
Bachelor Thesis

DIGITAL ENVIRONMENTS FOR TIME BASED MEDIA

Student of Media Design

Wilfried Kaiser

Charlottenhöhe 4

74592 Kirchberg

FHSH Matrikelnummer 061.213

www.wilfriedkaiser.de

Counselors

Main tutor Prof. Fried Dähn

Second tutor Prof. Beate Ehrmann

Third tutor Thilo Schnell

To review the more finely nuanced images in this document consulting the supplied digital PDF version is recommended.

Table of Contents

Introduction to the Topic	3
Topic Identification	3
Entering New Terrain	3
Introduction to the Shots	4
Final Deliverables	4
Scheduling Problems	5
Past and present of Matte Painting and Compositing	5
The advantages in Digital Matte Paintings	12
My Artwork	12
Hardware used	12
Software used	13
"Dying Motor Town"	13
Introduction	13
Real-life industry situations	13
Composition	14
Asset management	15
Efficient execution and interactive lighting	17
Digital Compositing and Animation	19
Motion Blur	21
Grain and digital noise	23
Lens Distortion	24
"Alaska Echo"	25
Introduction	25
Painting Process	26
3 D projection mapping	31
"All Good Things Come In Little Packages"	33
Introduction	33
Environment Application	34
Lighting and Motion Blur	36

"Isla Pandora"	37
Introduction	37
Rendering Issues	39
Future look out	40
References and Sources	41

Introduction to the Topic

This research based bachelor thesis is centered on the problem of how to develop and produce photo realistic or stylized digital environments for time based media like features, television series or advertisements. The topic may easily fill a whole library, but every important aspect will be briefly covered in this document.

Topic Identification

Digitally created environments are commonly used in today's entertainment industries as well as in graphic design and broadcast work. Their purpose is to be able to show an environment that for whatever reason cannot be filmed by a camera crew.

I am whole heartedly interested in the field of visual effects (from here on abbreviated vfx) and started looking into vfx in my spare time when I was still a student in high school. Unfortunately vfx were never covered at Fachhochschule Schwäbisch Hall (from here on abbreviated FHS), which was the reason for me to invest much of my spare time into its research.

My motivation for this bachelor thesis stems from the will to use state of the art software and hardware combined with imagination and artistic expression to create moving photo realistic images showing seemingly real environments and/or obviously stylized fantasy environments in a way that makes them appear to look photo realistic. The combination of technology and artistry is what interests me most and digital environments often fill a large portion of the frame, which allows the digital artist to have a huge creative effect on the final shot, even though there may be hundreds of other elements composited on top of the matte painter's work.

Entering New Terrain

In recent years interesting new developments like stereoscopic 3 D and procedurally generated landscapes have surfaced, all of which are covered in this document.

Research in the archives of FHS has also shown that this is the first bachelor thesis centered on matte painting at FHS. By widening its fields

of activities this thesis will improve FSH's reputation for versatility.

Introduction to the Shots

In the process of researching matte painting I managed to create five technically and artistically completely different shots. The original proposal was to cover all kinds of different techniques and create one 2 D, one 2.5 D, one 3 D, one procedural 3 D and one stereoscopic matte painting and all of them "with a limited amount of human-made structures." Not only did I meet these goals but also exceeded them.

Assets used in each of the 2 D or 3 D matte paintings were shot by myself and are supplied on the data discs together with the shots. The 3 D procedural scenes were created using preset elements that were shipped with the original software and are free and open to use to the customer. These presets were heavily modified to perfectly fit the requirements for the proposed scenes. No copyrighted material was used in any of my work.

Final Deliverables

All the deliverables are uncompressed 2k Film resolution.

- 2 D matte painting "Dying Motor Town"

A highly detailed, yet because of its night setting minimally colored piece. Many carefully animated assets help achieve a moody scene of a large dying former automobile metropolis.

- 3 D matte painting "Alaska Echo"

A giant high resolution panoramic matte painting of a remote facility in Alaska. The bitmaps are projections mapped on to 3 D geometry to encompass a complex camera move.

- 3 D stereoscopic matte painting "Alaska Echo"

The stereoscopic version of "Alaska Echo". A left and right eye was

extracted and composited to achieve an optical perception of depth.

- 3 D procedural "All Good Things Come In Little Packages"

A caricature of a tiny planet with disproportionately scaled-up flora and fauna. 16 million polygons would crash any traditional 3 D modeling and animation package. That is why I used specialized software to achieve this.

- 3 D procedural "Isla Pandora"

A vast scenery with a huge body of animated water, clouds and a small uninhabited island with palm trees.

Scheduling Problems

I prioritized the artwork creation over this document because of the fact that I had to expect severe render times and a plethora of very difficult problems to solve because of the unknown terrain I entered. This decision turned out to be the right one, as some of the shots finished only hours before deadline. The rendering of the procedural Vue scenes turned out to be especially cumbersome for the computers that were available for rendering. I tried to keep rendering issues at a minimum but didn't fully succeed, which made the re-rendering of some of the frames necessary. These problems, however, are not uncommon because this bachelor thesis was a highly experimental one to begin with.

Past and present of Matte Painting and Compositing

A matte painting is a photo realistic painting, montage or extension either to an existing set of live action footage or a sequence of entirely computer generated imagery (from here on abbreviated cgi).

Matte paintings are used in cases where it is impossible to film a scene with a real film crew.

Many of today's most renowned digital matte painters started in the world of physical or non-digital matte painting and have moved on to doing digital matte paintings in the 1990s when computers gradually became fast enough. All the rules that apply to painting or to matte painting

also apply to digital matte painting. But computers can help speed up the process dramatically and help the artists to be much more versatile. It was for example almost impossible for a traditional matte painter to prepare a matte painting that would perfectly fit without any seams at the borders when combined with live action footage. This is why traditional glass and pastel matte paintings were often used in very limited ways for example for very simple and hazy distant mountain ranges composited "in camera" behind actors on a live action stage.



Image 1a

Image 1a. Example of a matte painting shot in the film "The Wizard of Oz" in 1939 with a locked off camera. Live action footage (left) and the matte painting (in the center) are composited to form the final shot. Note how the live action element in the composited short is surrounded by stark contrasts, elegantly avoiding the hassle of trying to seamlessly blend the colors.



Image 1b

Image 1b. The famous government warehouse shot of "Raiders of the lost Ark" (1981) employs comparable techniques and composition like discussed with Image 1a, although it looks totally different.

Compositing is the process of combining different elements which may include moving as well as static elements to achieve a believable and realistic scene. The advantages of today's modern digital compositing are that it is very easy for a trained compositor to correct each of the elements in a nondestructive manor and fit them perfectly together without any seams.



Image 1c

Image 1c. Yusei Uesugi next to the original matte painting he made for "Die Hard 2" in 1990. The piece was the first digitally manipulated matte painting and was used as a large establishing shot in conjunction with seamlessly integrated live action footage.

Yusei Uesugi talked about the hardware he used for "Die Hard 2" in the book *d'artiste: Matte Painting 2*: "The hardware at the time was really low-spec compared to what we have today. From memory I was working on a 25MHz Macintosh with 32Mb of RAM and a 64Mb hard drive which was the fastest at the time. Each time I made a selection on a film-resolution image I was afforded at least a 25-minute coffee break. Pretty much any major step at the time gave me a decent coffee-break. Though I was pushing the hardware limits, there were still compelling reasons to do these mattes digitally. With traditional paintings at this time, everything I did required a big commitment. To airbrush a painting to give the appropriate amount

of haze was a one-way trip no going back."

While Yusei Uesugi's shot was captured by a locked off camera zooming outwards, it is now very common for digital matte painting and compositing to be combined in a much more sophisticated fashion with complex camera movements through live action sets.

