Fixing it in the Present – The Decisive Moment in High Dynamic Range Landscape Photography

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Exegesis

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PREFACE

An exhibition will take place with the PhD viva that demonstrates the visual outcome of this practice-led research in the form of high quality image prints that are approximately 24 inches on the longer side. The large print size allows for better scrutiny of the prints and image artifacts. A selection of larger size images along with respective histograms illustrating the dynamic ranges is provided in Volume 2: Portfolio.

A selection of Camera RAW files, intermediary image files and the final image files along with the software presets will be published as part of this thesis for research and educational use after the viva exam. The camera RAW files provide a software unaltered view of the scene. The intermediary files and software presets help catalogue and demonstrate the result of the image operations, or, craft processes at each stage of development and postproduction. These images can be used by students, researchers and practitioners to gain further insights into the workflow, track the look and assess integrity of the image as well as assessing tool, technique, practitioner and workflow competency. This is in line with Fairchild's (2007) public domain database of HDR images and scene data but with the addition of a more creative practice element. The creative insights provided in the case studies help contextualise this element of the thesis. A selection of interactive 360 videos documenting the photography process for these images will also be published alongside the images.

Any images contained in this thesis that are not created by the author are for the viva examination purposes only and will be redacted prior to this thesis being made public.

ABSTRACT

Photographing landscapes can be challenging given the wide range of tonal values present in the scene that can extend beyond the range of what most digital cameras can record. Moving elements in the landscape such as clouds, foliage, water, and, changing light pose a challenge, as well as creative opportunities, to create distinct creative image looks based on the degree of change these elements undergo during capture of the multiple exposures. Key photographic opportunities where the elements in the scene come together to create a certain sense of balance and composition, or, the Decisive Moment, may be missed between exposures given the multi-shot nature of this workflow. Stack-based high dynamic range photography can be used to capture the full range of scene values by photographing a range of different exposures and combining them digitally.

The aim of this practice-led research is to take better control over the potential look of the final image by capturing all tonal values available in the scene in best possible detail, thereby extending the range of creative possibilities available post-capture whilst also capturing the Decisive Moment.

The production workflow adopted allows for the original camera RAW files to remain unchanged and complements the reflective practice method used in this research that can be utilised in other virtual craft practices. The new technique offers insights into creative possibilities to allow better control over capturing the Decisive Moment in the scene whilst ensuring maximum image latitude for postproduction. This workflow also incorporates focus stacking and digital panorama techniques to extend creative control and image latitude. The images produced explore and evidence the look that can be achieved using this workflow.

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TABLE OF CONTENTS

1 INTRODUCTION

Real world landscape environments can be challenging to photograph given the wide range of bright and dark values that exist in the object surfaces across the scene. The difference between the brightest and darkest point in the scene is referred to as the "scene contrast", or, the "dynamic range" of the scene. The human eye can see details in the tones and textures of objects across a large part of the high contrast scene but cameras are limited by the dynamic range capture capacity of their medium – be it film or digital - and can only capture a limited slice of the scene dynamic range. Since the days of early black and white film photography, landscape photographers have endeavoured to devise techniques, methods and workflows that allow them to capture, map and render the wide dynamic range of landscape scenes to the limited dynamic range of the capture medium (see 2.12). The development of these techniques, methods and workflows relied on the photographers' practice and was informed by the lessons they learned in the process of image making. One of the digital photography methods that has gained popularity in recent times is to capture a series of multiple different photographic exposures each capturing a different slice of the scene tonal range and subsequently blending these exposures digitally to create a single image that has the collective dynamic range of all of the individual exposures. This method is known as stack-based high dynamic range (HDR) photography. This is a practice-led research study in the craft of stack-based High Dynamic Range (HDR) Landscape Photography and considers the practical implications of the tools and physical constraints of the scene as well as the creative intent of the practitioner.

1.1 Introduction to high dynamic range photography

HDR is an extremely active area of research and is replacing conventional photography in all areas including but not limited to camera design, software image processing, digital graphic arts and filmmaking (McCann and Rizzi 2012, p. 3). Digital sensors on conventional consumer cameras can only record a limited range of light values present in landscapes under high contrast lighting conditions in a single photographic exposure. The human eye, however, with its ability to adjust and adapt to the range of luminance values present in the scene can experience the landscape in far greater detail in terms of tonality and texture (McCann 2016).

1.2 Stack-based high dynamic range photography

High dynamic range photography using multiple exposures is a technique that dates back to the analogue era of film photography (Gurieva 2014). Ideas for stack-based digital HDR photography were proposed in the 1990's (Gallo and Sen 2016) but it was not till the release of HDR software HDRSoft Photomatix (HDRSOFT.COM 2015) that digital HDR photography gained wider popularity with photographers (Bloch 2013 p. 85).

Digital HDR photography tools and technology have provided unprecedented ease for capturing the entire dynamic range of the scene by photographing multiple different exposures that collectively capture the entire scene dynamic range. This technique is known as stack-based HDR photography and involves photographing a number of varied photographic exposures known as exposure brackets, or, collectively as the exposure stack (Gallo and Sen 2016). Each exposure within the exposure stack captures a certain segment of the wider range of luminance values present in the scene. These exposures can be blended together to generate a single 32-bit high dynamic range file that contains the combined range of scene luminance values from across all the individual exposures. This file can subsequently be tonemapped and manipulated to generate the desired visual output by extracting and outputting specific tonal values in the image. In order to capture different exposures of the scene, the common practice is use variable shutter speeds whilst keeping the aperture and ISO constant. This is due to the fact that changing the aperture alters the depth-of-field whilst changing the ISO changes the ISO noise pattern and image latitude. Blending different shutter speed exposures can work in a static environment but in a landscape setting where all the elements within the scene are in a constant state of flux and each exposure has to be photographed sequentially means that these scene elements may not line up perfectly (Johnson 2012, p. 3).

1.3 The Decisive Moment and the challenges of capturing it in HDR Landscape Photography

Photography as a means of creative imagemaking is known for its ability to capture key moments unfolding in the scene. Instances where the moving elements in the scene create an interesting or aesthetically pleasing juxtaposition are referred to as the "Decisive Moment" by Cartier-Bresson (Cartier-Bresson and Sand 1999, p. 20-43).

The multi-shot nature of stack-based HDR photography has some inherent issues when it comes to capturing the Decieve Moment; firstly given that the final image is composed of individual exposures, each being a slice in time, the Decisive Moment may occur during the interval between two exposure brackets, or secondly, it may not be possible to record the Decisive Moment across all the different exposure brackets. Moving elements in the scene may also not align across different exposures resulting in semi-translucent rendering of object forms known as ghosting. Therefore, whilst stack-based HDR photography may work well for photographing still objects, it can be challenging to use this technique for photographing moving elements in the scene especially when the juxtaposition of the elements in the scene in a particular instant is critical.

The landscape scene, as a subject for stack-based HDR photography, provides a unique set of challenges and opportunities. A beam of light coming through the clouds and falling on a particular region in the landscape, or, a wave crashing against the rocks on a beach, for example, can transform the look of the picture by adding or heightening the drama. But these events may happen over a fraction of a second making it extremely challenging for the photographer to record them across all the exposures. The dynamic range of the outdoor scene on a sunny day can be far greater than what can be captured in a single photographic exposure and therefore landscapes make for a good scenario where the stack-based HDR photography approach can be utilised. Capturing a wide scene dynamic range, however, requires a high number of exposures when the elements in the scene may be in a constant state of flux making it particularly challenging to eliminate ghosting artifacts. Conventionally, relatively small apertures are used when photographing landscapes in order to maximise depth-of-field and ensure all elements from foreground to background are rendered in acceptably sharp focus. The reduction in the amount of light coming through the smaller aperture has to be compensated by increasing the exposure time using slower shutter speeds as increasing the ISO results in an increase in ISO noise and reduced image latitude; noise in the exposure stack needs to kept low as tonemapping tends to accentuate it. The longer exposure times can further increase the likelihood of ghosting artifacts due to the motion of the scene elements.

Capturing a HDR exposure stack in Landscape Photography, therefore, can be a very challenging task that requires careful planning, critical awareness of the tools, and the environment, as well as excellent craftsmanship in order to capture every exposure at the right time as the Decisive Moment unfolds across the scene. It is important to carefully plan and visualise exactly what each exposure contributes to the final image and specific scene elements. The rendition of the moving elements in the scene also needs to appear cohesive in terms of motion; darker scene elements require longer exposure times whilst brighter scene elements require shorter exposure times. If there is too much variation in the exposure times, some scene elements will appear motion blurred whilst others will appear relatively still creating a mismatch in the rendering of motion within the scene. In windy conditions, longer exposures can lead to a greater chance of camera shake. It is, therefore, also important to critically examine the number of exposures required for a given scene as extraneous exposures can increase the overall time it takes to photograph the entire sequence resulting in greater time discrepancy between the first and the last exposure, thereby increasing the chances of ghosting. The best practice for this workflow has been explored as part of this research study (see Chapter 4).

