Self-Learning Package

#10

INTEGRATION TECHNIQUES
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Issue Date: 2nd July 2012

This scheme has been funded by the Creative Skillset Film Skills Fund as part of ‘A Bigger Future 2’, the UK film skills strategy. The Creative Skillset Film Skills Fund is supported by the National Lottery from the BFI and the film industry through the Skills Investment Fund.

AVAILABLE SLPs

Core Skills
SLP #01: Compositing Foundations, Part 1
SLP #02: Compositing Foundations, Part 2

3D
SLP #03: CGI Foundations
SLP #04: Rigging and Creature Effects
SLP #05: Effects Animation
SLP #06: Lighting and Look Development
SLP #07: 3D Matchmoving

Compositing
SLP #08: Matte Creation
SLP #09: 2D Tracking
SLP #10: Integration Techniques
SLP #11: Multi-Pass Rendering and Compositing
SLP #12: Rig Removal and Retouching
SLP #13: Advanced 3D Compositing Techniques, Part 1
SLP #14: Advanced 3D Compositing Techniques, Part 2
SLP #15: Matte Painting and Environments

INTEGRATION TECHNIQUES OVERVIEW

Integration Techniques looks into the industry methods of compositing CGI and live action in a realistic and believable way. We cover everything from grading and noise matching to lens distortions and motion blur.
DOWNLOADABLE ASSETS

Alongside this Self-Learning Package (SLP) we have also supplied you with a number of downloadable assets. We have specifically designed a folder structure for the assets to keep continuity across all the SLPs. This gives you the option to copy the assets for all your purchased SLPs into one location for easy access. The folder structure is as follows:

//3D Models/  3D geometry saved in formats such as .ma (Maya), .abc (Alembic), .fbx (FBX), etc
//Footage/  Any moving video or film footage. All saved as either openEXR’s or DPX sequential files.
//HDRi/  High Dynamic Range images in different environment layouts (Mirror Ball, Fisheye, etc)
//Lens Distortion Grids/  Lens distortion grids for the lenses we used to shoot our material, including both video and photographic for the 28mm and 50mm Canon primes.
//LUTs/  Various Look Up Tables, both 1D and 3D.
//Other/  Miscellaneous items such as animation files (.chan), application specific examples, etc.
//Stills/  Any still images saved as different formats, colour depths and channel sets.

Some of the video may appear washed out and soft - this is intentional. The video has been recorded using Stu Maschwitz’s ‘Prolost Flat’ settings which have become a standard for shooting with a DSLR camera. The result is a low-contrast, low-saturation “digital negative” which allows more flexibility for grading in post. What we’ve done is to totally remove the camera digital Sharpening effect, dropped the Contrast right down and reduced the Saturation. We’ve left the Colour Tone unaffected. This gives you maximum flexibility to sharpen, grade and colour correct the video to the style you require.

For more information on Prolost Flat, visit http://prolost.com/flat

These assets are licensed solely to you as a ‘Creative Skillset Academy Network’ tutor. The assets are not to be given out to students or redistributed.

Details of how to download these assets will have been sent to you via an eMail when you purchased this SLP. If you did not receive the eMail or have mislaid it, please contact us at bookings@vfxttt.com and we will reissue the download instructions.

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1.0 An Introduction to Integrating Elements

The integration of elements as part of compositing is key to making the final shot work as a whole. The ability to composite one element over another is almost child’s play nowadays, but being able to integrate those elements together is much harder. This discipline takes time and practice, a keen eye and some basic understanding of photography. This SLP is designed specifically to help with this valuable part of the compositing process, teaching you not only the ‘how’ but more importantly the ‘why’.

The process of integration can span two main areas, 3D and Compositing. Often the element being integrated is created in a 3D program such as Maya, and therefore you have lots of control over its lights, how it is shot, etc. In the situation where the object is a 2D element, a photograph or other live action piece, your overall control is less and special planning needs to go into how those elements are photographed. The hardest circumstance is when you are just handed a 2D (or pre-rendered 3D) element which then has to be massaged into place.