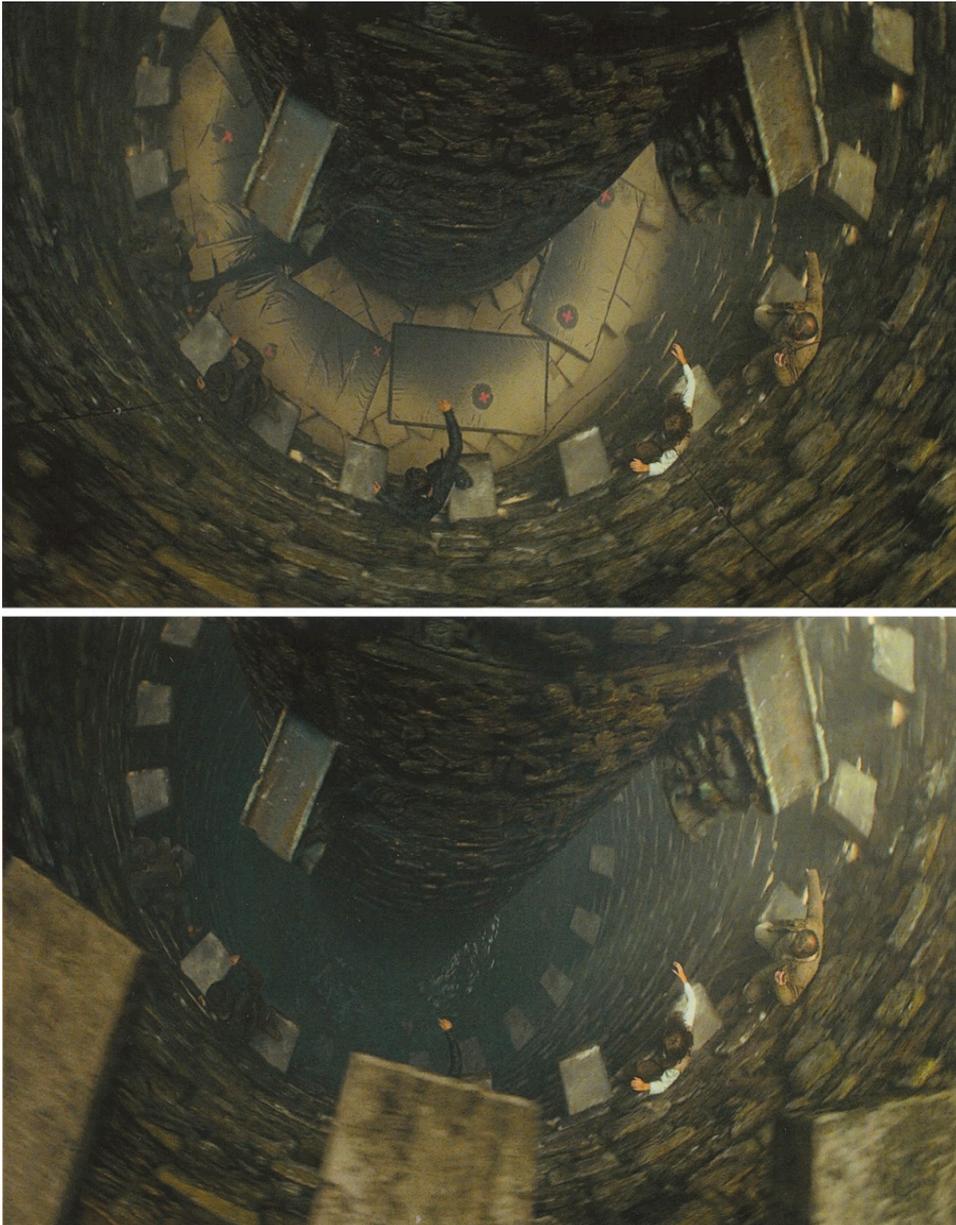


Image 1d

Image 1d. The people in the middleground of these two images are live action footage, filmed by a camera following the descent of the people. The live action footage with the red tracking markers at the bottom of the structure (upper image) was later used to establish a 3 D track and extend

the structure (lower image). 3 D tracking data is necessary to synchronize the coordinate space of real and cgi elements.



Image 1e

Image 1e. A frame of an entirely 3 D sequence. Note how every object independently receives the right amount of volumetric motion blur.



Image 1f

Image 1f. A Z-Depth matte of a frame of an entirely 3 D sequence. Darker pixels indicate a shorter distance, while brighter pixels indicate a longer distance between camera and geometry. Images like this can be output by all traditional 3 D applications and can help the digital compositor to

apply the appropriate amount of haze, for example. Notice how the distance between the downward facing camera and the top of the tall buildings is shorter than between the camera and the bottom.

The ability to compose huge three-dimensional cities with complex camera movements through them made artists want to do the same with natural environments. Unfortunately natural environments with a lot of vegetation are cumbersome to be built and much more unwieldy to be rendered because the rough and unorganized forms, shapes and patterns that occur in nature demand a much higher degree of detail. It was only in recent years that specialized environment tools like e-on Vue were introduced which allow digital artists to achieve these kinds of complex 3-D natural environments.



Image 1g

Image 1g. An "Indiana Jones and the Kingdom of the Chrystal Skull" scene with of vast 3 D natural environment (a rainforest) created in Vue. The rainforest was composed of billions of polygons, which would pose a problem for traditional 3 D packages.

Yanick Dusseault, who worked on the Vue scenes in "Indiana Jones and the Kingdom of the Crystal Skull", summarizes Vue's advantages in comparison to traditional 3 D packages on e-on's website: "The magic is in the trees! 3 D trees have been around for a long time, but lighting trees on such a large scale was practically impossible. They are always very heavy and you can use them for foreground and midground stuff. But creating entire vistas was a first in my playbook. That's just been wonderful with

Vue."

Digital matte painting and compositing packages have become very cheap, mature, easy to handle and can work on standard off-the-shelf hardware. This is why in recent years this area of vfx has branched out of the cinema and made its way into the realms of architectural visualization, print and TV ads.



Image 1h

Image 1h. The upper image shows an architectural visualization of the Apple Inc. San Francisco flagship store. The photo below was taken a couple of years later by myself in slightly different lighting conditions to compare the pre-visualization with the final outcome.

The advantages in Digital Matte Paintings

There is a plethora of reasons why it may not be possible to send a film crew to a specific location to shoot footage.

- The area might be locked down due to political or natural reasons.
- The area might be very remote.
- Shooting in the area may exceed budget.
- The area might be purely imaginative and nonexistent.
- The film might be set in a future or past time where the area might look or might have looked different.

My Artwork

This main part of the document is structured in such a way that it is both coherent and makes sure that every major area of digital matte painting and digital compositing is covered by the description of one of the shots.

Hardware used

- MacBook Pro with 2.5 GHZ Penryn Core 2 Duo multicore CPU with SSE 4 and 6 Mb of L2 Cache. GeForce 8600M GT with 512 Mb of RAM, capable of accelerating Open CL and Open GL code, which is a big help in certain applications like Adobe AfterEffects. This machine is equipped with 6 Gb RAM and was used for research and rendering as well as for matte painting and compositing at high resolutions.
- iMac with 2.93 GHZ Penryn Core 2 Duo multicore CPU with SSE 4 and 6 Mb of L2 Cache. ATI Mobility Radeon with 512 Mb of RAM, capable of accelerating Open CL and Open GL code. This machine is equipped with 4 Gb RAM and was used for rendering Vue scenes.
- Mac Mini with 1.83 GHZ Core Duo multicore CPU. Intel GMA onboard GPU, not capable of either Open GL or Open CL. This machine is equipped with 2 Gb RAM and was used for rendering

less demanding Vue scenes.

- Nikon D40 DSLR. I've set up a large library of photos, which is a common task in the industry to help enhance realism and reduce the amount of cumbersome manual paint work.

Software used

This is the complete list of software used for either research purposes or the actual production of the shots. All the findings reported in this document are formulated in a neutral way and independent of specific applications.

- Compositing/ Editing: Adobe AfterEffects
- Digital Matte Painting: Adobe Photoshop*,
Maxon BodyPaint 3D, Pixelmator
- Volumetric Particles,
Atmospherical Effects: Trapcode Particular, e-on Vue*
- Procedural Environments: e-on Vue
- Projection Mapping: Maxon Cinema 4D
- Operating Systems: Apple Mac OSX,
Microsoft Windows XP Pro 32bit

*Including elements shipped with the software.

Dying Motor Town

Introduction

The intention behind "Dying Motor Town" was to make a very dark and moody environment as a stark contrast to the other environments which are much more brightly lit with lush natural sceneries. The absence of people, cars and lights indicate that this is a slowly dying city.

Real-life industry situations

Technically, this scene may be a set extension, which means that a

previously filmed sequence was digitally extended and changed to deliver what the director required. In this particular city shot it might be very expensive or almost impossible to get the camera into this position above a major street, and furthermore to lock down the whole street and the surrounding pedestrian precincts. Instead it maybe much easier and cheaper for the Visual Effects Supervisor to get all the required reference photographs, hand them over to a digital matte painter and let him do the shot inside a controlled environment, the computer.

Composition

Usually it is a cinematographical and compositional no-go to use a perfectly centered vanishing point ("dead center"). Stanley Kubrick, however, used it very intentionally in his highly acclaimed horror film "The Shining" to build up and support the slightly uneasy, weird and moody hallway shots. Provoking these feelings is the exact intention in "Dying Motor Town" and that's why the shots are so similarly composed. In my shot, the clouds are animated to move slightly towards the vanishing point thus pulling the audience even more into the frame.



Image 2a

Image 2a. One frame from Stanley Kubrick's "The Shining". A steady camera follows the child actor in the lower part of the center of the image.



Image 2b

Image 2b. One frame from "Dying MotorTown". The four orange arrows point to the vanishing point in the "dead center" of the composition. The single red arrow indicates the movement of the camera, car and the direction the viewer is supposed to be drawn towards. Note the compositional similarities between Image 2b and Image 2a.