1.4 Exploring the craft of HDR Landscape Photography

This research study takes a holistic view of the HDR production process from a landscape photographer's perspective that not only explores the craft best practice but also takes into account the improvisation, adaptation as well as the location and tool constraints that the practitioner has to consider during the process of stack-based HDR Landscape Photography. The practitioner insights, thus, add value in terms of experiential craft knowledge gained from the lived experience of photographing in real world landscape scenarios where external factors such as the light, weather, tide, and, movement in the scene are beyond the practitioner's control. These practitioner insights, thus, help contextualise the production decision making process in line with the creative intent for the image, the prevalent scene conditions, and, any physical or technical limitations (see Chapter 0).

In particular, this research explores how HDR Landscape Photography techniques could be used to emulate the look of early 19th century British oil paintings (see 2.3 and 2.7) as well as exploring how far the look of HDR landscape images could be pushed in order to reveal tonal and textural detail that may not be apparent to the human eye whilst still aligning with the notion of Straight Photography (see 2.8) that could give HDR photography its own unique visual identity.

1.5 Background to the researcher-practitioner's wider practice

This research study was undertaken to serve the researcher-practitioner's wider practice that draws on his training and experience of visual effects and aims to explore the viewer's notion of the real and the unreal, or, fantastical, in the images created as part of his practice. Hollywood movies such as The Lord of the Rings, The Hobbit and the Harry Potter series, and Star Wars films show environments that are constructed digitally using digital matte paintings and 3D environments that sell the visual effect as being photoreal. By blending computer generated (CG) imagery with live action photography and matching image features such as lighting, camera movement, exposure, noise, lens distortion and chromatic aberrations from the live action elements onto the CG elements, visual effects practitioners make the CG elements appear as if they are part of the filmed sequence and actually exist in the real world. The aim of the researcher-practitioner's wider practice is to do the opposite by creating photographs of real world landscapes but bringing out details in the scene elements that make these landscapes appear unfamiliar, fantastical, or other-worldly, thereby grasping the viewer's fascination and challenging the viewer's notion of the real and unreal by questioning whether the image has been photographed or painted:

> "The photograph seems to have a special connection with reality and an independence of the photographer's intentions. For example, if there is a horse in a photograph, we assume that there must have been a horse in front of the camera, since the horse cannot just be a product of the photographer's imagination. For this reason, a photograph is thought to verify the existence of its subject in a way a painting never could; the photograph requires the presence of a horse for its production, while a painting could depend wholly on the artist's imagination." - (Savedoff 2010)

A photograph that looks like a painting, therefore, raises an issue much deeper than just the appearance of scene elements in the picture; it challenges the very existence of the what is depicted in the picture and creates uncertainty in the mind of the viewers who have not seen the elements themselves in real life as to whether what is shown in the picture actually exists in reality. If there are any clues in the look of the image that allude to its method of creation, the viewer may be able to easily identify how the image was constructed and snap out of the charm that the image holds over them. The question that keeps the viewer intrigued is: "How did they do it?", i.e. the craft of image creation (Coughlan 2019).

1.6 Rationale

Imagemakers have long strived to use the latest technology at their disposal to create images the likes of which have not been seen before whilst keeping their working methods secret in order to gain competitive advantage. This can be evidenced from the recent discoveries pertaining to the use of the camera obscura and other optical devices used by painters of the past (Falco 2016, Hockney 2001; Gorman 2003; Hockney and Falco 2004, Hockney and Falco 2005) as well as the non-disclosure agreements visitors to film visual effects companies are made to sign today.

The latest tools and technologies require considerable testing and practice to realise their true potential as well as their constraints and limitations (Sennett 2008, p. 196). Such is the case with stack-based high dynamic range photography that allows for a greater range of light values to be captured. The nature of the tools and processes used, however, can leave telling signs in the resulting image that allude to the use of this technology and other camera tools thereby giving away the secret to its construction.

This resarch study was undertaken to serve the wider practice of landscape photography by exploring ways of capturing and creating images that were free of camera, sensor and tonemapping artifacts. Having the ability to identify and resolve these issues is critical for the practice in order to free the creative flow and not let it be compromised due to technical craft issues. It should be noted that the rendering intent here is not to produce an accurate representation of the real world scene but to create a signature look (McCann and Rizzi 2012, p. 3-4).

1.7 Research aims

This research aims to:

- Create landscape images that have a shared visual characteristics to some of the oil paintings created by John Constable, William Turner and John Martin (henceforth refered to as the painterly look) but are devoid of digital camera sensor, lens and processing artifacts, such as noise, diffraction, chromatic aberrations, shallow depth-of-field, ghosting and inverse tonemapping which allude to the use of a camera as the imagemaking device, whilst still retaining the common characteristics between painting and HDR photography highlighted by Torcellini (2010);

- Exploring other visual possibilities between these looks mentioned above and the Straight Photography look particularly dominent in Landscape Photography genre. The motivation behind this aim was to enable the practitioner to craft the images to their own personal taste and style as well as being able to submit work to various Landscape Photography competitions where excessive image manipulation is not allowed;
- Explore best practice for capturing high dynamic range landscape photographs in order to take better control over the visual look of the final image as well as having the latitude available to explore multiple different creative possibilities, and, delay making some of the key decisions related to the framing, composition and tonality of scene elements till the postproduction stage along with the ability to capture the Decisive Moment.

1.8 The research question(s)

How can stack-based high dynamic range landscape photographs be captured that are devoid of, or have minimal, camera sensor and lens artifacts in order to have greater flexibility and control over the final look of the image during postproduction? Is it also possible to capture the Decisive Moment unfolding in the landscape scene and maintain extenisve depth of field?

These questions need to be explored in the problem setting in light of the limitations of the tools and technology available to the practitioner at the time and under the physical, logistical and practical constraints of the location.

1.9 Research objectives

The objectives of this research study are listed below:

1. To maximise dynamic range capture across all relevant scene elements in the final stack-based HDR image in order to allow greater range of data that can be utilised for experimenting with the creation of different image looks
2. To eliminate or minimise image artifacts and issues resulting from lenses (diffraction, shallow depth of field, chormatic aberrations), camera sensor (noise, banding), stack-based HDR acquisition (ghosting and misalignment), and, tonemapping (halos/inverse tonemapping)

3. To be able to capture the Decisive Moment unfolding in the scene whilst utilising stack-based HDR photography technique

1.10 Research phases

The initial phase of the research was concerned with maximising the dynamic range in the HDR images in order emulating the look of classical 19th century British landscape paintings by William Turner and John Constable as well as experimenting with other image looks using stack-based HDR photography as per the first research objective.

The middle phase of the research went beyond emulating the look and explored a unique and distinct look that was specific to HDR photography whilst retaining the rigour and craftsmanship expected in the genre of Landscape Photography. The focus during the middle phase of the research, in line with the second research objective, was on finding solutions to minimising or eliminating discernible camera sensor, lens, HDR and tonemapping artifacts. Issues related to the capture, processing and workflow of images were identified and critically examined over the initial and middle phase of the research study.

The final phase of the research was concerned with the third research objective and refining the capture process to create a workflow framework that enabled the capture of the Decisive Moment whilst maximising dynamic range (see Chapter 4).