The follow sections are a breakdown of 3D and 2D techniques which will help integrate your new elements into your main composite. We have categorised them as either a 3D technique or a Compositing technique. Obviously 3D techniques need to be completed before moving into compositing.

Throughout this SLP we are going to focus on a single shot. Although this won’t be a tutorial, it will be useful to help illustrate how each extra integration technique helps to sell the illusion that all the pieces were filmed together.

2.0 Matching Lenses - 3D

The first area we’ll look at is the lens through which the background plate was shot. Hopefully you will have received the lens information before starting your 3D modelling and animation, but if not this is the first thing you will have to work out. If the wrong focal length is chosen it will have dramatic effects on how the new elements are integrated into the plate.

For our example we are dealing with a moving shot, which was taken with a 28mm lens on a Canon 5D Mark III. Knowing the lens information makes life infinitely easier, but if you don’t know the information and you need to Camera Track the footage the chances are your tracker will work out the lens used to take the shot. If however you
are dealing with a static image which can’t be tracked, then you will have to try and work out the lens information by hand.

The process for doing this is reasonably straightforward but involves a lot of trial and error. Hopefully you have something in the image which is man made, eg. a building, a road, etc. What you need to do is create a cube in 3D space, then create a camera guessing to the best of your ability what lens may have taken the picture. From here you need to place the background image into the camera’s image plane (if you are using Maya) so you see the picture as you look through the camera. Now move the camera, while looking through it, until the cube lines up with the object (eg. the building) in the scene. You may need to scale the building a bit until it fits. However unless you are extremely fortunate on the first attempt the perspective will be off. This is where the hard work comes in. Adjust the lens by 5mm at a time and re-adjust the camera position to see if the perspective gets better or worse. If it is getting continually worse you are adjusting the lens in the wrong direction, so go back to your original setting and start adjusting it 5mm the other way. Eventually you will have a perfect line up. From here add another cube and check it lines up with another building in the scene if you have one.

This process can take a good few hours, so if you haven’t cracked it in 10 minutes don’t be disheartened. Whatever happens don’t be tempted to start adjusting the geometry of the cube, distorting its shape to give you a better line up. Although it may look OK now, once you start adding more geometry into the scene things will go badly wrong and you’ll have to go back to this stage again, potentially wasting hours of work.

The image to the right shows the process early on. You can see the top part of the building is beginning to come into line but the bottom is way off. There is a lot more work to be done here before the job is finished.

3.0 Film Back Size - 3D

Often people get confused between the camera’s Film Back Size and Render Resolution. What tends to happen is the Film Back Size is left at the default and the Render Resolution is adjusted to the size in which the renders are required. But what is the difference?

The Render Resolution is the most straightforward as most people who do 3D will already have a good understanding of it. It is simply the size you require your 3D to be rendered out to, i.e 1920x1080 (full HD) or 2048x1556 (Full Aperture), etc.

The Film Back Size can also be called the Aperture size or Sensor size. What it refers to is the size of the capture medium. In its simplest form it crops the image after it has come through the lens and before it goes out to be rendered.
If you are making some 3D that doesn't relate into a live action plate in any form and you are not trying to accurately mimic a certain camera look, such as filming with a RED Epic, etc, then you can get away with leaving the film back size set at its default. However if you are matching CG into a live action plate, then it is essential to set this correctly.

The next question you probably have is “how do I know what settings to use for my film back?”. We have provided a list of over 20 common film back sizes in SLP #02: ‘Compositing Foundations, Part 2’.

4.0 Colour and Light - 3D and Compositing
One of the key jobs of a Lighting and Look Development artist is to accurately match their CG lighting with that of the background plate. This is one of the key factors in integrating CG elements with live action and can often make or break the shot.

In matching your lights, a number of areas must be considered to create a pleasing and realistic end result.