Asset management

Most of the assets for this piece were taken in Kansas City, USA, while some others were taken in Bremen, Germany. Because I knew this image was going to be a typical day for night digital set extension I visited the buildings twice: the first time during midday with a more dominant sunlight presence and the second time shortly after sunset. I used the data gathered from these two visits to cover the huge contrast with almost pitch black areas for example in the lower right of the image, but also very bright areas in the spotlights. It is very common for digital matte artists to build up a large data set with assets sorted after day times. To achieve this more quickly and more efficiently small digital cameras are being carried by the digital matte artist on as many occasions and trips as possible.



Image 2c

Image 2c. These two assets show the same building at a different time of day. The large, brightly lit "Western Auto" sign, for example, was used to get the best results for the light spot in the final piece, while the surroundings were based on the darker asset presented in the lower right corner. All shadows and highlights had to be removed from the source assets to ensure they were applicable to this night setting. Other artifacts removed from the source material included digital noise, lens distortion and numerous cars and passengers that inhabited the scene.

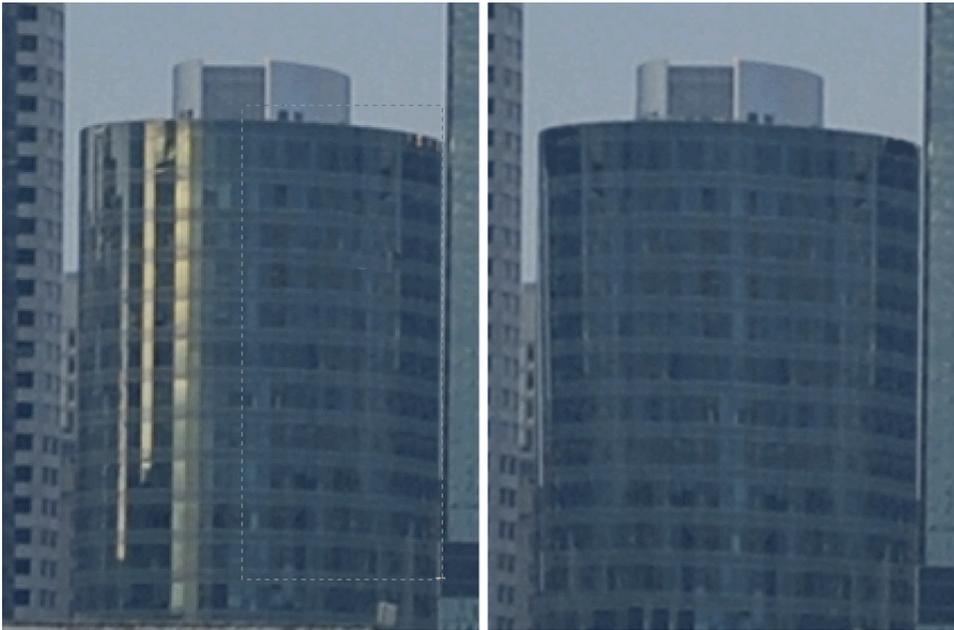


Image 2d

Image 2d. The complex reflections and highlights on the left part of this rounded building were removed by copying, flipping and skewing the data of the right part of the building. Tricks like this need to be employed constantly to enhance efficiency while improving quality.

Other elements of the plates have been altered or removed in order to be animated later in the compositing.

Efficient execution and interactive lighting

One of the most important aspects of cgi is the presence of dynamic or interactive lighting. This is achieved when light and cast shadows are scattered and gathered on numerous elements in the scene. Especially animated layers of interactive lighting help make an artificially created scene more seamless and less "constructed".



Image 2e

Image 2e. These three images all present examples of interactive lighting in the piece.

To be able to efficiently adjust and alter a single light source or a large element like the sky, I made sure to always work in a way that kept most of the elements editable.

This caused compatibility issues at one point in the process between matte painting and digital compositing which led me to "flattening" or "baking" some of the elements of the image just before I entered the compositing phase. I made sure that I still had a copy of the editable version.

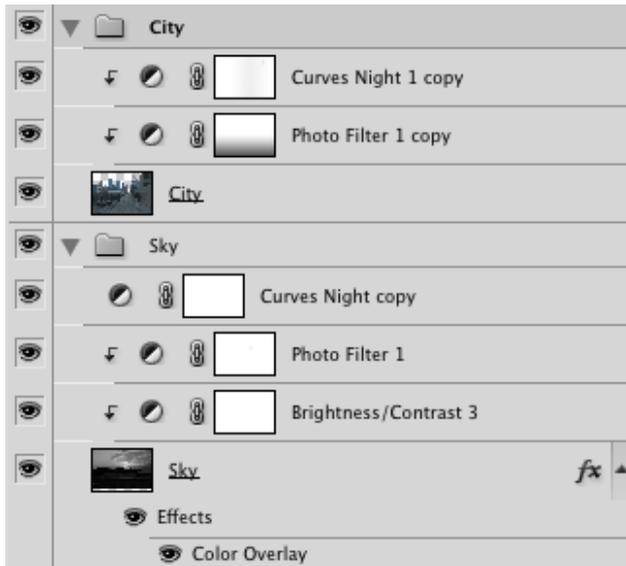


Image 2f

Image 2f. The sky and the city element in the Adobe Photoshop layer window. The composited pixels are determined by the software rendering the layers from top to bottom. The sky element, for example, is being affected by three adjustment layers above it, all three of which are again affected by a layer mask and two of these affect only the sky element while one (without little arrow) affects also elements further below the sky element. The layer effect "Color Overlay" is also applied.

Digital Compositing and Animation

"Dying MotorTown" is a 2 D composition which is possible since there is no three-dimensional camera movement, a dolly, required, only a change in focal length, a zoom.

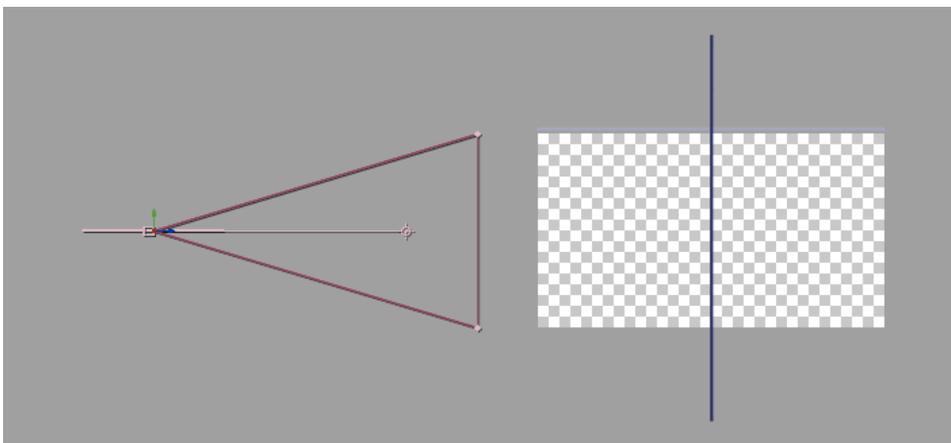


Image 2g

Image 2g. The work view is rotated by 90° to the right, which exposes the artificial camera on the left and the actual composition as a simple vertical blue line on the right. The camera's field of view and its focal point are represented by the cone or triangle between the camera and the composition. A 2.5 dimensional composite would reveal numerous flat elements on the right, and allow to take advantage of this depth information to animate the focus of the camera.

To underline the strength and rigidity of the scene I decided to animate the change in focal length also in a very strict way, without any keyframe interpolation or ease ins and ease outs.

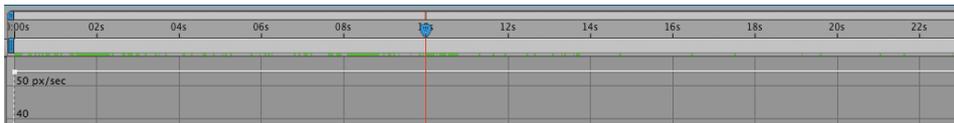


Image 2h

Image 2h. This graph shows how much an animated parameter changes over time. In this case the light gray, perfectly horizontal lines show the movement of the artificial camera, which is a linear animation at 50 pixels per second.

The car and its light cone were carefully animated to achieve the impression of the vehicle moving away from the camera. To do this the car was broken down into several elements which were animated independently. The interior of the car as well as the light cone were combined with animated masks to fit the shape of the street.