1.11 Conceptual framework

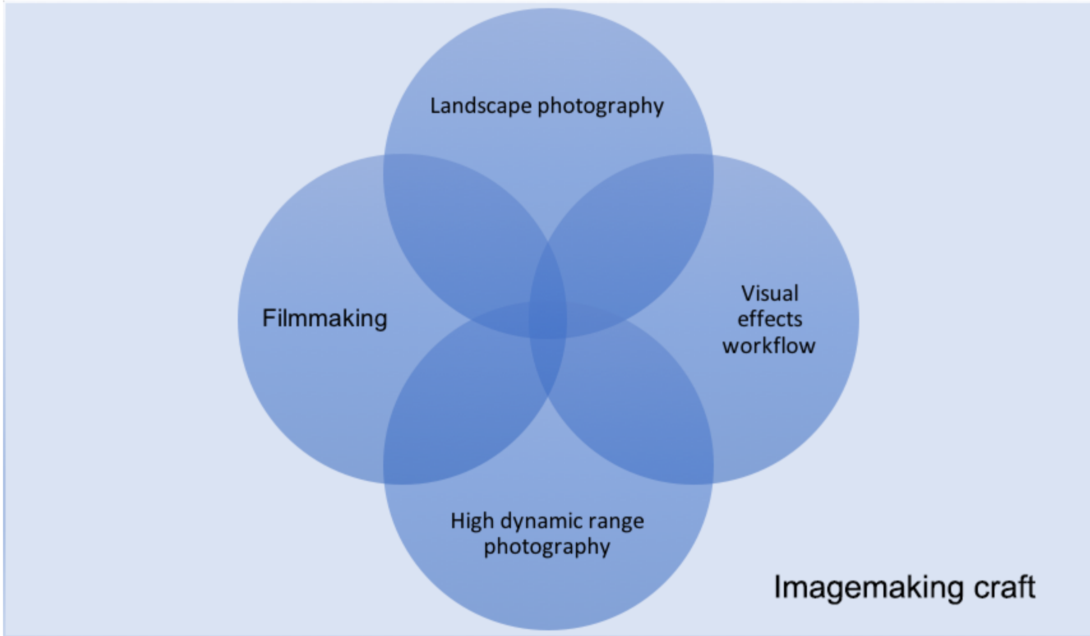


Figure 1 Conceptual framework

Nelson (2013, p. 34) recognises that rigour in Practice as Research comes from "syncretism" and not "depth-mining" given the interdisciplinary nature of Practice as Research. This research study draws upon, and combines, different concepts, methods, techniques and workflows from the disciplines of Landscape Photography, high dynamic range photography, filmmaking, and, visual effects that lie within the wider domain of imagemaking craft practice (see Figure 1). "Craft" as it applies to making and doing to a set specification is central to this research study in terms of reflective practice and solution-focussed thinking.

The workflow, method and approach to practice in this research study have been adopted from filmmaking and visual effects workflow. High dynamic range photography and other multi-shot photography techniques serve as a crafting tool in the production process of the images. Governing concepts, established norms and the dominant look within the genre of Landscape Photography serve both as guiding principles and points for discussion with regards to image integrity and image manipulation, and, how these principles apply to HDR photography.

1.12 Summary

Stack-based HDR photography allows practitioners to capture a greater tonal range of the scene than can be captured in a single photograph enabling practitioners a greater degree of flexibility when crafting the image look during postproduction. In the context of Landscape Photography, stack-based HDR photography can be challenging due to motion in the scene that can cause motion artifacts and alignment issues. Key photographic opportunities may also be missed in between, or across, multiple exposures. This PhD research study has been undertaken to allivaite the key issues identified in the researcher-practitioner's HDR Landscape Photography practice. The practice-led approach employed in this research study allows for a holistic view that takes the situational, practical, logistical, and craft elements into consideration in the pursuit of creating the desired image look for the final image.

2 CONTEXTUAL REVIEW

2.1 Introduction

This chapter sets the context for the research study by drawing on, and providing linkages to, a number of different disciplines ranging from photography, film, visual effects, craft and painting. The chapter starts with providing a basic introdution to the fundamentals of photographic exposure and the importance of craft in image making. A critical analysis of different HDR acquisition and post-production processes is provided. The context for the image look given the similarities between 19th century British landscape paintings and HDR photography are discussed followed by an historic overview of Landscape Photography as a genre. This leads on to the status quo and the prevelent attitudes towards HDR amongst landscape photographers today. Works of HDR photographers creating a similar look to the author's own practice are also illustrated to provide visual context. The challenges of using HDR methods, techniques and workflow for Landscape Photography are highlighted including difficulties in capturing of the elusive Decisive Moment unfolding in the scene when using stack-based HDR photography. A critical analysis of the different acquisition techniques and methods, as well as the workflows of a number of different HDR photographers is discussed identifying the gaps in craft best practice. The chapter concludes with a discussion on the value and importance of practice-led nature of resarch and craft competency.

2.2 Fundamentals of photographic exposure

The photographic image is created by exposing film or the digital sensor to a certain amount of light for a certain period of time. Too much light results in overexposure where the brighter tonal and textural details in the scene, known as highlights, are clipped. In the case of digital photographs, they render as pure white and reducing the exposure value subsequently during postproduction does not bring back any textural detail in the highlights and only results in the overexposed white pixels turning grey. Too little light results in underexposure where textural and tonal details in the darker parts of the scene, known as "shadows" in photography, are clipped. Subsequent exposure increase in postproduction only makes these pixels appear grey. Increasing exposure in underexposed images during postproduction also adds the risk of making digital noise more apparent in the image. Digital RAW files are allocated more bits for the highlights than for the midtones or shadows (Fraser 2004). The amount of light coming through the lens to the sensor can be controlled by varying an aperture inside the lens whilst the exposure time is controlled by varying the speed of the shutter in front of the film or camera sensor. The film's response to light, indicated as ISO, also influences how dark or bright a photograph is with higher ISOs such as ISO 800 or ISO 1600 being more responsive to light and lower ISOs, such as ISO 50 or ISO 100 being less responsive to light. Digital camera sensors usually have only one base ISO and emulate film ISOs by amplifying the digital signal (Diprose and Robins 2012, p. 27-28). This amplification can result in noise as well as compromising image latitude in post-production. The photographer has to decide what combination of aperture value, shutter speed and ISO to use in order to achieve the desired result as each of these variables also affect other aspects of the image look. Wider apertures allow more light to come through to the film or camera sensor but decrease the volume in front of the camera that can be rendered in acceptably sharp focus known as the depth-of-field. Smaller apertures provide greater depth-of-field but allow less light in. Smaller apertures can also result in diffraction artifacts such as noise, highlights in the scene rendering as "star bursts" and/or softening of the image. This poses a challenge when it comes to Landscape Photography where the entire scene depth in front of the camera may need to be rendered in sharp focus without any diffraction artifacts to acquire the clearest view of the landscape. The depth-of-field also depends on the focal length of the lens and the focus distance. Wider focal length lenses, such as 21mm, tend to generate greater depth-of-field whilst longer telephoto lenses, such as 125mm, generate shallower depth-of-field. The focus distance is also a factor that affects depth-of-field; focussing the lens at a closer distance produces a shallower depth-of-field than when the lens is focussed at a distance further away. The time for which light is allowed to come through to the camera sensor, or exposure time, is controlled by the camera shutter which functions as a gate in front of the camera sensor.

2.3 Importance of craft skill in photographic imagemaking

The discovery and use of the camera obscura enabled painters to create a better sense of perspective and real world 3D space in paintings, but, it also created a divide in the creative intent behind the image in terms of whether, it was the spiritual portrayal where the "symbol transcended its model", or, an accurate representation of the real world scene (Bazin and Gray 1960). Bazin and Gray (1960) state that great artists have always been able to fuse these two ambitions together by crafting reality to suit their desired creative intent. To achieve this level of expertise requires the development of practitioner skill to a high standard as well as gaining insights and understanding of the tools, techniques, material processes and workflow in order to craft the desired look which is the purpose of this research study. As Adams and Baker (1981, p. 48) suggest:

> "As photographers, we should study and reflect upon the details of the process; practice is essential, for when we are making photographs, we should be free to work creatively and intuitively, drawing upon our knowledge and experience to bring everything together as a performing musician must do – with no interference of technical issues with the "creative flow."

2.3.1 Emulating an image look

Emulating a particular visual style or look is a key part of the craft of fimmakers, cinematographers, photographers and visual effects practitioners involved in visual storytelling. Filmmakers and visual effects artists often use visual references to convey ideas and ensure consistency in the look of images across the project. Visual references may come from other photographs, films, paintings or visual media, or, from concept art specifically created for the project. In the context of this research, visual references help convey specific features with regards to the look of the image that the practitioner seeks to emulate. These intangible visual features in an image can be difficult to describe verbally and are only meaningful when conveyed in visual form (Adams 1983, p. 5).

The visual references serve as a guide only. Over the course of prodution, the creative vision for the look may evolve and deviate from the visual references based on the creative opportunities available given the captured photographs, or, be limited due to practical or technical constraints; Kovacs states that whilst the motivation is to create the final image as close as possible to the visual reference, "in the process, you may even improve upon it." (Kovacs in Schaefer and Salvato 2013, p. 186). Thus, whilst the visual reference may serve as the starting point, the end goal may change, or, be further refined, along the way. Improvisations may be made during production that may deviate from the prescribed or planned look for a particular shot if better alternatives can be found - Conrad Hall describes a "visual accident" (Hall in Glassman et al. 1992, 45:21- 46:48 min.) whilst filming "In Cold Blood" (Brooks

1967) where the shadow of the rain spray falling onto the actor created an illusion of tears running down the actor's face. This unplanned look was incoprorated in the final film and provoked curiosity amongst other cinematography practitioners as to how it had been achieved. On larger productions such as film, visual references serve a critical communication function for filmmakers to be able to convey the visual style or concept for the final images to other crew members, particularly the cinematographer, who is responsible for the look of the image. Cinematographer Laszlo Kovacs considers visual references such as paintings, photographs and other movies as being of major importance and a means for directors to communicate their desired look of the movie (Kovacs in Schaefer and Salvato 2013, p. 186). Lumet (1995, p. 91) describes how he used a Caravaggio painting to communicate the feeling he was after to his cinematographer. In the context of practice-led research, Mäkelä (2007) states that the work created as part of practice-led research also has to function as a conveyer and communicator of the thing not yet concieved or created. Visual references can help alleviate this burden from the work created by conveying and communicating key features of the intended outcome. Not having any visual reference and having to explain visual images verbally is a "cruel, impossible task" according to Kovacs (Kovacs in Schaefer and Salvato 2013, p. 186). In addition to serving as a visual guide for the images to be created, the visual references used in this research study also help clarify the context and rationale for creative decisions made during production. It should be noted that whilst visual references used in this reseach study provide a direction for the creative look, the look of the final image may evolve during the production process.