- Light Direction
- Light Intensity
- Light Colour
- Light Area or Fall-off
- Shadow Opacity
- Shadow Definition
- Breakup or Occlusion
- Physical Characteristics (God rays, dust particles, etc)

4.1 Light Direction
One of the key areas to look at first is the direction the light is coming from in the scene. Sometimes this can be very straightforward, such as in the image below left, while at other times it can be much harder, such as in the image below right.
To begin with, hopefully you will have some lighting data from on-set which would have been collected by either yourself or the Visual Effects Supervisor. This could include on-set photographs, HDRI's and lighting spheres (both chrome and grey). However in situations where no information has been provided, and this is often the case in corporate low budget projects, hard work and a keen eye can get you a long way.

**Note:** Chrome Spheres for lighting reference can be purchased on-line at Amazon.co.uk. Search for “Stainless Steel Mirror Sphere Garden Ornament 18cm”. For grey spheres just spray paint a second chrome sphere matte mid-grey.

If we take the photo of Tintern Abbey above combined with the information we get from a high dynamic chrome sphere shot on location, we can clearly see the direction of the light. Once this data has been converted from a mirror ball environment map into a *lat long* environment map, the data can be used to help light the scene in a 3D program such as Maya or 3dsMax. This data should only be used for the main diffuse lighting of the scene. A directional light, simulating the sun, should also be added and oriented correctly to shine from the same direction as the sun in the photo.
4.2 Light Colour

The colour of the light is also an important factor. Often this information can be extrapolated from your lighting spheres, in this case the grey ball gives good diffuse colour data.

You can also use a standard Degrees Kelvin chart (this one by Jeremy Birn, www.3dRender.com) to work out the colour based off the time of day (if you know it) when the background plate was shot.

Its often useful to have the background plate visible in your 3D scene so that as you adjust your lighting, for both colour and direction, you can see if things are in the right ball park.

Often the fine details are done in the composite, but you should aim to get a good 85% of the way there in 3D first.

4.3 Shadow Definition

In CG by default, unless you are using an area light (or Grid Light if you’re coming from Houdini), the source of the light itself is very small and this means that the edges of the shadows are going to be very hard. However in nature and man-made lights the light source always has a size, be it a lightbulb or the sun (as seen from Earth). Take a look
at the examples below. The cylinder on the left is illuminated by a spotlight with a light radius of 0. Note the hard unrealistic shadow edges. However the image on the right is lit with a spotlight using a light radius of 1cm (entire scene is only 30cm square) and with the number of rays being increased to 20 a more realistic shadow is produced. Note that the shadow is not blurred evenly from top to bottom but is sharper at the point where it meets the cylinder and becomes more blurred further away.

Going back to our example from Tintern Abbey, the light in the picture is coming from a single light source, the sun which has a diameter of 865,000 miles. However viewed from Earth the sun appears to be only a cm or two across and therefore the light used in the cylinder example above right gives a reasonably accurate shadow falloff.

The next important area to consider is shadow opacity. In the image below left you’ll notice the shadow under the car varies quite dramatically depending on the area. For instance, the shadow becomes darker the further under the car you go, especially in the middle, whereas at the edges it’s far more opaque. This effect cannot be created with a single light under normal conditions but requires extra rendering techniques such as Global Illumination or additional lights to create multiple shadows, such as the image below right.

4.4 Shadows, Highlights and Saturation Matching
As we mentioned at the end of section 4.2, your work in 3D should get you about 85% of the way with regards to your lighting, however the final 15% or so needs to be done in the composite. Of course if you are integrating another 2D element (nothing to do with 3D) then it all takes place in the composite.

One of the most important thing to do when integrating images is to make sure the black and white levels match, the shadows and the highlights. This is one of the keys areas that if missed can lead to the overall image looking wrong. Take for example the images below. The blacks and whites of the background have an overall blue tint to them, while the right foreground image has a mainly red tint.
An obvious question is, what should we correct the shadows and highlights to? We don't want to change the shadows on both images to pure black and the highlights to pure white - this would be very bad. The normal process would be to colour correct the foreground image into the background plate as the background plate will probably be cutting with other similar plates in the sequence and so we need to keep them constant in colour.