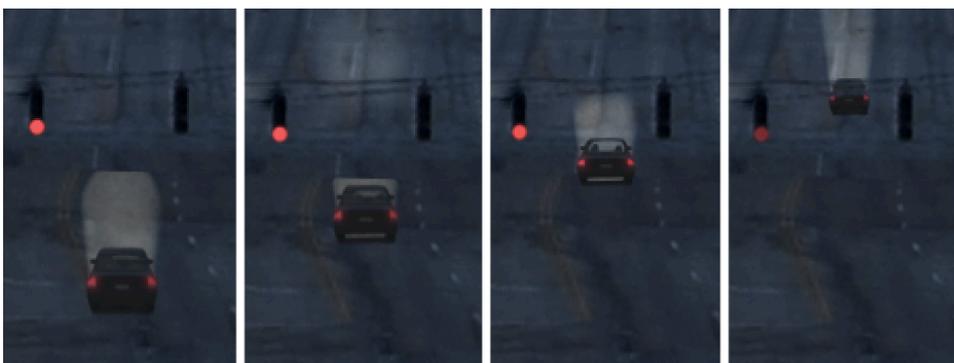


Image 2i

Image 2i. To support a "grounded" appearance, the angle, size, and light cone of the car are animated as the car drives over a little bump in the street. The flickering red traffic light is the only traffic light in the whole scene. The opacity of the light is animated using the famous "wiggle" expression.

The sky is animated to move from the left to the right and from close to the camera into the distance. This inwards move is supposed to support the cars movement and help draw the viewer even more into the frame.

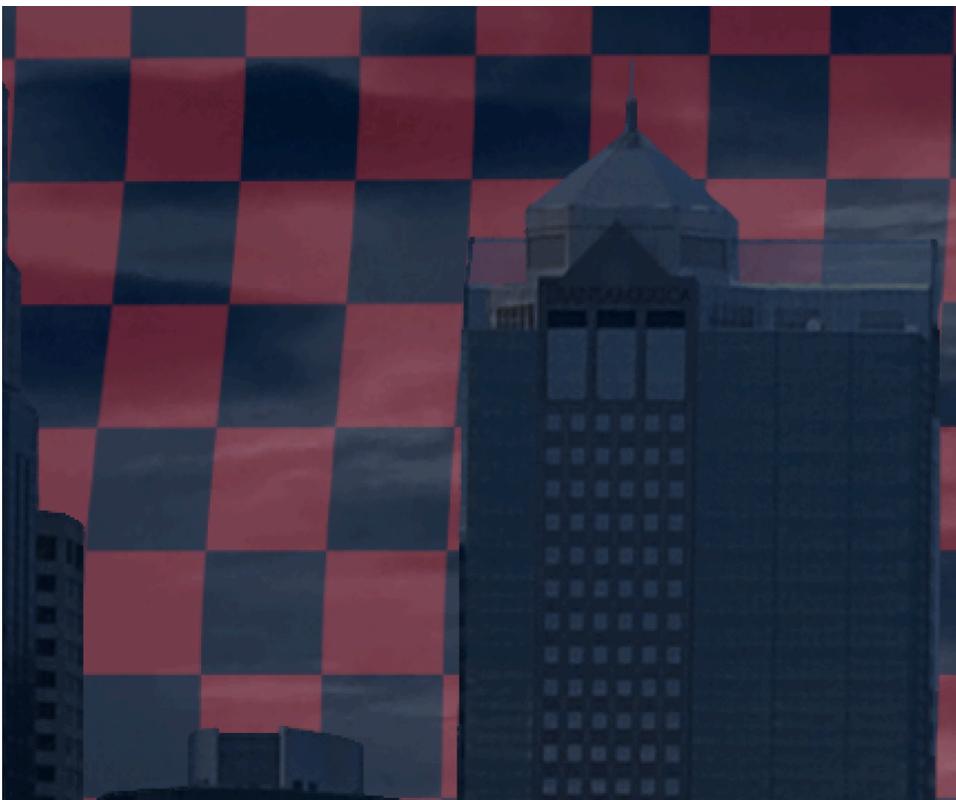


Image 2j

Image 2j. The checkerboard pattern reveals an animated bezier warp which has been applied to the sky element to help give it a volumetric appearance.

Motion Blur

When a quickly moving object is filmed, a motion blur will be recorded with the object. The amount of blur recorded depends on the distance the object moves while the frame is being recorded or exposed. Depending on the shutter speed more or less light enters the camera and more or

less motion blur is being produced. Not only are we used to seeing motion blur in film or video but also are we unconsciously confronted with motion blur in daily life. When we look at a flying helicopter, for example, the rotor blades are surrounded by radial motion blur. Only after focusing and concentrating on the rotor blades will we manage to see them without motion blur. A lack of motion blur on cgi elements can often be witnessed in amateur movies and will immediately, unconsciously, tell the viewer that he is watching an artificial animation instead of live action footage. A cgi animation without any motion blur is essentially a stop motion video.

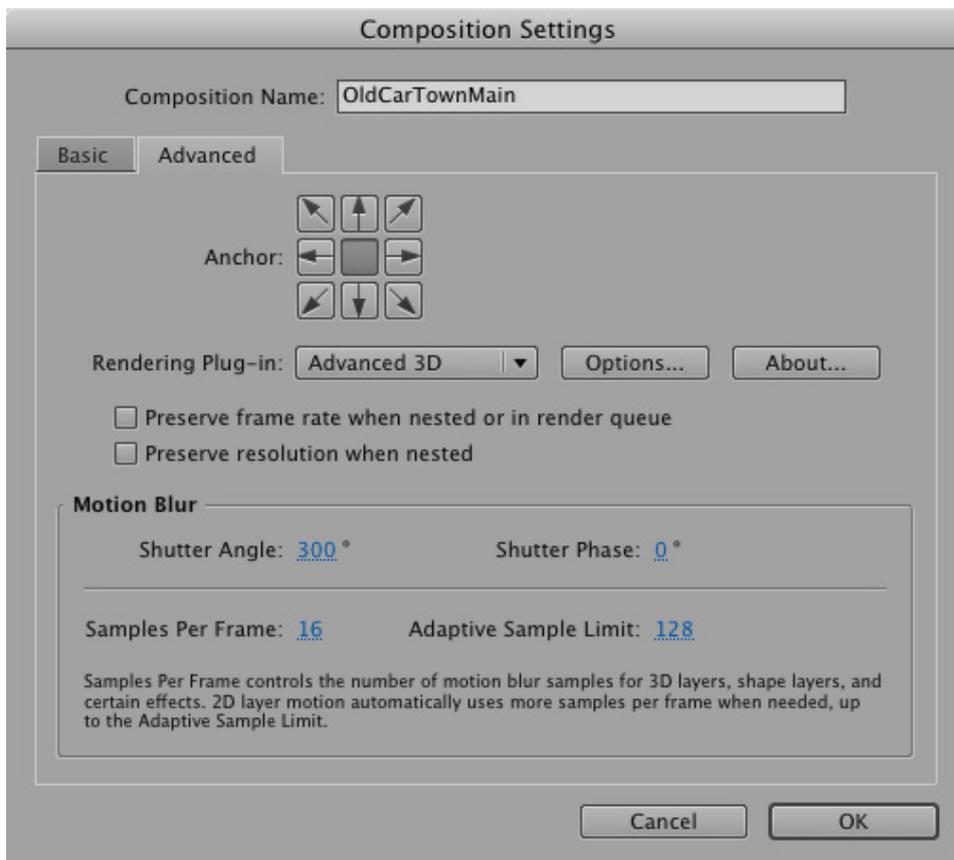


Image 2k

Image 2k. The shutter angle was increased to 300° in the motion blur settings in the AfterEffects compositing application.

Modern compositing packages like in this case Adobe AfterEffects can simulate proper amounts of motion blur on moving objects. AfterEffects offers settings for the angle and phase of the shutter to increase or decrease the amount of blur. Since motion blur affects rendering times nega-

tively AfterEffects also offers quality settings to fine-tune the results. To make the motion blur appear properly in this nightly shot and the long exposure times which would be involved filming such a piece, I heavily increased the shutter angle which then yielded longer and more accurate motion blur.



Image 21

Image 21. Because of the high shutter angle a bird that crosses the screen becomes almost invisible, smeared (on the left) because of the motion blur. Only when motion blur is deactivated for presentation purposes, can the bird be seen sharply (on the right). Subtle "disturbances" like this bird add a lot to the overall realism of the composition and the viewer should remain unaware of it.

Grain and digital noise

Grain is another artifact that is produced during the process of exposing film or recording footage. Silver halide particles are distributed in a non-uniform way in a piece of film and capture the image when exposed to light. The nonuniform distribution is what is responsible for a grainy look. In modern digital cameras like the Red camera for example, digital noise is still produced although in a much smaller quantity and is dependent on numerous specifications like the software version or the size of the chip used to record the frames. The more light enters the sensor, the lower the sensitivity of the chip can be, lowering the amount of digital noise. The ability to add and animate noise in the compositing phase is heavily dependent on the availability of a noise free matte painting. A total lack of grain or digital noise would have a similar effect on the viewer like a total lack of motion blur. It would make a film or animation seem less real because the experienced viewer is so used to seeing this artifact. In this

piece, it is present in a very subtle amount to reflect developments in digital recording technologies and prevent a "cheesy" look.



Image 2m

Image 2m. A comparison of "Dying Motor Town" without (on the left) and with added noise on the right. Brightness and contrast have been gained for presentation purposes. Not only is the noise distributed in a nonuniform way, but also is it dependent on the brightness of the image. While darker parts of the image are more noisy, lighter parts are less noisy and some highlights seem to appear almost noise free.