2.3.2 The value of the emulated look as a craft process and commodity

Creating a particular look is a matter of craft competency for practitioners involved in the prodction pipeline. All practitioners involved in the image production pipeline, from camera acquisition through to colour correction, visual effects, editing, postproduction and colour grading work to bring the director's creative vision for the look of the final image to life. This vision for the final look may change or evolve during the production process requiring changes to be made at whatever the current stage of the process may be at the time, or, later down the production piepline. Hence, the images need to have maximum possible dynamic range, available to be adapted to a different look and this dynamic range needs to be preserved down the production pipeline (Okun and Zwerman 2015, p. 626). Having the dynamic range to make image adjustments later down the pipeline also provides the opportunity to experiment with, and test, different image looks before finalising the image. The practitioner needs to know how far they can push the image, given its latitude, dynamic range and inherent lens and camera artifacts, before they take the photograph in order to match the final image to the desired look as closely as possible. Creating a particular look, therefore, is not simply a matter of applying software presets during postproduction but has to start with a planned approach that starts even before the photographic exposure is made and ends with the final published image. Practitioners also need to be aware of implications that their production decisions have down the image pipeline (Dodgson et al. 2010).

The parameters for different image looks have a commercial value with a number of different photographers selling software presets and look-up tables online. Look-up tables (LUTs) and presets for software programs such as Adobe Photoshop (Adobe 2014) and Photomatix (HDRSOFT.COM 2015) allow practitioners to create a range of distinctive image looks quickly and easily. Specialist software such as Alienware Exposure (2015a) emulate the look of specific film stocks and camera effects enabling photographers to apply these characteristic looks during postproduction. However, the original photographed images need to have the latitude (see Glossary) available to withstand the processing applied using these software presets.

2.4 Landscape Photography and the challenge of capturing the full dynamic range of the scene

Landscape Photography brings a unique set of challenges in terms of the moving elements in the scene and changing light as well as a high contrast difference between the darkest and the brightest values in the scene known as dynamic range (Bloch 2013, p. 16). The dynamic range of the real world outdoor scene on a sunny day can be far greater than what the photographic film or digital camera sensors are capable of capturing in a single photographic exposure. The latest digital full frame sensor cameras can capture just under 15 stops of light but the signal to noise ratio in the RAW files varies greatly across different tonal regions with the darker parts of the image having more noise.

2.5 Overview and critical analysis of different tools, methods, techniques and workflows used for HDR capture of the scene

2.5.1 Neutral density filters

In Landscape Photography, one of the most common method employed by photographers to maximise scene dynamic range capture is to reduce the scene dynamic range difference prior to exposure by placing graduated neutral density (ND) filters in front of the lens. Graduated ND filters come in various strengths and are darker at the top and clearer towards the bottom allowing the photographer to decrease the exposure of the sky and bring it closer to the exposure values of the landscape (Diprose and Robins 2012, p. 133). This technique works for scenes where there is a flat horizon (see Figure 2). However, in scenes where the scene objects protrude out across the horizon it can be problematic as it ends up either: a) darkening any elements that protrude beyond the horizon if the photographer covers entire region of the sky with the darker section of the graduated ND filter (see Figure 3), or, b) leaving part of the sky overexposed if the photographer chooses not to cover the protruding scene elements with the darker section of the filter (see Figure 4).

Figure 2: This image illustrates how neutral density graduated filters can be used to bring the exposure of the sky closer to the exposure of the land in order to capture details in both in a single photographic exposure

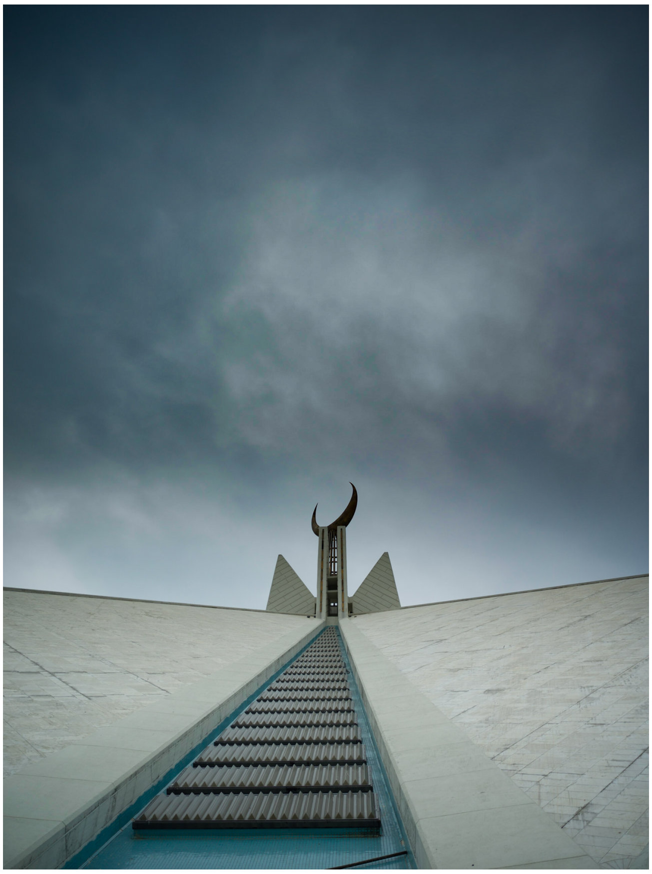


Figure 3: This image illustrates the problem with graduated neutral density filters where there is not a flat horizon and scene elements protrude out. The entire region of the sky has been covered by the darker section of the graduated ND filter resulting in the crescent structure to become underexposed.

Figure 4: This image illustrates the problem with graduated neutral density filters where there is not a flat horizon and scene elements protrude out. The entire region of the sky is not covered by the darker section of the graduated ND filter in order to avoid darkening the crescent structure at the top resulting in the lower part of the sky being brighter.

2.5.2 Stacked-based HDR photography

Another approach that has its origins in the work of Gustave Le Gray dating back to as early as 1850 is to extend the dynamic range of a photograph by combining two or more different photographic exposures, or, brackets (Gurieva 2014). Today, this is one of the most common methods of capturing the entire scene dynamic range and comprises of taking multiple exposure brackets, or low dynamic range (LDR) images, at different exposures to capture a higher dynamic range of scene values that would not be possible to capture in a single exposure (Banterle et al. 2011, p. 15). Most high-end digital DSLR and mirrorless cameras today allow for auto-bracketing where the photographer can specify the base exposure, number of exposure brackets to capture either side of the base exposure, and, the bracketing interval between exposures. The photographer can then photograph these exposure brackets in sequence without the need for changing the exposure manually after photographing each exposure bracket. Some cameras also allow photographers to specify the order for photographing the exposure brackets such as base exposure first, base exposure + 1 second, base exposure - 1 third, and so on. Whilst this functionality offers a fair degree of automation, a key problem is that it cannot be tailered for every scene and condition. A photographer may, for example, only need the base exposure, two exposure brackets lower than the base exposure with a single stop interval, and, one exposure bracket three stops higher than the base exposure but this level of control is not yet available in cameras today. Whilst the shutter speeds can be changed manually on the camera, this results in longer time delay between exposure brackets. The photogorapher thus becomes subservient to the tool and has to work with its limations. This demonstraters that the autobracketing process can involve considerable craftsmenship if only greater customisation was introduced. Changing the shutter speeds manually can also cause misalinghtments as the photographer may need to physically touch the camera on the tripod in order to change the shutter speed inadvertently causing the camera to move slightly. Most cameras, however, allow remote functionality via cable or wireless interfaces that resolve this problem.

2.5.3 Direct HDR capture

Some of the advanced cameras now offer a direct HDR functionality where all the exposure brackets can be automatically merged in-camera to create an HDR file (Banterle et al. 2011, p. 14). The problem with this approach is the lack of manual intervention and control when correcting for image blending artifacts such as ghosting. The considerable processing time cameras take to combine the exposures into a single HDR file during which more photographs cannot be captured means that photographic opportunities may be missed during this period.

