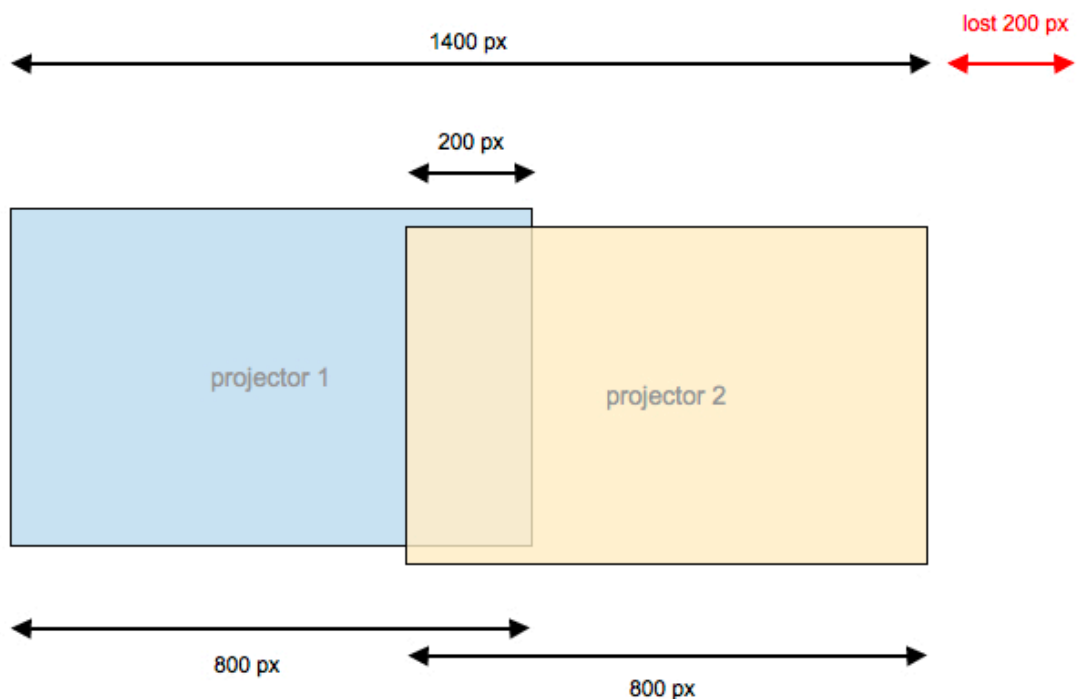


## 5 EXECUTING ON LOCATION

Final video files were created with estimated projectors placement in mind. For the operating projector output, mapping footage onto building and video playback control production team required to utilize additional software. Several applications are providing mentioned features available on the market. Most popular between small video mapping production companies are Mad Mapper and Millumin. For the performances at Tampereen Tuomiokirkko and Tullikamarin Klubi production team decided to proceed with the Millumin.

### 5.1 Setting up equipment. Blending projectors — soft edge and hard edge

Buildings might be quite complex and large structures and to create a truly immersive impact on the viewer we have to try to cover entire construction. Most of the mapping software designed specifically to help the production crew to do so. There are two ways to archive desired coverage, but the general idea behind is the same: create a large screen that covers the entire building.



PICTURE 14. The principle of blending projectors.