Lens Distortion

When light falls through a camera lens it is being banned and appears slightly warped. To consider lens distortion is especially important in a scene with an animated camera and numerous straight lines like the buildings in this piece. I did a lot of experiments to figure out the right amount of lens distortion and settled on a very small amount, just enough to give the audience a slight feeling of watching the sequence through a lens attached in front of a camera. As the camera slowly zooms into the scene, the pixels, especially on the borders of the frame, are slightly warped inside. It is important to establish a parenting between the camera and the lens distortion node or layer in front of the camera. A lack of such would equal an animated change of lenses which is only possible with pauses between recording frames (like in the production of a stop motion movie) and is very uncommon.

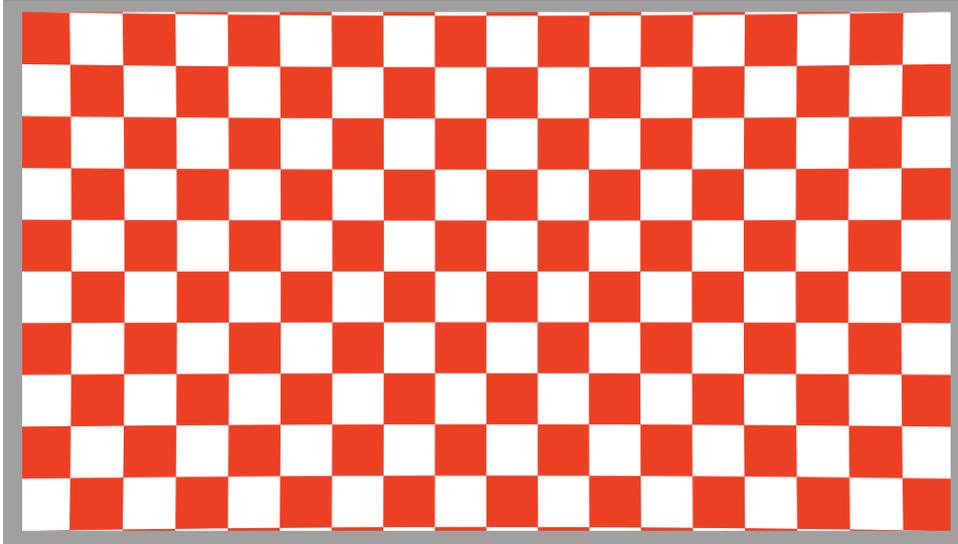


Image 2n

Image 2n. The warping in this red and white checkerboard pattern represents the subtle but important amount of lens distortion in the piece.

"Alaska Echo"

Introduction

"Alaska Echo" was born out of the wish to produce a large landscape digital matte painting set in a remote mountain range somewhere in Alaska. During the long process of digitally painting the piece I thought about possibilities of introducing a minimal amount of man-made structures to collide with the rough natural forms. This is when the secret platform with the helicopter on the right side of the image came into my mind and quickly appeared to be a good fit. I especially like the contrast between the clean, straight lines and the rough nature. Another important reason for introducing this platform was to give the whole scenery scale.

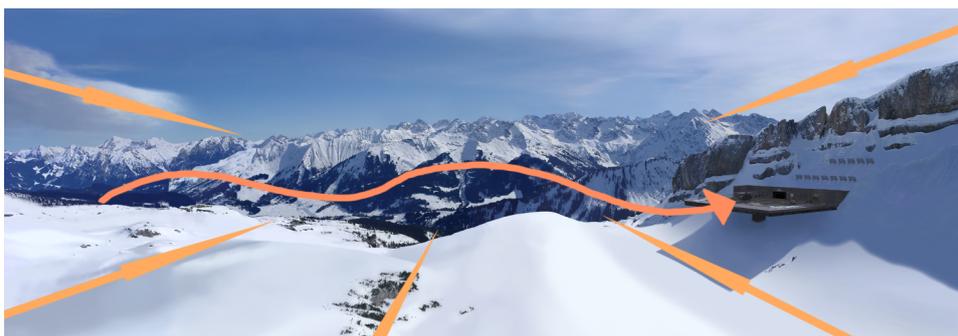


Image 3a

Image 3a. "Alaska Echo". The orange arrows show how the whole landscape was composed in a way that helps guide the viewer's eyes through the scene and prevent them from being "pushed" out of the frame by the composition. The single red arrow indicates the direction the viewer is supposed to be drawn towards.

Painting Process

Painting "Alaska Echo" was a process that took weeks. This chapter will analyse this process and its separate steps.



Image 3b

Image 3b. Pixels are being copied and modified instead of being painted from scratch. To be efficient, a digital matte painter tries to make good use of the tools which digital technology offers. Usually, only concept artwork and only a small percentage of the final matte painting are painted manually. In many cases for example, manual paint work is required to make different elements match together seamlessly. To achieve this quality of digital painting skills I had to practise for years. In "Alaska Echo" I have applied all the theoretical painting skills acquired during the last three years.

In "Alaska Echo" I started with very low quality photos as a reference for shape and color palette in a landscape like this. The next step was to figure out how the landscape had to be composed and to start filling it like a huge patchwork carpet.



Image 3c

Image 3c. This illustration shows how far the painting developed in the process. The two images on the left are taken straight out of the reference photos while the images on the right show the same areas in the final work.

I quickly filled the whole image with colors to establish the narrow color palette and continued painting finer structures and added more details into new layers. I heavily relied on Photoshop's ability to simulate virtually any brush and developed brushes especially for the snow, for example.



Image 3d

Image 3d. Comparison between a reference photo (on top) and a detail from "Alaska Echo".

I studied numerous reference photos of fresh, untouched snow landscapes and trained my eye to detect the fine nuances and patterns in the snow. I replicated them with custom made brushes using a Wacom graphics tablet and Photoshop's brush engine. After building this foundation I used very simple brushes and clone operations to introduce vegetation into the image.



Image 3f

Image 3f. Like in 3 D applications I used Photoshop's brush engine to stimulate ambient occlusion. The image on the left shows the untouched snow and the ambient occlusion, while the image on the right shows the final composite with some vegetation and rocks.

After finishing the vast majority of elements I started applying the correct amount of haze to give every element the appropriate perception of depth. This is a very long back and forth process and it is important to keep all elements editable.

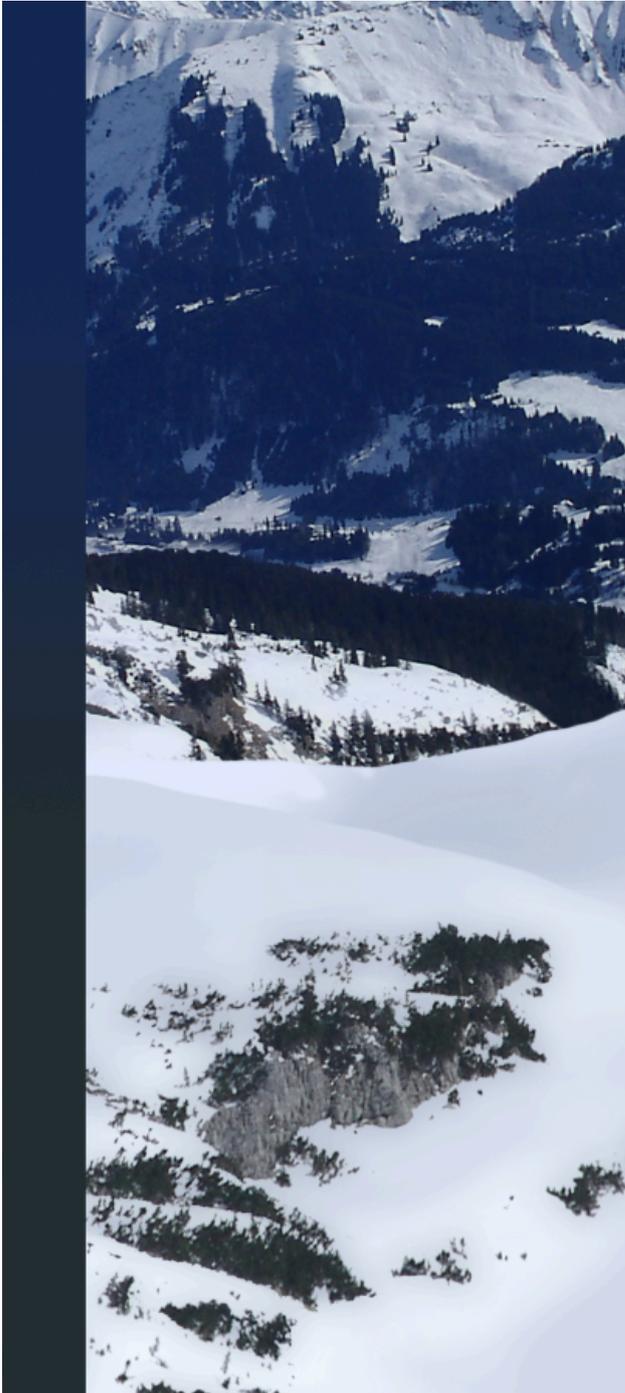


Image 3g

Image 3g. The vertical line in this image shows how the green tones in the foreground become more and more blue tinted as the distance to the camera increases. This is the atmospheric effect known as haze which is

caused by air particles and the light traveling through them. It is one of the most important aspects of color correction to consider when doing digital matte painting or digital compositing work.