Going back to our two images above, we can see from the saturation information below that the foreground image is almost twice as saturated as the background, so in addition to the blacks and whites, the saturation values also need to be brought into line.

The final piece of the colour puzzle is the mid tones, which need to be evened out using a Gamma tool.

**4.5 Shadow on Shadow**

A key problem that can sometimes come up is the need to composite a CG shadow over a shadow in the live action plate. In reality, when two shadows cross each other the shadow colour / density remains constant.
However if you composite a CG shadow over a live action shadow the intersection is normally darker, which is incorrect. There are a number of ways to avoid this happening, all of which involve the removal of the original shadow where the intersection takes place. This can be done with a mixture of Luma keying and roto. Once the intersection has been removed, the CG shadow is then graded until it matches the other live action shadows in the plate. This will probably involve adjusting the opacity, colour and possibly the blur as well, though most of that should have been matched in 3D.

5.0 Light Wraps - Compositing

5.1 Understanding Light Wrap
In 3D lighting you have what is know as Global Illumination which simulates bounce light in a 3D scene. When this is used, the light in the environment bounces from surface to surface illuminating everything from different directions. Eventually the light energy, or Photons, run out of power and the light stops bouncing. This is the same in real life. A light coming in through a window bounces around the room illuminating the entire environment. If this did not happen, anything not facing the window would be in total darkness.

Another example of this, known as spill, is often seen when shooting a subject too close to a green or blue screen, where the light from the screen bounces off onto the foreground subject. In this instance, the spill causes a problem, but as Light Wrap is a perfectly natural phenomena in most cases we want it in our image and without this light pollution, something can seem ‘off’ in the final composite. This is where ‘Light Wrap’ comes in.

Take for example the image below, the foreground object has been composited over the background but something is lacking. The light from the background is not bouncing, or wrapping, round onto the foreground element, and why should it? They were filmed in totally different environments - the hill outside, and the girl in a blue screen studio. However in order for the two images to appear more integrated we need to add that bounce light, and that is where a Light Wrap helps us. A Light Wrap takes some of the background image and wraps it round onto the foreground object based on its matte, see image on the right.
5.2 Building a Light Wrap Setup

Depending on which compositing system you are using, you may or may not have a ‘Light Wrap’ tool included. Nuke and Flame have one built in, while Fusion and After Effects require you to build one from scratch. This process is not overly complicated. You basically need to create a matte from the foreground image’s alpha channel which follows the edges of the matte on the outside perfectly and fades off to black on the inside. This matte can be made with a couple of Erode tools, see Nuke diagram below for an example custom Light Wrap tool.

6.0 Edges - Compositing

When we photograph a real scene, we either capture the image by exposing a piece of film or the image is detected by a digital sensor and then saved to a disk. During this process a number of things are happening: the lens is focused on some area within the scene, there may be motion taking place somewhere causing blur, filtering is being applied to the image digitally, etc. Basically reality is being converted into a digital or analog representation. In the process, everything is slightly merged together, so hard edges are smoothed into their surroundings. This is further
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exaggerated as the moving images are shown at 24 frames per second on a screen or television. Interestingly one of the criticisms which came out of early test showings of Peter Jackson's 'The Hobbit' was that the image looked too clean and crisp. This was due to the images being shown at 48 frames per second, making the overall effect crisper. After 90 years of watching films at 24 frames per second, it is hardly surprising that people didn't like the change.

6.1 Edge Softening
When we composite multiple elements together often the edges of these pieces are crisp and hard. This may be what is required to avoid the whole image looking soft, however unless these elements are smoothed together you can be left with an image where everything doesn't quite seem integrated.

One method people sometimes use is to add an Edge Blur effect to the element being composited into the plate, but we believe this does not achieve a good result. Instead we would recommend creating a matte which is a few pixels inside the foreground element's edge and a few pixels outside. This amount can be varied depending on the amount of pixels you want to blur. This matte is then used to add a blur over both the background and the foreground after the two images have been composited together. This basically smooths the two pieces together very slightly and creates a more integrated look. See below for an example Nuke script.