2.5.4 Panoramic HDR capture

These solutions serve a specific purpose of capturing images that can be used for image-based ligthing (Banterle et al. 2011, p. 31) and photogrammatry in specialist areas such as in visual effects, forensics and environment surveys (SpheronVR 2013b). The SpheronVR SceneCam 2.0, for example, can capture upto 26 stops of dynamic range as 360 x 180 degree images (SpheronVR 2013a). These specialist tools are considerably more expensive. They may require other hardware components to be connected to the camera and thus can be restrictive for photographers to carry to the scene location given the extra weight. Additionally, the setup time for the shoot also increases that may risk missing out on key photographic opportunities. They may also not offer the level customisation required for aesthetic purposes in terms of lenses and functionality.

2.5.5 Dodging and burning

Dodging and burning techniques were used in film photography to make local area adjustments to the print. Dodging involved holding back the light coming from the enlarger and falling on the photosensitive paper to lighten certain areas of the print whilst with burning more exposure could be given to brighten areas. Digital counterpart for these processes exist today in the form of tools inside most popular image editing softwares (Adobe 2020). Bloch (2013, p. 328 - 335) demonstrates how these tools and processes can be used to make local adjustments and can work well when the intention is to create a naturalistic look. Given that this technique provides complete control in terms of manual selection and manipulation of local areas in the image, the practitioner can have considerable control over the final look of the image. However, manually making small local adjustments can require considerable work, time and effort. Maipulating fine details such as grass, foliage, crest of ripples and waves etc. is very difficult if not impossible using this approach.

2.5.6 Luminosity masks

Luminosity masking is a technique (McIntyre 2018) where specific areas of individual exposures can be masked and manipulated based on their luminosity values in order to create an image that contains good tonal latitude across all the regions. This allows the practitioner to reveal only the required sections of each exposure bracket. There is better control for fine edge detail (Bloch 2013, p. 336 - 338), however, the amount of manual intervention required may still involve considerable time and effort.

2.5.7 Tonemapping via software algorithms

Tonemapping is the process of compressing the values contained in an HDR file (mostly 32 bit) in order to fit them in an LDR file that may be usually be 16 or 8 bit (Bloch 2013, p. 237). Automatic tonemapping operations are available in a number of image editing softwares that may it relatively easier for practitioners to reveal details in the final LDR image saving them from the more laborious aforementioned techniques. The final outcome of these operations and the amount of user control over different parameters may vary considerably from one software package to the other. The latter can be somewhat limiting as the parameter adjustments are applied to the entire image and the practitioner does not have much control over selecting specific regions using masks.

Tonemapping can produce a number of image artifacts such as halos around areas of high contrast, tone reversal making the landscape appear brighter than the sky and vice versa, exaggerated noise, oversaturation of pixels, and, webbing where continous gradient of the background object tone appears to be fragmented into individual sections where it shows through small gaps in the foreground objects (Bloch 2013, p. 272-274).

2.6 The painter's technique

Prior to HDR photography, painters, given the limited relfectance gamut of paints, made use of their Human Visual System (HVS) in order to create high dynamic range scene appearances on low dynamic range reflective media (McCann 2016). McCann (2016) states that the painters did not attempt to reproduce scene radiances but that "the painter's ground truth is the appearance of the image". The painters, thus, used their own creative judgement and artistic licence to reproduce scenes based on how these scenes appeared to them. Hockney & Falco (2005) have demonstrated how painters were also made use of lenses or concave mirrors in their creative practice as early as c1425. Hockney & Falco (2005) also note that optical projections allowed artists to make measurements and note key points on the subject and serve as a visual aid in the form of a static projected image with highlights and reflections that were not viewpoint dependent. The composition, colours, textures and tonal range, however, were dictated by the artist. Thus, these paintings were hence a mix of real world references that were "lens-based" and "eyeballed" (Hockney and Falco 2005). Although the technology was used as an aid to get the desired result, the artist still had the control over what scene elements they wanted to present and what state they wanted to present them in. The resulting scene renditions were thus closer to the real world whilst still rendering the artistic intent. Contemporary visual effects workflows face a similar situation where whilst striving to create images that match the real world phenomenon more closely, the workflows still need to allow a level of flexibility for the artists to take more creative control even if it means deviating from the physically correct real world phenomenon models. Creating and recording real world phenomenon that is physically correct may be a good starting point but some level of artistic control is required at times that the tools and workflow need to be able to provide (Seymour 2011)

Renowned landscape photographer Ansel Adams also used his mastery of technical photography to render his aesthetic intent which is a similar approach to what can be seen in some examples of contemporary HDR photography where mulitple exposures are combined with specific LUTs to create the desired image look (McCann 2016). This approach, based on the practitioner's HVS, combined with image manipulations based on the practitioner's creative intent, is referred to as the "Painter's Technique" by McCann (2016). This Painter's Technique has been the approach used in the production of images in this research study given that the practitioner intent is not to accurately reproduce scene radiances but to create images that have shared characteristics with landscape oil paintings, and, explore best practice for emulating some of the key features that are characteristic of landscape oil paintings.

2.7 Similarities between classical 19th century landscape paintings, Pre-Raphaelite paintings, and, HDR photography

Torcellini (2010) describes the main shared features between paintings created by the Pre-Raphaelite Brotherhood and HDR photography as being coloured shadows, colour in the shadows, low global contrast, high local contrast, high colour saturation, and, well represented reflections of light and colour. These chracteristics can also be found in the works of nineteenth century British painters, John Constable and William Turner whose paintings were used as visual references in the earlier part of this research. Turner's rendering of the scene in "The Fighting Temeraire" (see Figure 5) shows good textural and tonal detail in the shadows as well as the highlights. Although the sun is rendered as a bright circle, a wisp of cloud can till be seen across it. Similarly, the darkest surfaces of the tugboat retain a sense of tonal gradation and shading instead of being rendered as an even, flat, black surface. In addition, all scene elements, from the foreground to the background appear in focus despite the tonal recession seen in the background scene elements. The motion in the moving elements in the scene such as the smoke from the tugboat chimney, the clouds, the ripples in the water, the wake of the vessels and the birds in the sky depict a sense of naturalistic motion blur, or, motion as it is observed by the naked eye. The colours are saturated and there is an accurate sense of reflection in the water, both in form, and, colour.

Image removed due to copyright restrictions

Figure 5: "The Fighting Temeraire" by Joseph Mallord William Turner (1839) courtesy of the National Gallery, London. [Copyrighted image for examination purposes only]

Similarly, in Constable's paintings, there is a sense of a wide dynamic range in the scene and the motion is rendered in a naturalistic manner. The fine textural details of scene elements, however, are much more elaborate in Constable's paintings as compared to some of Turner's work. In "The Cornfield" (see Figure 6), for example, the leaves in the trees are rendered in great textural detail, contrast and clarity that makes some of the individual leaves discernible. This sense of clarity and local contrast in the texture of scene elements is one of the key attributes that this research study looks to emulate.

Image removed due to copyright restrictions

Figure 6: "The Cornfield" by John Constable (1826) courtesy of the National Gallery, London. [Copyrighted image for examination purposes only]

2.8 A historic overview of the development of Landscape Photography as a genre and the tensions that exist today

Landscape Photography has its roots in landscape painting and the concept of Straight Photography. Ward (2012) states that the "majority of Landscape Photography is concerned with the wider view, partly as a result of a dominant aesthetic in western art passed on from the Dutch school through to Ansel Adams".

Landscape was classified as a genre of art by the French academy in the seventeenth-century and saw extremely stylised landscape backgrounds appearing in the works of painters Claude Lorraine and Nicholas Poussin whilst the Dutch painters, such as Jacob van Ruysdael, created more naturalistic renditions of day-to-day scenes where the landscape was not merely a backdrop but the subject of the painting (Tate 2019b).