After the untouched natural landscape was finished I finally introduced the secret military platform with the helicopter on it. Since it was the only man-made object in the whole scene I began by setting up two vanishing points and drawing numerous red and green help lines from the two vanishing points towards the area where I thought I was going to place the platform. On another layer I made a concept drawing and moved, scaled and skewed it to figure out its perfect position and size. After figuring this out I added even more help lines and executed the concept drawing.

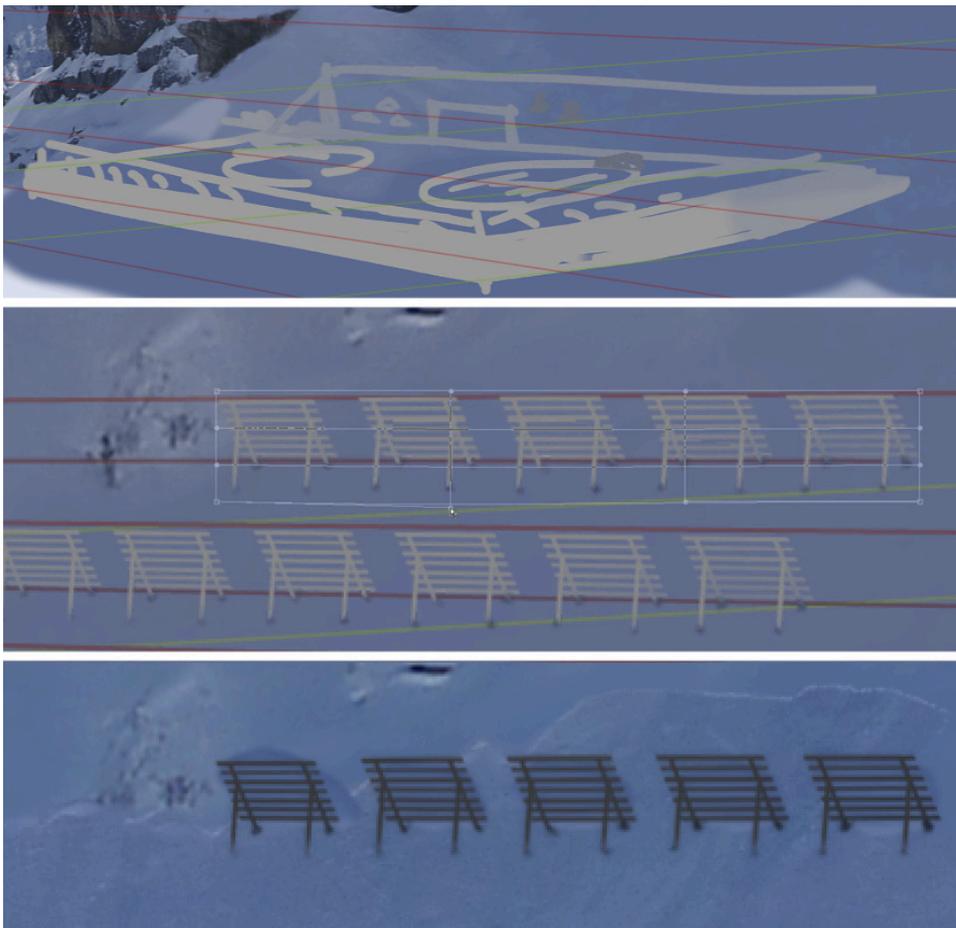


Image 3h

Image 3h. The first image shows the vanishing point help lines with the concept drawing, the second shows the placement process of some

snow barriers (note the intentionally imperfect placement), the third image shows the final area with interactive snow added in between, underneath and on top of the snow barriers.

Reflective light plays a very important role in brightly lit environments especially when a lot of snow is in the perimeter and reflects the sun beams many times. During the work on this piece I not only kept the sun's direction in mind all the time but also tried to imagine how exactly light was being scattered around in the scene.

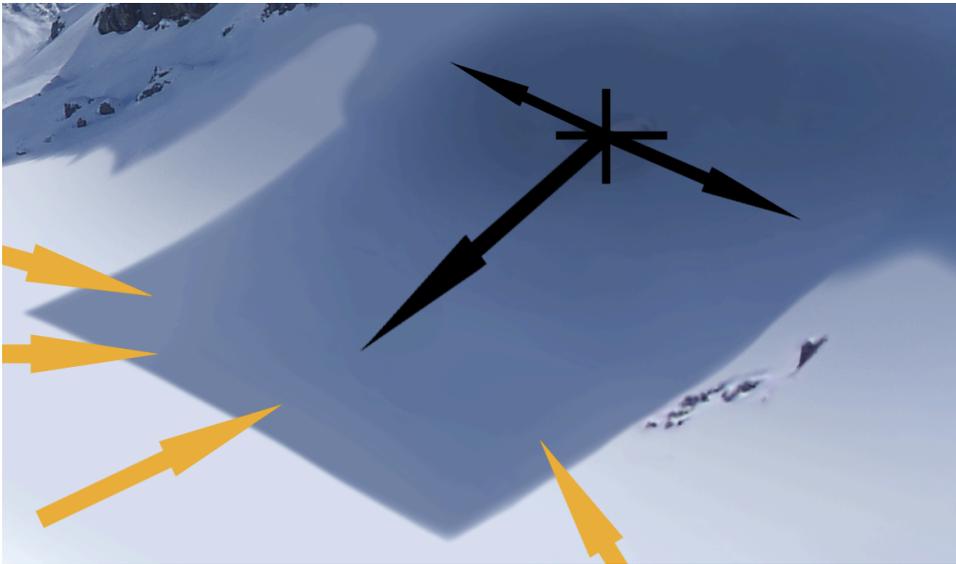


Image 3i

Image 3i. This is the large shadow the platform drops. The yellow arrows indicate scattered light coming in from almost all directions especially from the left while the black arrows indicate the darkest part underneath the platform which is invisible in this image. Also note how I paid attention to how far the distance was between shadow emitters and surfaces with shadows dropped onto them. You can see how the shadow which the rocks cast on the right is much less sharp than the shadow which the platform in the center of the image casts. This is because the rocks are much higher and the light travels a bigger distance through the air before it reaches the ground.

3 D projection mapping

The most difficult part in the process of 3 D projection mapping was to

find the proper distribution and scaling of the different elements in 3 D space. The other tasks in the process like applying the different textures to the 3 D models or building the actual simple 3 D models were fairly easy because of 3 D projection mapping software development in recent years. 3 D projection mapped scenes are usually very quick and efficient to a render and can be done by a digital matte painter who needn't be a specialist. This does not only improve turnaround times dramatically, which is a very important aspect when working under tight schedules, but it also improves the quality of the final piece because the digital matte artist who worked for days or even weeks on the painting can construct a 3 D scene out of his own work. 3 D matte paintings have many advantages over 2 D or 2.5 D matte paintings. Since everything is properly distributed in 3 D space, computer programs can easily add particle simulations like rain or snow into the scene or different cameras can be output in order to achieve a real 3 D stereoscopic look.



Image 3j

Image 3j. Recent developments in 3 D projection mapping software have made it very easy for the user to select the appropriate bitmap graphics and apply them to the correct piece of geometry. The image shows the window that handles this process in Maxon's Cinema 4D projection man.

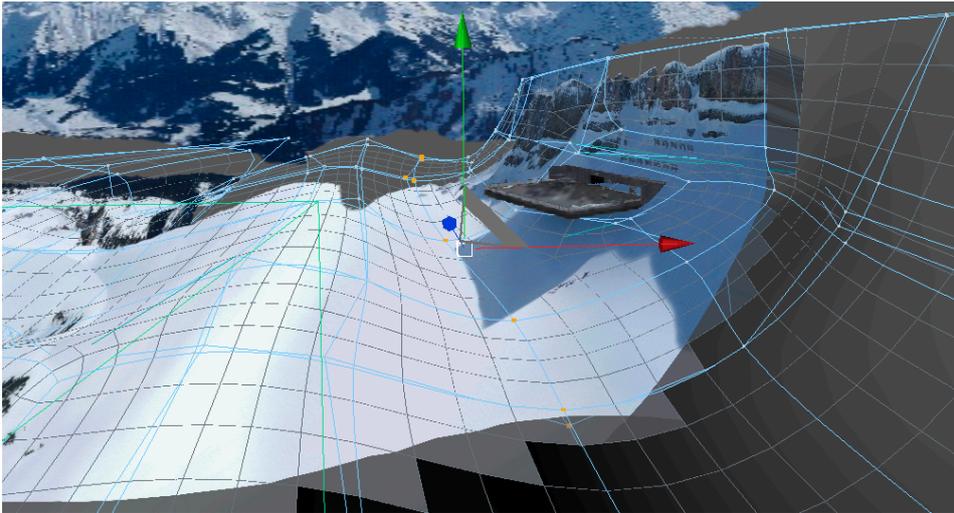


Image 3k

Image 3k. When working on the geometry the projection mapped bit-map graphic updates in real time to help the user avoid distortions and work very efficiently. Large scenes like this require a graphics card with a lot of memory and a lot of system memory.