7.0 Depth of Field - Compositing

7.1 What is Depth of Field?
In photography depth of field is the distance between the nearest and farthest object that appears in focus. The lens can only focus precisely at one point at a time, however the sharpness falls off gradually on each side so you normally end up with an area of graduation where the image goes from being pin sharp to being blurred (this area could be either small or large).
In some cases your whole image may be required to be in sharp focus - this is deep depth of field. In other instances you may just want one area of the image in focus to draw your eye in - for this you require a shallow depth of field. There are a number of factors which affect the depth of field. These include the distance from the camera to the object, the lens focal length, the selected lens f-stop, format size and circle of confusion.

Depth of field is determined by the object’s magnification at the film or sensor back and the selected aperture or f-stop. For any given f-stop, increasing the magnification (either by moving closer to the object or increasing the focal length) will decrease the depth of field. Likewise if you decrease the magnification you will increase the depth of field. Also for any given object magnification, if you increase the f-stop (which decreases the aperture diameter) you will increase the depth of field, while decreasing the f-stop will decrease the depth of field. For all of this the f-stop is the main controlling factor.

In some situations it is important to know the exact depth of field amount for both near and far planes ahead of time. For these situations you can use a depth of field calculator (many of which are available on-line or as iPhone Apps) or use a chart like the one below for the Canon 5D Mark III, 50mm Lens.
7.2 Matching Depth of Field

When it comes to matching new elements into your composite, getting the depth of field correct is critical to making your final image look realistic. How you approach the problem of getting your new elements to match will depend on what you are compositing in.

3D - If you are integrating CG elements into the rest of your composite, then hopefully you will have been supplied with an extra render pass called a Z-Depth pass. This grey scale, often 8bit image, describes the scene in terms of distance from the camera out into the scene. Using the image you can then apply a depth of field blur across the whole image controlled by the Z-Depth pass.

Composite (3D Environment) - If you only have 2D elements to integrate into your main scene, you can use your compositor's 3D environment (if available) to place the new elements into 3D space and then use the compositor's depth blur system to add the depth of field effect required. As an example the image below shows five words placed on 3D cards and spaced out in depth. The environment is then rendered and a depth of field blur applied.

Composite (2D Environment) - The final type of setup you may need to do is a straight 2D integration. This requires the new element to be placed onto the scene and then the blur to be added by eye until the new element is blurred to the same degree as the surrounding image. The example below shows the word 'Wire' added and blurred into the image.
8.0 Lens Distortion - Compositing

8.1 What is Lens Distortion?
Lens distortion is a natural phenomena of shooting with camera lenses and is caused by the image passing through the curved glass. Often the distortion occurs more towards to edges of the image than the middle, but the result is that straight lines which do not pass through the centre of the image become bent (the amount of bending increases with distance from the optical axis or centre). There are two types of lens distortion, Barrel and Pincushion.

With Barrel Distortion the lines bend out away from the centre, so the effect is like an image which has been mapped around a sphere or barrel.

With Pincushion Distortion however the lines are bowed inwards towards the centre of the image, like a pincushion.

A mixture of both types, sometimes referred to as moustache (or complex) distortion is less common but not rare. It starts out as barrel distortion close to the image centre and gradually turns into pincushion distortion towards the image periphery, making horizontal lines in the top half of the frame look like a handlebar moustache.
8.2 Matching Lens Distortion
Unlike some of the other integration methods we have mentioned, lens distortion normally has to be done accurately. More often than not, the plate will already have been undistorted as part of the matchmoving process and your job will be simply to invert that data and reapply the lens distortion to the new elements being added into the scene.

8.3 Lens Distortion Management
When an image is manipulated, the process uses filtering to help keep the image clean and unpixelated. However if an image is manipulated lots of times the filtering causes the image to become softer. It is the job of the compositor to try and find ways to reduce the number of filter hits to keep this to a minimum.

A logical, but incorrect method would be to un-distort your image straight after it has been Read in, then add your CG elements (which would probably have been rendered without any lens distortion on), and finally reintroduce the lens distortion (Invert) at the end.