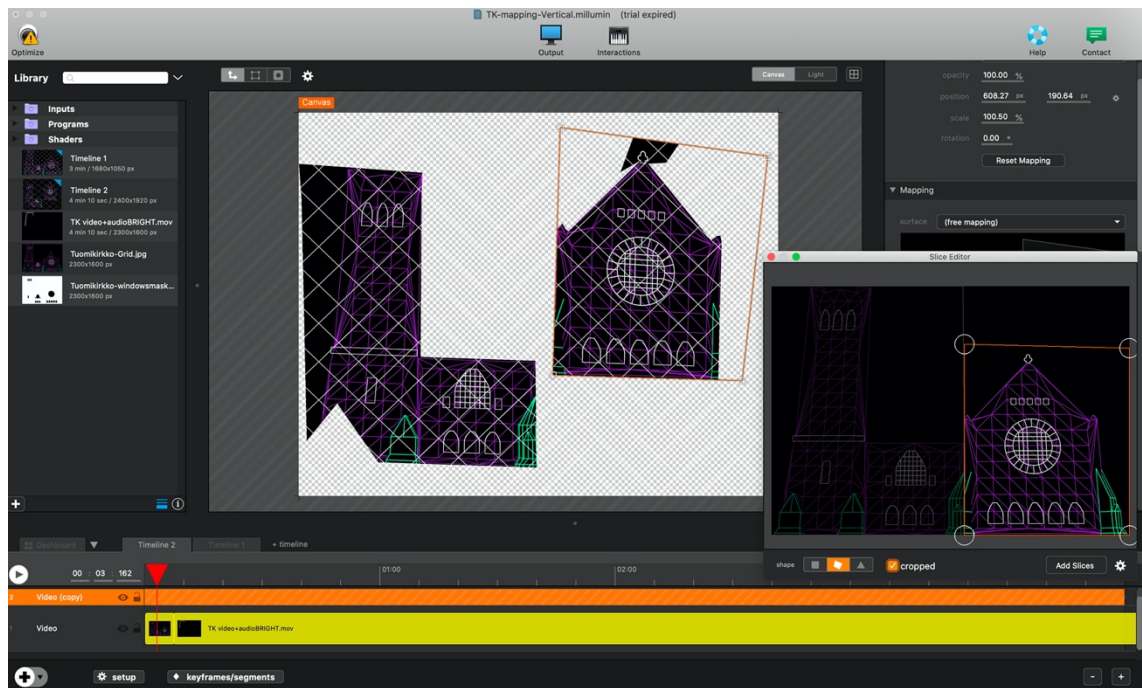
One of the options is to use soft edge blending technology that allows creating one continuous large screen with two or more projectors. The principle behind is simple projectors are placed certain way to slightly overlap output and utilize software, for instance, Millumin to blend the edge seamlessly (Picture 14). The result resolution will be slightly smaller due to the blending (Millumin, 2020). Moreover, the application allows to tweak output colours, thus it will be impossible to distinguish a seam. Blending process will take time to match outputs.

The second option is to use so-called hard edge blending. If building structure has a sharp edge and placed projectors output is overlapping nearby, sometimes it is easier to mask extra pixels along this edge. Utilizing described option designer will still have virtual seamless canvas and Millumin allows to clone the video layer and mask it accordingly. For both video mappings at Tampereen Tuomiokirkko and Tullikamarin Klubi production team utilized hard edge blending to map projectors.

### **5.1.1 Tampereen Tuomiokirkko**

Tampereen Tuomiokirkko building has complex shape, where one part is short and long, while other part is tall, narrow tower. To cover this building production team combined two projectors: one was placed vertically to cover the tower and middle part and second was placed horizontally to cover rest of the building. Hard edge blending was simplest solution to map projectors. While sound designer and technician were installing sound system, motion designer was adjusting projectors output wrapping.

Manual video output wrapping, or mapping is a required process to have visuals placed on the building surface correctly. Millumin allows having one source video file layer duplicated and sliced into several parts. The result layers can be manually fitted the building part by adjusting corners position and lately by creating additional mesh point to have a more precise overlay (Picture 15). As you can see I created two layers separated by the hard blending edge and utilized specially prepared outlined neon-bright grid to simplify mapping final video file with building elements.