"All Good Things Come In Little Packages"

Introduction

This is the only obviously stylized. That is the main reason why I decided to add it to my thesis. The second reason was the need to research into the realm of a "real" 3D environment with very complex geometry (vegetation) very close to a moving camera.

The piece is inspired by the PS3 game "Little Big Planet" and numerous TV spots and is populated by absurdly large vegetation compared to the size of the planet. My goal was to make this planet just incredibly beautiful and not realistic.

The camera is animated to make a cartoon like pull back, traveling backwards through trees and exposing numerous interesting aspects and advantages of making a scene like this in a specialized "environment application" like Vue instead of a traditional 3D application. While the camera moves backwards I animated the sun to make a half-day cycle showcasing Vue's advanced lighting capabilities. The clouds are hand animated while Vue's "ecosystem" feature simulates the wind.

Environment Application

In the past three-dimensional digital environments had to be modeled and textured in a traditional 3 D application like Autodesk Maya. This workflow was incredibly inefficient and very hardware intensive. Often digital artists were forced to render single elements like a tree in separate passes putting them together in an external compositing application. e-on Vue is a relatively new application that may be called an "environment application" because it is a specialized 3 D application that actually understands what trees, clouds, water and all the other elements are that appear in an environment. Rather than handling complex 3 D models, Vue's workflow is to allow the user to introduce these elements based on rules instead of importing unhandy models. The application is also optimized for rendering these complex scenes very efficiently. Traditional 3 D applications may become difficult to handle when they are faced with 2 million or more polygons, Vue can render scenes with many billions of polygons.

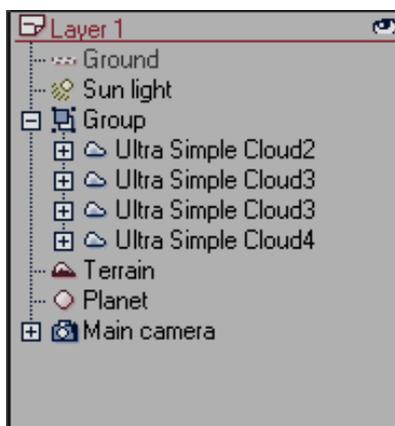


Image 4a

Image 4a. This image shows the layer view of my piece. Vue treats everything as an editable environment object instead of just a textured polygon mesh. Double clicking on these objects opens the corresponding editors for terrain, sunlight or clouds.

Vue allows the user to handle the terrain in an editable way by offering procedurally generated terrains. These terrains are not described by polygons but by mathematical formula like three-dimensional vectors. Different combinations, defined by a node-based terrain editor enable the user

to build exactly the terrain he wants with a minimal amount of mathematical knowledge.

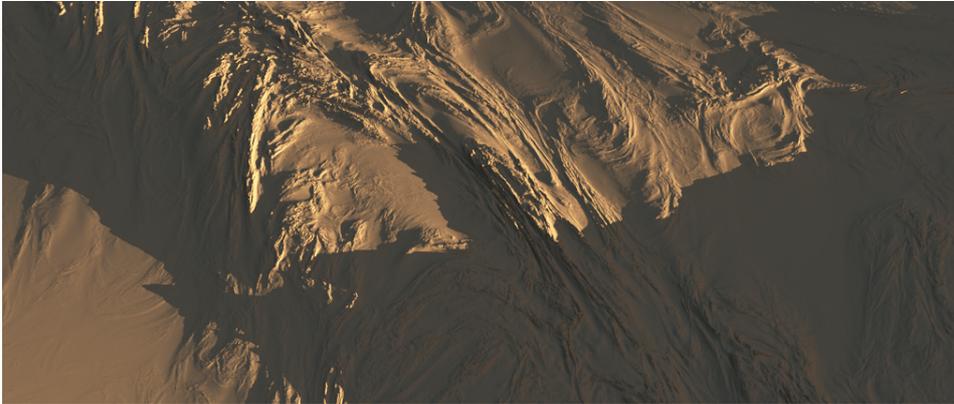


Image 4b

Image 4b. One of my early Vue renders. I built this structured procedural terrain to get used to Vue's terrain editor. The shadows are too sharp, the sun's position was accidentally animated, there are no textures and no objects to give the whole environment scale.

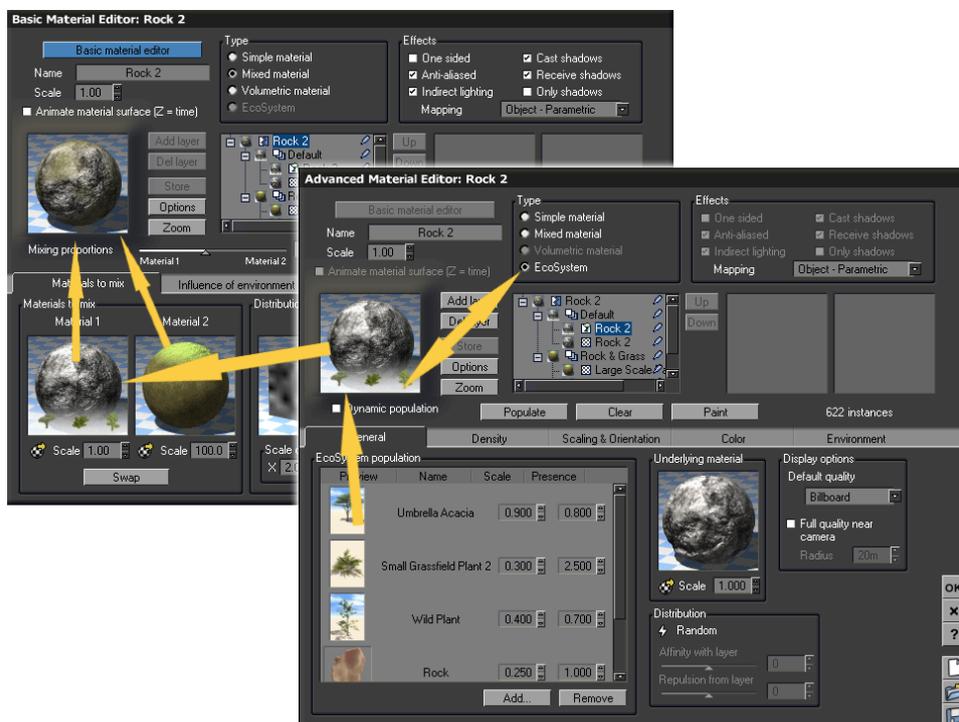


Image 4c

Image 4c. The material editors show how the material on the planet is put together inside Vue. This image helps explain how everything in Vue can be created based on rules instead of just importing fixed textures or

fixed polygon models.

Lighting and Motion Blur

It is very easy to apply appropriate lighting and motion blur in vue animations. In "All GoodThings Come In Little Packages" I applied all these features and therefore the rendering process took weeks. I had to use three computers.



Image 4d

Image 4d. The orange lines indicate the movement of the camera. Note how the little plant in the orange circle is almost perfectly sharp while everything around it is affected by a circular motion blur caused by the camera movement. Also note the rich volumetric lighting especially in between the trees and clouds on the left side of the image.

Vue offers different lighting models, depending on the rendering resources the user is willing to invest into a scene. He can choose between Standard, Global Ambience, Ambient Occlusion, Global Illumination or Global Radiosity lighting models. To help Vue properly calculate how light is scattered around on the piece, I placed a big piece of terrain below the planet outside of the camera's field of view. This terrain essentially acted as the large reflector shield, reflecting light that illuminates the lower part of the planet.

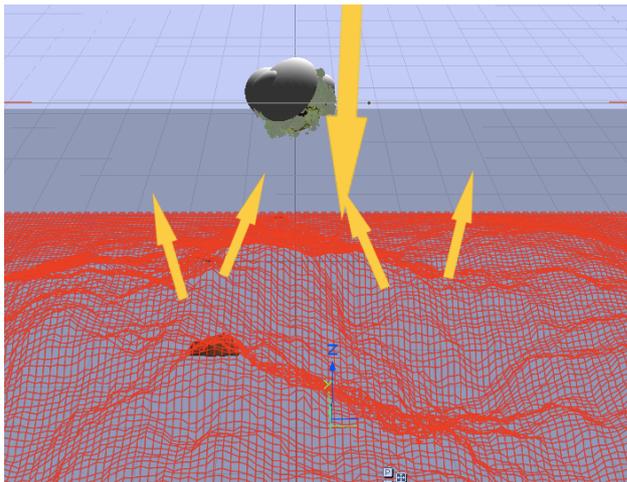


Image 4e

Image 4e. The red lines indicate the terrain placed below the planet. The green arrows indicate how the light is cast by the sun above the scene and reflected onto the lower part of the planet. Note that it is important to choose the Global Radiosity lighting model to get this result.