2.8.1 The rise of Straight Photography

Landscape was one of the earliest genres to be photographed possibly due to the fact that early photography processes, the daguerreotype and the calotype, necessitated long exposures under bright light (Diprose and Robins 2012, p. 292). The daguerreotype photographs were too fragile, making retouching difficult whilst the calotype "camera image" was not frequently altered significantly, although opaque pigments were sometimes used to reinforce the negative densities (Newhall 2009, p. 167). Newhall (p. 167) states that at the start of the twentieth century, critics started praising "photographs that looked like photographs", and, "pure photography" in opposition to the prevalent Pictorialist approach that rejected point-and-shoot photography for more labour intensive methods that emphasized the role of the photographer as a craftsman (Hostetler 2004b). Emerson (1890, p. 22-23) advocated naturalistic photography where the scene is rendered as it appears to the eye and is interpreted by the photographer without the addition of any elements not in the scene. Emerson (1890, p. 24-25) goes on to make the distinction between naturalism and realism by suggesting that the naturalistic painter is only concerned with scene elements as they appear from the practitioner's point of view but the realist painter would bring the elements closer to render more details and focus on a matter-of-fact rendering of the scene rather than his or her own interpretation. Hartmann (1904), in his "Plea for Straight Photography" voiced similar opinions when vehemently advocated for Straight Photography that was free from excessive manipulation adopted by Pictorialist photographers and the film negative only required minor adjustments. Hartmann's idea of Straight Photography was for the photographer to study and analyse the scene, and, expose the photograph perfectly in terms of exposure and composition when "the scene or object of your pictured vision reveals itself in its supremest moment of beauty" - (Hartmann 1904). Hartmann thus not only infused the idea of craftsmanship and rigour into the act of photography but also sowed the seed for capturing the Decisive Moment when the scene elements were at their ripest to be harvested by the camera. Hartmann concludes with stating that he wants the photographer to be "be *more artistic*, but only in legitimate ways." - (Hartmann 1904). The implication thus created is that any photographer's practice that does not comply to the notion of Straight Photography is illegitimate.

2.8.2 Group F.64 and the work of Ansel Adams

The idea of Straight Photography was embraced by Group F.64 photographers who were concerned with presenting the camera's vision as clearly as possible, and free from, what they considered, personal prejudices. F.64 denotes the smallest aperture on the large format camera lens (Hostetler 2004a), allowing for greater depth-of-field across the scene and rendering all elements within the depth-of-field in acceptably sharp focus. The Group F.64 manifesto defined pure photography as "possessing no qualities of technique, composition or idea, derivative of any other art form." (Alinder 2014, p. 87-88). Group F.64 thus changed the photographer's role from printmaker to photographer (Hostetler 2004a).

Ansel Adams, a founding member of Group F.64 came to be one of the most recognised and influential of landscape photographers. Adams photographs share two main characteristics with the paintings produced by Constable and Turner. First, all scene elements, from the foreground to the background, are in focus; Group F.64 photographers sought to create images where the camera was seen as offering a clearer view of the world than could be observed from the naked eye (Hostetler 2004a). Second, these photographs retain good tonal detail in the shadows as well as the highlights. In comparison to some of the paintings by Turner (see Figure 5) and Constable (see Figure 6), the dynamic range in Adams photographs (see Figure 7) is still low given the lack of texture and shading details in the brightest and darkest regions of the image. Creating a high contrast look may have been Adam's stylistic choice, nonetheless, the dynamic range in the final image was limited by the dynamic range of black and white film used by Adams to just over 10 stops, and, how far this dynamic range could be pushed during film development and printing.

Image removed due to copyright restrictions

Figure 7: "Yosemite Valley Winter" by Ansel Adams (1938) [Copyrighted image for examination purposes only]

The painters, using their HVS, were able to see and paint a lot more detail in their paintings. Another characteristic that is different between the paintings produced by Constable and Turner, and, some of the photographs produced by Adams is the representation of motion within the scene. Whilst Constable and Turner depicted moving scene elements in a frozen state and captured “the instant”, the camera with its ability to vary the shutter speed during exposure made it possible for Adams to render motion in the scene in a number of different variations of motion blur (see Figure 8 and Figure 9), from the movement being completely frozen to completed blurred.

Image removed due to copyright restrictions

Figure 8: "Nevada Fall" by Ansel Adams (1947) [Copyrighted image for examination purposes only]

Image removed due to copyright restrictions

Figure 9: "Early Morning, Merced River, Autumn" by Ansel Adams (1950) [Copyrighted image for examination purposes only]

2.9 Optical truth, representation, craft and the challenges to status quo brought about by new technologies

Faster shutter speeds result in frozen movement where the moving elements in the scene are captured as if they are perfectly still whilst slower shutter speeds result in moving elements appearing blurred as the position of the elements change over the course of the exposure being made. Scharf (1962) states that this characteristic of the camera to render movement in a way that revealed or blurred details in the image compared to what the naked eye could see was considered a distortion of the optical truth and deemed unacceptable within the definitaion of naturalism. Even the photographs of locomotion produced by Muybridge (2000) were considered false and deceptive as his cameras showed much more detail and rendered motion too differently from what could be observed by the naked eye (Scharf 1962). Scharf (1962) states that: “Artists had become devoted to what they believed was optical reality and to the 'truthful' representation of nature, though most often imitated not nature, but the way in which the camera imitated nature.”. This criticism of the photographic look is intrinsically connected to the process of how the photograph is created.

A similar attitude is prevalent today when it comes to the dominant look in the genre of Landscape Photography where, the idea of Straight Photography, and, the notion of the camera providing a clearer view of the natural world, appears to have been forgone in favour of the look of early Straight Photography images of the naturalistic inclination as far as the tonal range of the image is concerned. Photographs depicting a tonal range wider than what a camera can capture in a single exposure, or what the eye can see at a given time, is seen as a subversion and deemed unacceptable by a number of veteran landscape photographers. Torcellini (2010) points out that the idea of HDR photography as an art form has again sparked the debate of the latest innovation in photography being challenged as an art form and being subjected to criticism. HDR photography, or tonemapped photographs, are categorised as, or with, image manipulation techniques and viewed as an automated process devoid of craft, rigour and creative control;

Ranger (Cole and Ranger 2018) undermines HDR photography by suggesting that it is “somewhat easy to apply mechanical thinking to camera settings to work around the light, Bracketing/HDR, filters and whatever other tricks you can apply to capture a dynamic range of light in excess of the sensor's native capability” and uses this as the basis for opting for monochromatic photographs that he sees as the “only way to go” for the photographs that he produced for a project under harsh natural lighting. Firstly, when it comes to HDR acquisition and processing, Ranger (Cole and Ranger 2018) does not factor in the low and changing lighting conditions, and movement within the scene that can make multi-shot HDR photography and exposure bracketing extremely challenging, and, require extensive planning, critical examination and creative execution to previsualise and produce the desired look. Secondly, he implies that HDR photography is inferior to the more established monochromatic look by characterising the latter as creatively challenging and portraying the former to a mere mechanical process devoid of creativity and craft skill. It can be argued that the monochromatic look of the image deemed acceptable by most Landscape Photography award standards, professional photography bodies and practiced by the great Ansel Adams himself, is a greater deviation from the real world scene than HDR photography in that it strips the image of colour in the scene as well as capturing a lower dynamic range whilst the HDR photography does not change the hues in the scene, may retain correct level of colour saturation depending upon the processing parameters, and, renders a higher dynamic range of the scene.

Cartier-Bresson acknowledges the limitation of black and white photography and treats it as an opportunity for creative decision-making:

> "Black-and-white photography is a deformation, that is to say, an abstraction. In it, all the values are transposed; and that this leaves the possibility of choice." (Cartier-Bresson and Sand 1999, p. 38).

By the same token, HDR photography offers greater creative possibilities by offering a wider dynamic range to manipulate tone and colour values in the scene.

Livesey (Livesey and Griffith 2016) referring to his earlier images, greatly discredits HDR photography by grouping it with "the garish and dishonest extremes of post-processing" and sky replacement that are deemed quite unacceptable in the Landscape Photography genre and Landscape Photography award guidelines. Livesey describes feeling these earlier works of his were "the result of subterfuge" and how since then he has "tried to be more honest" with himself and give the landscapes the respect that they deserved by not indulging in these practices (Livesey and Griffith 2016). What Livesey fails to understand is that HDR photography sequence is spatially and temporally connected whilst sky replacements are usually not. The reason one replaces the sky in a landscape is because they are not happy with the look of the sky in that picture at the time it was taken. The sky in the picture is replaced with a different sky photographed at a different time and/or location whereas the HDR exposures are photographed in a sequence and at the same location without moving the camera. The assertion Livesey makes in grouping of HDR photography with the more extreme forms of image manipulation, is that HDR photography is a dishonest representation of the scene and photographers using HDR techniques are deceiving the viewers. Hunter (2017) states that he is not keen on "HDR, supersaturated images, or extreme effects" in his own practice and uses the HDR tonemapping software Silver Efex Pro on some of his images "with restraint" but would remove a lens glare [in postproduction], if possible. Hunter accepts that the camera cannot render reality faithfully and that a photograph is only an interpretation of the scene. Waite (Harris and Waite 2017) has a similar opinion in that good Landscape Photography requires the photographer to be “a responder and an interpreter” and whilst Waite considers Photoshop (Adobe 2014) to be the “electronic darkroom”, he discourages excessive image manipulation that he feels could make the viewer suspicious resulting in the viewer’s connection with the image being broken. When it comes to HDR photography, Waite draws the line at increasing shadow levels any more than what the eye can see. According to Waite’s criteria, the photographer’s response and interpretation of the landscape should limited to what the eye can see and no more (Harris and Waite 2017). This is where the main issue with the acceptability of HDR photography lies. Ansel Adams worked to match the limited dynamic range of film to what the human eye could see and in doing so, Adams was expanding the photography tonal range, not limiting it. HDR photography, by capturing a dynamic range much greater than can be seen by the human eye and rendering a tonemapped image that compresses these tones allows more of the scene details and textures in the scene to be viewed all at the same time. But photographers such as Waite still cling on to the notion of matching the tonal range to what the human eye can see but in doing so, greatly limit the creative possibilities and go against the spirit of the Group F.64 manifesto that emphasised on the camera’s ability to show a clearer view of the world. There is also the contradiction when on one hand, Waite expects the photographer to be a responder and an interpreter but on the other hand, greatly restricts the practitioner’s interpretation of the scene if that interpretation requires the use of a wider dynamic range that helps details not discernible by the human eye, as is the case in this practice. Waite also advises against too much manipulation of the image that makes the image look unfamiliar and states that such tactics create distrust in the viewer and makes them turn away from the image (in Studio 2016). However, revealing more detail than can be seen by the naked eye can also have the opposite effect of engaging the viewer by creating a sense of intrigue as is evident from the Zia’s exhibition feedback (see Appendix C).