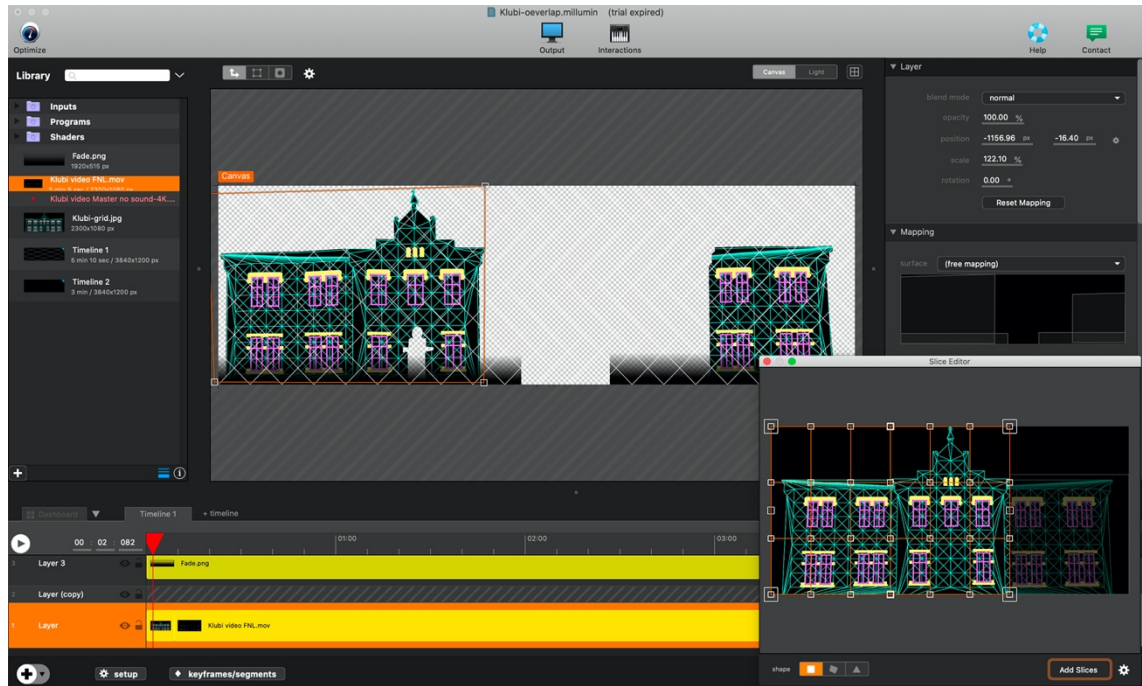
PICTURE 15. Millumin settings for the Tampereen Tuomiokirkko

Some minor issues were revealed during the initial setup. First of all, the church has dark grey stone walls, thus it would be better to have brighter projectors or even blend 4 projectors together. In this case, 2 devices would have been projecting the same image onto the same area hence it would be possible to significantly multiply brightness. The other drawback was quite heavy light pollution from the surrounding park, unfortunately, those lights were not possible to switch off without permission from the city authorities. Despite the mentioned minor issues, video mapping performance went well.

### 5.1.2 Tullikamarin Klubi (Tullikamarin Aukio)

Tullikamarin Klubi set up was relatively easier, comparing to Tuomiokirkko. In this case, both projectors were placed horizontally. The production team used hard edge blending as well. Since the building is significantly smaller, comparing to the church, projectors were placed closer allowing to archive overall brighter image. The mapping process was approximately the same as with the Tuomiokirkko setup. I utilized a bright grid to map the surface of the building, but in this case, also mesh wrapping to match every window perfectly. Also was decided to apply fade was on the lower part of the building to avoid interference with the passing

by cars and pedestrians (Picture 16). Moreover, to avoid bright light of the beamer distracts visitors inside of the building – the part of the video that overlaps the entrance of the building was masked out.



PICTURE 16. Millumin settings for the Tullikamarin Klubi.

Despite the fact that Klubi building has brick surface with low light reflection capabilities, proximally placed projectors combined with dimmed areal lights created bright enough show to entertain visitors of the festival and people who were just passing by.

### 5.1.3 Finlayson area

The Finlayson area has not required specific setup besides solving camera to map existing projector settings. The theoretical aspect of the required video settings was covered in the previews chapter (4.1.2 Solved camera rig), still to validate the camera rig I have created test video files to prove the theory. As you can see on the left picture (Picture 17) solved camera renders more realistic looking perspective. On the right picture captured regular frontal placed the camera in Cinema 4D for comparison purposes. Both captures were made from the best view spot. Furthermore, meaning for the second video was to res readability for

the QR code placed into the video. This test was aiming to confirm the possibility to overcome limitation with the sound setup production team encountered.



PICTURE 17. Comparison camera rig with regular camera.

## 5.2 Importance of sound. Streaming workaround for Finlayson area

Video mapping shows are mostly outdoor performances, they always considered to be immersive with strong visual impact. However, it is hard to ignore the importance of the audio component to create a better experience for the viewers. As it was mentioned before Tampereen Tuomiokirkko and Tullikamarin Klubi had full audio setup during the show and there was no possibility to install the sound system at Finlayson area. To overcome this limitation and deliver better experience sound designer created async soundtrack and crew utilized YouTube live stream capabilities every evening during the performance.