"Isla Pandora"

Introduction

After "All Good Things Come In Little Packages" was done I thought it was important to make another piece in Vue. "Isla Pandora" was developed in order to learn about Vue's capabilities of simulating very big scenes with vast bodies of water. Fluid simulation like required for simulating oceans is usually one of the most hardware intensive task in the visual effects industry. My experiments in this area showed that Vue can handle this task very efficiently as well.

The shot begins with a flight above the fluffy clouds and ends with a small island appearing on the horizon, somewhere in the Pacific. Everything in the scene is animated: the clouds, the water and the vegetation on the island. This is only scratching the surface of Vue's full potential. To make this large scene possible within my time limit and hardware constraints I carefully tweaked the lighting to be less computationally demanding, yet beautiful. All the textures, clouds, trees I used are included with Vue and can be freely used (like the brushes included with Photoshop, for

example). Of course they are only presets and required a lot of tweaking to fit the scene.

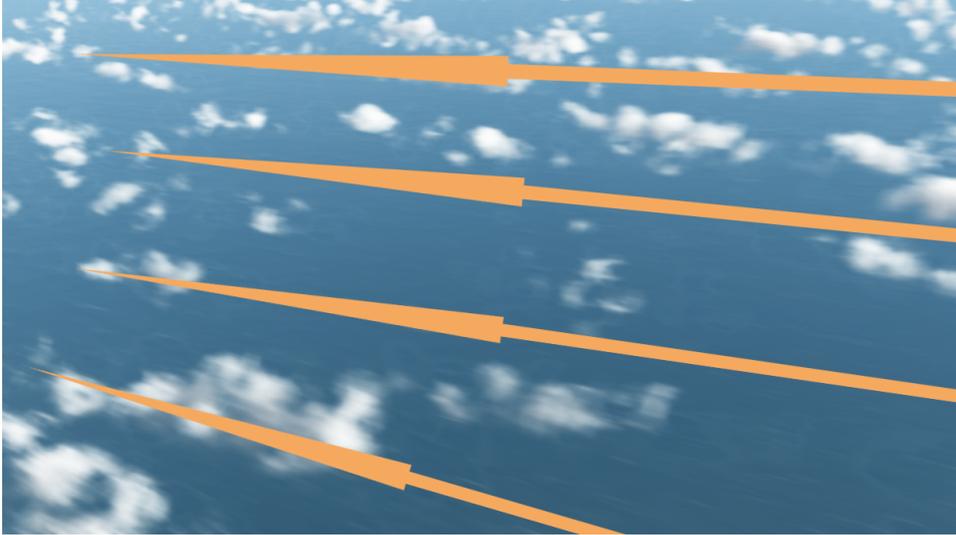


Image 4f

Image 4f. Using Vue's animation assistant the camera was animated in a way that makes it seem to be attached to the outside of a plane. The yellow arrows indicate the direction the plane flies. While the plane begins to land, the camera rotates and moves more and more to the left where eventually the tiny island appears on the horizon. Other than in "All Good Things Come In Little Packages" where the clouds were hand placed and animated, the clouds in this scene were set up using the atmosphere editor.

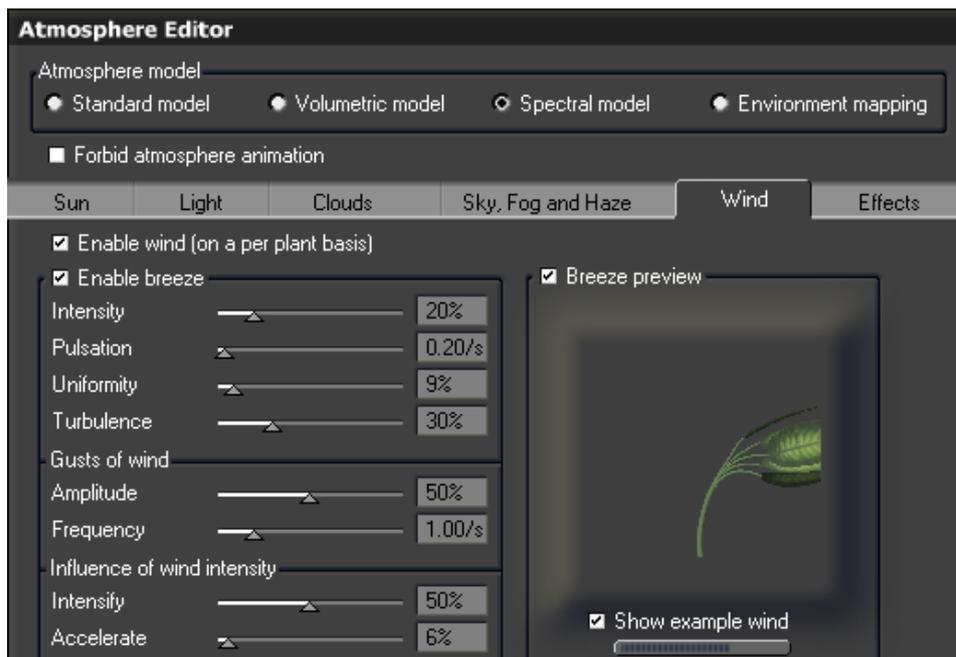


Image 4g

Image 4g. The wind category in Vue's atmosphere editor. The reaction of vegetation to wind, water and clouds can be determined separately. While in some cases this separate determination may be useful there doesn't seem to be an option to automatically synchronize all the settings to create a coherent wind experience.

Rendering Issues

With numerous frames of "Isla Pandora" rendered, I noticed a very subtle pattern in the sky that slowly became apparent. Due to the lack of additional time it wasn't possible to simply render the scene again. Instead I re-rendered single elements with alpha channels and reduced resolution and quality that helped me cover up the problematic areas in the compositing process. Tricks like these can be applied to improve the general quality of the shot without being too expensive. The Vue user must make sure that the light and wind settings of all the elements are synchronized. Additionally the artist should invest some time to find out the highest possible render setting to avoid light simulation problems like the ones I encountered.

Future look out

It is a very interesting time for digital matte painters because their field of activity right now is shifting and expanding from the field of 2 D digital painting within traditional applications like Photoshop to increasing amounts of 3 D work in applications like Cinema 4D or Vue. This makes the whole field of digital matte painting more interesting and richer. A single artist can now develop a scene by creating concept artwork, digital matte painting and finally projection mapping. And while all of this happens, tools like Vue will become increasingly mature and will give the artists the freedom they didn't have in the past.

References and Sources

Books

The Art and Science of Digital Compositing

by Ron Brinkmann (Second Edition)

Published by Morgan Kaufmann Publishers, Burlington, USA

Adobe After Effects CS3 Professional Studio Techniques

by Mark Christiansen

Published by Peachpit, Berkeley, USA

d'artiste: Matte Painting

by Daniel Wade

Published by Ballistic Publishing, Mylor, Australia

d'artiste: Matte Painting 2

by Daniel Wade

Published by Ballistic Publishing, Mylor, Australia

Landschaften

by Terry Hope

Published by Christian Verlag, München

Vue 7 From the Ground Up: The Official Guide

by Ami and Vladimir Chopine

Published by Focal Press, Burlington, USA

Videos

cmiVFX Cinema 4D Projections

Published by The Gnomon Workshop

The Techniques of Dusso 1 and 2

Digital Matte Painting Fundamentals

From Speedpainting to Matte Painting
with Sebastien Larroude

The Techniques of Dylan Cole 1, 2 and 3
Advanced Digital Matte Painting

The Techniques of Christian Lorenz Scheurer 2
Advanced Digital Painting in Adobe Photoshop

3D Matte Painting and Camera Mapping

Matte Painting for Film with Chris Stoski

Matte Painting Production Techniques

Websites

e-onsoftware.com/showcase/spotlights/?page=8

en.wikipedia.org/wiki/Matte_painting

Proposal

Digital Environments for Time Based Media

Images

Images shown for educational/ research purposes only. All copyrights stay with their original owner.

1a DVD "The Wizard of Oz"

1b DVD "Raiders of the lost Ark"

1c d'artiste: Matte Painting 2

1d d'artiste: Matte Painting 2

1e d'artiste: Matte Painting 2

1f d'artiste: Matte Painting 2

1g "Indiana Jones and the Kingdom of the Chrystal Skull"

1h d'artiste: Matte Painting 1

2a "The Shining"