This system of course adds two filter hits to the background plate: one when you undistort the image, and a second when you re-distort the image at the end of your composite.

A better method would be to first undistort the background plate, then invert this Lens Distortion node and use it to add the correct lens distortion onto the CG elements. Finally add the distorted CG elements into the original (still distorted) background plate, as shown in the diagram on the right.

This system only introduces one filter hit on the CG element and none on the background plate.
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9.0 Grain and Noise - Compositing

9.1 What is Grain and Noise?
Grain and noise is often introduced into footage due to low light conditions during filming. To try and compensate when filming in dark situations, faster film stocks may be used or when shooting digital a higher ISO too. Sometimes a director will deliberately use a film stock that is known to create a grainy look to stylise the look of the shots, while at other times a director will try to remove as much grain as possible. Good examples of these two extremes are the films Planet Terror which has a very grainy look and Speed Racer which has a very clean look. The main difference between grain and noise is that grain is normally associated with film whereas noise is more often than not seen in digitally captured material.

Note: for the purposes of this section we will use the word 'grain' to refer to both grain and noise.

9.2 Matching Grain and Noise
Matching the grain is an essential part of integrating elements in a plate. This is normally done as part of the compositing process where you have maximum control. There are a number of ways in which grain can be matched. The first step is to determine whether the element you are integrating already has grain on it. If this is the case and the grain is the wrong grain, ie. it has been filmed with a different film stock under different lighting conditions, etc, then that grain will need to be removed. This is done with special grain removing tools which you hopefully have in your compositing system.

Once you are working with a non-grained element, the correct grain can then be applied. This can normally be done in one of four ways. Firstly you can dial in the grain manually, adjusting the size, irregularity and intensity of the grain. To do this you need to work with each colour channel (red, green or blue) one at a time, matching the grain look against a uniform area of the background. The second way is to sample a uniform area of the background and let the software analyse the grain it sees and replicate it on the new element. The third way is to use a predefined grain structure based off a certain film stock already setup by the compositing software supplier. Some common examples of film stock presets are:
- Fuji F250
- Fuji F500
- Kodak 200T
- Kodak 320T
- Kodak GT5274
- Kodak FX214

The final way is to use pre-scanned grain. This is created by filming a grey card using the same film stock or ISO setting as the rest of the sequence. That footage is then sampled by the compositing software and the grain it finds is applied to the other elements.

9.3 Grain Management
Grain management works in a very similar way to Lens Distortion workflow. Instead of removing the grain and then re-introducing it across the whole final composite (which adds unnecessary filter hits and hence softening to the image), it is better to keep the grain in the background plate and add it to the CG (or non-grained) elements. This workflow, minimises the number of filter hits.
10.0 Vignetting - Compositing

10.1 What is Vignetting?
In photography, vignetting is a reduction of an image's brightness or saturation at the periphery compared to the image centre. The word vignette, from the same root as vine, originally referred to a decorative border in a book. Later, the word came to be used for a photographic portrait which is clear in the centre and fades off at the edges. A similar effect occurs when filming projected images or movies off a projection screen. The resulting so-called "hotspot" effect defines a cheap home-movie look where no proper telecine is used.

Vignetting is often an unintended and undesired effect caused by camera settings or lens limitations. However, it is sometimes purposely introduced for creative effect, such as to draw attention to the centre of the frame. A photographer may deliberately choose a lens which is known to produce vignetting to obtain the effect, or it may be introduced with the use of special filters or post-processing procedures.

Optical vignetting is caused by the physical dimensions of a multiple element lens. Rear elements are shaded by elements in front of them, which reduces the effective lens opening for off-axis incident light. The result is a gradual decrease in light intensity towards the image periphery. Optical vignetting is sensitive to the lens aperture and can be completely cured by a reduction in aperture of 2 to 3 f/stops.

Pixel vignetting only affects digital cameras and is caused by angle-dependence of the digital sensors. Light incident on the sensor at a right angle produces a stronger signal than light hitting it at an oblique angle.