Most of the people nowadays carry smartphones connected to the internet with them. A lot of the phone owners also have headphones to listen to music during walks. Thus, the idea behind this workaround was simple: to place QR code into the video on the building and by scanning it the view was able to join a sound live stream with personal headphones. Utilizing YouTube live stream allowed to experience the same part of the soundtrack to multiple people simultaneously.

Async soundtrack also solved a problem with the physical delay during the streaming and possible latency while the viewer was connected during the performance. For the live stream I also created a poster (Picture 18) with stream time and key image for video mapping shows to maintain consistency. To avoid excessive YouTube advertising and branding I have created a simple webpage with just embed video player with the stream.



PICTURE 18. YouTube video stream screen.

Due to the website specific, YouTube created a new code for the video overtime stream is restarted. Thus, webpage containing video player had to be updated manually as well. Despite the requirement of being onsite permanently during the shows at a different location and autonomous run the show at the Finlayson area the production team was controlling stream remotely utilizing internet access to the host computer.

Remote audio streaming allowed to bring the sound to the area where was impossible to have speakers installed. Extended development of this idea might bring individual experience to the viewer for the same show. By solving streaming start delay and possible latency issues it might be achievable to create a fully synced audio performance as well.

## 6 SHOW DOCUMENTATION AND POST PRODUCTION

Like in every project it is crucial to have proper documentation for the portfolio after. Since most of the video mapping events are one veneering show it is a good idea to collect as much footage as possible. Hence for this purpose production team utilized every possible piece of equipment. Moreover, the footage was captured not only during the event but also during setup and test run the night before.

Here it is also good to mention changing light conditions during the performance from the twilight to complete darkness. This also might limit possible footage combination in post. Thus, production team had taken several repeating shots at different time. However, the light conditions are not the only possible limitation – photo or video camera lens could be as well. Considering proximal city buildings placement, it is better to utilize a wider angle lens with as much open aperture as possible. Furthermore, it is good to include drone to the list of the equipment. Having areal footage included in the final video will enrich it and can keep viewer attention.

Therefore, the equipment list for the reporting consisted of Canon 5D with 35mm/F1.4 lens, DJI Mavic Mini and iPhone XS with ProMovie app making manual control over the video capabilities possible. iPhone was mostly used as a backup camera but in post-production, motion designer decided to include some of the footage as well. Cameras layout for the capturing was quite simple: one shot of the entire animation from the best viewer position, the same shot at the approximately same time with side angle view, during both filming shots was also made areal capture: one with hovering in from of the building and several panning glides to have establishing or closing shots.

Even before installation process production team developed documentation plan and agreed to have one short promo reel that will include all of the locations to provide an overview of the project and its scale and individual videos for each location with full performance. An original soundtrack was developed for Finlayson area video in order to create a better viewing experience. Alongside with



widescreen videos I have rendered special square video with the length of 30 seconds to promote reports on personal social networks accounts.

To produce better quality video reports motion designer utilized Final Cut Pro function to synchronise and replace original audio from location with clean, studio file. This also was required step, since drone footage comes without sound at all. Editing in areal shoots with ongoing cameras footage was precise, manual matching frames task.

The result files were exported on H264 format and published to the most popular video distribution platforms Vimeo and YouTube. Every production team member received the same original files to include in their portfolios, as well as project concept description.

## 7 CONCLUSION

STRUKTUR video mapping series was complex but nevertheless interesting project. The development process took over 5 months and several months in research earlier. Originally planned ideas, as well as new discoveries during described work, successfully validated theoretical production pipeline, that can be applied for the future performances.

Overviewing the early stages of the project it is proven now that extensive time for planning part can significantly reduce possible issues in the future. Utilizing modern technologies such as photogrammetry will speed up development as well as the wise distribution of the workload between team members. Collaboration with the city authorities and providing them with clear vision of the project will make obtaining required permits easier.

Therefore, proposed production pipeline consists of the following steps:

1. Planning and research, initial photos of the location
2. Theoretical research on the possible equipment, ideas for visual components and detecting prerequisites
3. Layout design, building and surrounding area modelling
4. Validation of the planned equipment specifications and determine projectors and sound system placement
5. Creating a camera rig to match the best viewer perspective
6. Production of the animation
7. Rendering and compositing final video files
8. Creating additional visual materials for the event promotion
9. Equipment installation, mapping the building and test run of the entire show the night before the event
10. During the event evening monitoring equipment and capturing footage for the report phase
11. Event documentation and postproduction for the portfolio

Keeping the original idea of the production pipeline in mind it is quite simple to alter or even omit some steps for the particular project needs. Thus, I cannot call proposed work plan an ultimate solution for every possible project but merely a draft outline that allows structuring work process in the future. It is also good to mention usage for the brightest projectors possible and overlaying possibility to boost the image quality.