It is evident from a review of the award winning and highly commended images from two of the most prestigious Landscape Photography competitions, the Take-A-View Landscape Photographer of the Year (Take a view - Landscape Photographer of the Year n.d.), and, the Outdoor Photographer of the Year (Outdoor Photographer of the Year 2018), that these competitions favour the Straight Photography look (see

Figure 10) where the dynamic range is no more than what the eye can see over more extreme HDR interpretations of the scene.

Image removed due to copyright restrictions

Figure 10: "Bat's Head, Dorset, England" - Andy Farrer –Winner, Landscape Photographer of the Year 2015 [Copyrighted image for examination purposes only]

The craft of photography in these competitions focusses on "getting it right in camera" and only minor image adjustments are allowed in all but the "Your view" category of the Take A View Landscape Photographer of the Year competition. The Take A View Landscape Photographer of the Year competition rules specifically prescribe the limits to which photographs being entered for the competition can be manipulated as follows:

> "The integrity of the subject must be maintained and the making of physical changes to the landscape is not permitted. You may not, for example, remove fences, move trees or strip in the sky from another image. Digital adjustments including dodging & burning, changes to tone & contrast and cropping are allowed, as are High Dynamic Range imaging techniques, stitched panoramas and focus stacking. We will require the RAW file(s) or original camera jpeg(s) for any shortlisted image in these three categories and TAV reserves the right to disqualify any image that they feel lacks authenticity due to over-manipulation."
> - (Take a view - Landscape Photographer of the Year n.d.)

Similarly, another prestigious photography competition, the Outdoor Photographer of the Year, prescribes the limits of image manipulation as:

> "Image manipulation is allowed but is limited to the following types of adjustments: black and white points, highlights/shadows, dynamic range, contrast/clarity, saturation/vibrance, curves, dodging and burning, vignetting, distortion correction, white balance, cropping, dust spotting, minor element removal (adding elements to a scene is not permitted), sharpening and noise reduction. Stitched images are permitted if the source images are taken at the same location within a short time of each other. Images that are composited from different scenes or different times of day or year are not permitted. The judges will be looking for a sophisticated and gentle approach to image editing, so avoid overdoing any particular image adjustment unless it clearly adds to the interpretation of the photograph." - (Outdoor Photographer of the Year 2018)

2.10 Contemporary HDR photographers creating a similar look

Photographers such as Trey Ratcliff, who use extreme tonemapping and post processing considered to be the acceptable bounds for the image look (see Figure 11, Figure 12, Figure 13 and Figure 14) are seen as damaging the integrity of photography (Ratcliff in ZeitgeistMinds 2012).

Image removed due to copyright restrictions

Figure 11: "The River That Ran Through Lyon at Midnight" by Trey Ratcliff (2007) photographed using Nikon D2Xs [Copyrighted image for examination purposes only]

Image removed due to copyright restrictions

Figure 12: "The Grassy Roof in the Central Icelandic Farms" by Trey Ratcliff (2007) photographed using Nikon D2Xs [Copyrighted image for examination purposes only]

Image removed due to copyright restrictions

Figure 13: "The Private Pool at Hearst" by Trey Ratcliff (2010) photographed using Nikon D3X, AF-S Zoom-Nikkor 14-24mm f/2.8G ED at 14.0 mm [Copyrighted image for examination purposes only]

Image removed due to copyright restrictions

Figure 14: "The Blackbird in the Hanger" by Trey Ratcliff (2010) photographed using Nikon D3S and AF-S Zoom-Nikkor 14-24mm f/2.8G ED [Copyrighted image for examination purposes only]

Peck (2017), hailing Adamus' work as "fearless" and drawing visual parallels between Adamus' work (see Figure 15 and Figure 16) and that, of painter John Martin's (see Figure 17), describes how photographers who dare to go against the dominant look and create images that are based on their own creative interpretation of the scene rendering a higher dynamic range than can be captured in a single exposure, or, using excessive image manipulation, can suffer from critical backlash.

Image removed due to copyright restrictions

Figure 15: Fearless (2016) Grand Canyon, Arizona by Marc Adamus [Copyrighted image for examination purposes only]

Image removed due to copyright restrictions

Figure 16: Minus Fifty (2011) Ogilvie Mountains, Yukon, Canada by Marc Adamus [Copyrighted image for examination purposes only]

Image removed due to copyright restrictions

Figure 17: John Martin: The Great Day Of His Wrath, 1851-3, Tate [Copyrighted image for examination purposes only]

Adamus in his artist statement (Adamus n.d.) embraces the new generation of photography as being limitless and enabling the photographer to fuse their vision with the landscape rather than merely documenting the scene. Adamus acknowledges the use of multiple exposures but at the same time, emphasises the importance of photography craftsmanship that helps overcome the limitations of the camera. Adamus states that:

> "The abilities that define great photographers are first and foremost how to seize the moment and make it theirs, reacting quickly and precisely to often rapidly changing situations. No amount of processing in today's digital darkroom can ever fix a bad composition, an out of focus image, create great light or change a mid-day sky into a sunset."
> - (Adamus n.d.)

There are strong similarities in both the process and look of the work created as part of this research study and that of Adamus' where the emphasis is on the craft of photography capture and both look to create a view that transcends the literal rendering of the scene.

Another photographer who takes a similar photography approach (Ae 2017) is Daniel Cheong (Cheong 2019) who aims to show his idealised version of reality whilst still being reserved to a more naturalistic look (see Figure 18).

Image removed due to
copyright restrictions

Figure 18: Cryogenic Sunrise by Daniel Cheong [Copyrighted image for examination purposes only]

In terms of the visual appearance, Johnson (2012, p. 181) is one of the few who appreciates the "powerful and movingly surreal bodies of work" that can be produced using HDR and mentions the work of Dan Burkholder as an example.

Some photographers, such as Fisher, who has written an entire book titled "The Anti-HDR HDR Photography Book – A Guide to Photorealistic HDR and Image Blending" (Fisher 2016), attempt to align the look of HDR photography to a similar more naturalistic look as endorsed by Waite. This prescribed look for HDR may be a knee jerk reaction to the early HDR photographs that experimented with pushing the boundaries of the image to extremes resulting in the grungy look, or, an effort to preserve the sanctity of the craft of Landscape Photography and the long-established notion of Straight Photography from becoming what has wrongfully been perceived as a simple mechanical process, or, automation. In case of the former, all this new notion for the prescribed look for HDR Landscape Photography has done is substituted from one extreme look of the 'grungy' inclination to another that leans more towards what could be captured in a single photographic exposure without leaving any room to explore the true potential of HDR photography. In case of the latter, the HDR photography process has been seriously undermined as the craft of photographing a range of exposures that captures the entire scene dynamic range and ensuring there are no ghosting, misalignment or processing artifacts can be arguably much more challenging than photographing a single exposure.