Most digital cameras use built-in image processing to compensate for optical vignetting and pixel vignetting when converting raw sensor data to standard image formats such as .jpg.

10.2 Matching Vignetting
The way a vignette is normally matched is by placing some form of matte over the image which adds a black edging to the corners. The matte then needs to be feathered until you reach the required vignetting size. It is often impossible to determine what kind of vignetting would be achieved by a certain lens as the f/stop plays a heavy part in the end result, so the rule 'if it looks good it is good' often comes into play.

For the best result you should usually avoid the corners being 100% symmetrical. A slight difference in size and feather will create a more organic and realistic result.
11.0 Lens Aberration - Compositing
On top of vignetting and lens distortion, various other aberrations take place which are a direct result of the light hitting the camera lens. All of these, when added into your shot, make for a more realistic image.

11.1 Chromatic Aberration
Chromatic aberration is a type of lens distortion where there is a failure in the lens glass to focus all the colours to the same convergence point. It occurs because lenses have a different refractive index for different wavelengths of light (dispersion of the lens). The refractive index decreases with increasing wavelength. Chromatic aberration manifests itself as fringes of colour along boundaries that split the dark and bright parts of the image. This is caused because the different colours in the optical spectrum cannot all be focused at a single common point.

Since the focal length of a lens is dependent on the refractive index, the different wavelengths of light will be focused on different positions. There are two types of chromatic aberration, axial longitudinal, and transverse lateral.

11.2 Flares
Lens flare is an effect of light being scattered in the camera lens system, through mechanisms such as internal reflection and scattering from non-uniformities in the lens material. Flare manifests itself in two ways, as visible artefacts and as a haze across the image. The haze makes the image look washed out and is caused by reducing contrast and saturation. Lens Flares are often caused by a very bright light source either in the image (which produces visible artefacts) or shining into the lens but not in the image (which produces a haze). Most often this occurs when shooting into the sun or at a light on set. Lenses with large numbers of elements, such as a zoom lens, tend to exhibit greater lens flares as they contain multiple surfaces at which many unwanted internal scatterings occur.
When adding flares to your scene be very cautious, as too much flare can create a very artificial look unless done well (see J. J. Abrams ‘Star Trek’ and Ridley Scott’s ‘Blade Runner’).

11.3 Bokeh

Bokeh is the blur or aesthetic quality of the blur in out-of-focus areas of the image. However differences in lens aberrations and aperture shape cause differences in the look of the blur shape. Bokeh occurs for parts of the scene that lie outside the depth of field, and photographers sometimes deliberately use a shallow focus technique to create images with prominent out-of-focus regions. Bokeh is often most visible around small background highlights such as specular highlights and light sources.

![Bokeh Image](image1)

© Sarah Jean Photography

The shape of the blur in Bokeh is based on the shape of the aperture causing the number of sides to vary. In some stylised situations the blur shape can be completely changed, such as in the end scene of Speed Racer.

![Bokeh Image](image2)

The use of Bokeh often creates a more realistic lens blur than simply using a Gaussian or other filter.

12.0 Atmospherics - Compositing and 3D

One of the key cues to depth after scale is atmosphere - things further away have more air, cloud, dust, etc in front of them. All of this creates a more diffused, desaturated look to far away objects. Objects closer to the camera will have a wider contrast range, while for farther away objects there is little difference in contrast. Often far away objects have very little detail and they can even be just a silhouette. This affects everything, including the sky. For instance you will have noticed that the sky often looks bluer above you than at the horizon where it becomes a lighter blue. This again is caused by looking through more air, dust, etc at ground level than looking straight up. Moist air has a greater affect than dry air - that is why you can see further in the desert than you can in the rain forest.
As objects recede into the background they will also become more sky coloured. They will often take on a blue tinge from the sky, resulting in the foreground colours appearing warmer than the background ones. This however is reversed at sunrise or sunset when the sun is low and the sky is a warmer colour.