Sound also plays a significant role in creating immersive performance and where it is not possible to install speakers, live audio streaming solution could enhance show to some extent. Moreover, future development of this idea could bring individual experiences to the places that could not have that before.

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## APPENDICES

Appendix 1. Finlayson Area - Full performance.



STRUKTUR: Finlayson - Full Video (Vimeo 2020)

(<https://vimeo.com/397695423>)

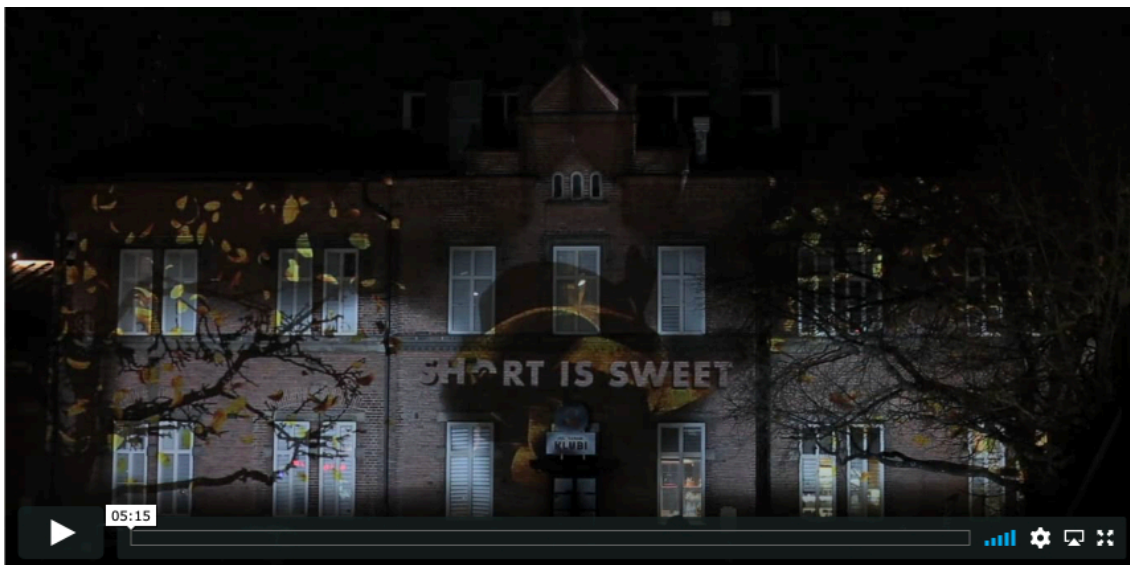
Appendix 2. Tuomiokirkko - Full performance.



STRUKTUR: Tuomiokirkko - Full Video (Vimeo 2020)

(<https://vimeo.com/397696042>)

Appendix 3. Tullikamarin Klubi - Full performance.



STRUKTUR: Tullikamarin Klubi - Full Video (Vimeo 2020)

(<https://vimeo.com/397697108>)

## Appendix 4. STRUKTUR: Project reel.



STRUKTUR: Project Video (Vimeo 2020)

(<https://vimeo.com/397693771>)



## Appendix 5. STRUKTUR: Marketing materials.



Appendix 6. STRUKTUR: Project concept.

STRUKTUR: The story about the structures in sound.

Animation and Mapping: Konsta Fed ([www.konstafed.com](http://www.konstafed.com))

Sound Design: José Montaña (<https://ello.co/josemontano>)

Projectionist: Carlos Portilla

The core idea for this project was to explore structures of the buildings animations and sounds. Animation in some parts of the show was driven by the sound sampling which was extremely interesting to experiment with. We were developing visuals structured not only by shape but by the sound as well in dense collaboration with the sound designer. Also was important to blend art techniques with brand identity in order to create a unique visual set for each location yet still have key visuals unified.

Due to technical reasons for the Finlayson show, we couldn't use sound on set. Thus, we created a show where the sound was accessible via live streaming from the website. Other locations had a sound system installed to create an immersive experience.