For integration, the key thing to keep in mind when it comes to atmospherics is layers. You will basically need more than you think to create the desired look. Often feature film environments may have 4-5 layers of atmosphere (air, smoke, dust, etc) just to bed the elements into the background plate.

13.0 Motion Blur - Compositing (and sometimes 3D)

13.1 What is Motion Blur?
Motion blur is the apparent streaking of rapidly moving objects in an image and is caused when the image being photographed changes during the capture of a single frame, either due to rapid movement or long exposure.

If you are filming at 24 frames per second with a 180˚ shutter, at 1/48 of a second exposure you will have a very filmic looking motion blur. However if you increase the frames per second to 48 frames per second (as in Peter Jackson's The Hobbit) keeping with the 180˚ shutter, you will have an exposure of 1/96 of a second which will half the amount of motion blur, creating a very clean ‘video’ look.

13.2 Matching Motion Blur
Sometimes motion blur can be matched by knowing how the original background plate was shot, ie. shutter speed and exposure, and then just dialling in the numbers creating a technically correct motion blur. At other times you will have to guess the amount of blur to use by eye. Because of this motion blur is usually added in the composite, which gives you more flexibility. The exception is when you need motion blur based on a deforming shape (such as a bee's wing flap). In such cases it has to be rendered as part of the 3D.
Contrary to popular belief, a motion blur is not sharp at one end and blurred behind the moving object - both ends of the motion blur are blurred by the same amount.

### Assignment
For this SLP, we are setting just one assignment which is to take the elements we've provided, and others you can find, and try to integrate as many of these elements as possible into a background plate, taking care to match the various factors we have discussed in this SLP.

### 14.0 Summary
Throughout this SLP we've looked at numerous ways to integrate elements into a background plate in order to make the most convincing digital composite. These techniques are instrumental to creating a seamless photo-real final shot. In order to master these skills however, you will need to both observe the real world carefully and then practise compositing in order to understand and transfer what you see into what is required to make a beautiful looking shot. Finally, we suggest you take a look at the shot breakdown from 'Pirates of the Caribbean: At World's End', a truly inspirational integrated composite by Digital Domain, which can be viewed here: http://www.youtube.com/watch?v=7rocRxFtUSc

### 15.0 Further Study

#### 15.1 Additional SLPs
SLP #01: 'Compositing Foundations, Part 1’
SLP #02: 'Compositing Foundations, Part 2’
SLP #03: ‘CGI Foundations’
SLP #15: ‘Matte Painting and Environments’

#### 15.2 Books
The Art and Science of Digital Compositing (Ron Brinkmann)
Digital Compositing for Film and Video (Steve Wright)
Encyclopedia of Visual Effects (Damian Allen & Brian Connor)
Visual Effects in a Digital World (Karen Goulekas)
The Art of 3D Animation and Effects (Isaac Kerlow)
American Cinematographer Manual (Ron Ryan)
The VES Handbook of Visual Effects (Jeffrey Okun)
Special Effects: The History and Technique (Richard Rickitt)
Industrial Light & Magic: The Art of Innovation (Pamela Glintenkamp)
Industrial Light and Magic: The Art of Special Effects (Thomas G. Smith)
Industrial Light and Magic: Into the Digital Realm (Mark Cotta Vaz)
The Invisible Art: The Legends of Movie Matte Painting (Mark Cotta Vaz)
The Digital Matte Painting Handbook (David B. Mattingly)
d'artiste: Matte Painting (Alp Altiner)
d'artiste: Matte Painting 2 (Y Dusseault)
d'artiste: Matte Painting 3 (Ballistic)

#### 15.3 Periodicals
American Cinematographer (Magazine)
Cinefex (Magazine)
3D World (Magazine)
15.4 Websites
www.fxguide.com
www.spherevfx.com

15.5 Podcasts
fxguide
The RC
The VFX Show
American Cinematographer
International Training Company

3D, Compositing, Visual Effects and Stereoscopic Post Production

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AUTODESK
MAYA
SIDE EFFECTS
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PIXOLOGIC
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THE FOUNDRY
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