2.11 The craft in HDR Landscape Photography and the Decisive Moment

It can be argued that with the single exposure the craft of photography lies in the ability to capture and map the entire scene dynamic range as best as possible to the dynamic range of the camera sensor. But this still holds true for each of the HDR exposures; each exposures captures a different section of the scene dynamic range, and thus, the craft and rigour in photographing the HDR exposure stack lies in ensuring that each exposure captures the respective values at the best possible latitude, minimising the inherent artifacts related to multi-shot photography, HDR processing and tonemapping, and, ensuring that the individual exposures create a seamless image when joined together. The execution of the photography capture has to be quick and precise so as to capture what Cartier-Bresson termed as the Decisive Moment in photography:

> "Of all the means of expression, photography is the only one that fixes forever the precise and transitory instant. We photographers deal in things that are continually vanishing, and when they have vanished, there is no contrivance on earth that can make them come back again." (Cartier-Bresson and Sand 1999, p. 27)

2.11.1 The Decisive Moment in Landscape Photography

In Landscape Photography, the Decisive Moment is not just restricted to an instant but can extend to a number of hours. The longer exposures times do not mean that this period of exposure time is not decisive; Michael Kenna refers to "decisive 12 hours" given the long exposure times it takes him to create some of his photographs (in Green 2018). There are natural cycles that unfold in the landscape from the changing of one seasons (yearly cycle), the changing of day to night and night to day (the 24-hour cycle), appearance of the Halley's comet (75 year cycle) and so on. On top of these cycles, there are the rhythmic patterns of the weather systems, sea tides, colour changes of the leaves and vegetation etc. as well as the much shorter cycles of the breaking ocean waves, gusts of wind, rain and sunlight. The Decisive Moment in the landscape is these cycles and patterns combined with 'one off' instance that is unlikely to occur again in the relatively short period of time such as, for example, a beam of light breaking through the clouds and illuminating a particular feature in the landscape that lasts only a fraction of a second and offers the photographer a very small period of time in which to capture this moment. Longer exposures are required if there is not enough light in the scene or if the creative intent of the photographer is to capture a sense of blurred motion in the moving elements of the scene. Waite (2016), in the context of Landscape Photography considers light as being the decisive or most important element. On a partly cloudy day, the natural light can change very quickly whereas on a sunny day with no clouds, or on an overcast day, the light may remain constant over longer periods of time. The period of time over which the exposure is made has a profound effect on the visual outcome given that shorter exposures made in a fraction of a second using a fast shutter speed render moving elements in the scene appear as if frozen whilst longer exposures made using slow shutter speeds render moving scene elements as a blur. Painters can take time to paint the scene over a relatively longer period and yet make moving elements in the scene appear as if it were instantaneously captured with no sign of motion blur as is the case with Constable's cloud studies that indicate the studies took an hour to paint (Tate 2019a) . The photographer does not have this luxury of time as the look or absence of motion blur in the moving scene elements is linked to the length of the photographic exposure and how fast the scene elements are moving. A photographer cannot make a single, hour-long exposure of the sea, for example, and render the movement of the water as it appears to the naked eye or how it would appear in an exposure made in a fraction of a second. Under low natural light, the photographer may be forced to use a long exposure so as not to compromise the depth-of-field, and, a low ISO setting in order to keep the ISO noise low. Doing so, renders the moving elements of the scene as a blur in the photograph (see Figure 19).

Figure 19: "Sea, Sky and Shore" by Rehan Zia – Long exposure photograph rendering a misty look to the sea waves in motion

2.11.2 Making necessary decisions and improvising with the changing scene

The act of photography requires the photographer to make a number of necessary decisions (Benovsky 2011). These necessary decisions include, but are not limited to, the framing and cropping of the shot, exposure brightness, focus, exposure time, lens focal length and so on. The amount of light that goes through the lens and is recorded by the camera sensor is known as the exposure value. Increasing the the exposure value by one unit, doubles the amount of light being recorded by the camera whilst reducing the exposure value by one unit decreases the amount of light recorded by half. One of the key decisions that landscape photographers have to make relate to capturing the wide range of brightness values that may exist in the outdoor scene onto film or digital camera RAW files that have a much smaller bandwidth. This range of values or the contrast difference between the darkest and the brightest values is known as dynamic range and is measured in exposure values (Bloch 2013, p. 16). The landscape photographer has to adapt and improvise to the changing conditions of the scene that are beyond their control. This requires of craft practice and tool profeciency, experiential knowledge, the right tools and the ability to adapt quickly to the changing situation.

2.12 The Zone System and other workflows adopted by photographers to maximise dynamic range capture

2.12.1 Ansel Adam's Zone System

Ansel Adams and Fred Archer developed The Zone System as a tool for previsualising and mapping the scene dynamic range to film and subsequently to the print by categorising the scene exposure values on a one stop exposure increment across eleven zones ranging from completely black (Zone 0) to completely white (Zone X) with Zone V being the average middle gray/18% reflectance value (Adams and Baker 1981) by. As one moves from either end of the Zone towards the middle Zone V, first the shading detail starts to appear followed by the texture detail. The darker areas are known as shadows whilst the brighter areas are called highlights. The values in the middle are known as midtones.

Image removed due to copyright restrictions

Figure 20: Dynamic and textural ranges – Ansel Adams, The Negative, Little Brown and Company (1995)

Image removed due to copyright restrictions

Figure 21 Description of zones – Ansel Adams, The Negative, Little Brown and Company (1995)

Adams and Archer thus created a structured approach and workflow to understanding and visualising luminance values of different objects in the scene as they would appear in the final image print. Prior to this, photography students either had to study sensitometry or use a trial and error approach (Johnson 2012, p. xiii). One of the rules when it came to film photography and the Zone System was to expose for the shadow values in the scene and develop for the highlights given that exposure dictates the amount of detail in the shadows whilst the development time for film dictates the details in the highlights (Johnson 2012, p. 15).

2.12.2 The Modified Zone System by Koren

The Modified Zone System by Koren (Fisher 2012) made use of a spot light meter and rather than placing the shadow area on a particular zone, the photographer would place the most important scene element on the specific zone they wanted that element to be at knowing where all the other scene values would fall relative to this value (Fisher 2012, p. 12). Koren, thus, besides shifting the emphasis from shadow values to the luminance value of the most important element in the scene also added the notion of prioritising a specific scene element over others which is similar to the approach taken in this research study (see chapter 4).

2.12.3 Digital sensors and the RAW file structure

Digital sensors respond differently to light than film in that they have a linear response (Fisher 2012, p. 53). The dynamic range of camera sensors varies considerably depending on different camera types and models. Contemporary digital single lens reflex camera and mirrorless full frame sensors can typically record around 13 EVs in camera RAW file format. However, the bit distribution in a camera RAW file is biased towards the highlights with the brightest EV being allocated half of the total bits available in the camera RAW file, the second brightest exposure being allocated the remaining half of the bits and so on (Fraser 2004). This means increase in the shadow or midtone values during postproduction can result in noise and banding artifacts due to the reduced number of bits allocated to these areas. It also means that whilst camera manufacturers may advertise a camera being able to record 13 EVs, the photographer, may find that only 4 or 5 EVs towards the highlight end are usable for their purposes depending on the amount of latitude required in postproduction and acceptable noise in the final image. The last EV may store as little as 4 levels of information compared to the brightest EV which may store up to 8192 levels of information in a 14 bit RAW file that has 16384 levels of information altogether across a 12 stop brightness range (Fisher 2012, p. 58). Johnson (2012, p. 169) notes that not only are underexposed images dark and lack shadow detail but they also contain noise in the shadow regions which can be an aesthetic issue.

2.12.4 Exposing to the right (ETTR)

In order to maximise latitude in the image, some photographers have adapted to using a technique known as exposing to the right (ETTR) where they expose their photographs such that the majority of pixel values recorded lie close to the right edge of the image histogram whilst ensuring that values do not go over the right edge of the histogram. Values that fall over the right edge of the histogram are clipped as the pixels become completely saturated and are unable to record any scene detail. Digital sensors reach this saturation point decisively (Okun & Zwerman 2015, p. 235) and any details beyond this point cannot be recovered in postproduction. Fisher (2016, p. 69) argues that ETTR is only beneficial where the dynamic range drops by less than 1 stop for an ISO level increment and recommends testing the camera in order to ascertain how high the ISO can be increased whilst still adding value in terms of ETTR (2012, p. 56).

2.12.5 A critical analysis of select digital HDR photographer workflows

Fisher (2012, p. 58) regards ETTR as the holdover from the film Zone System in that it allows the flexibility to increase exposure and contract development whilst reducing noise artifacts. Both Johnson(2012) and Fisher (2012) have attempted to translate the Zone System developed by Adams and Archer (Adams and Baker 1981) for film into one that works for digital photography.

Johnson (2012, p. 158-167) makes use of ETTR in his Zone System for digital photography and suggests taking a spot meter reading off the textured highlights in the scene which should lie in Zone VII. Given that the reading returned for these highlights is actually for mid-gray or Zone V, Johnson increases the value by two EVs placing it in Zone VII. Johnson's (2012) workflow does not involve advanced postproduction techniques to provide for better control during postproduction and is limited to the Camera RAW adjustments, layer adjustments, and, dodge and burn tools in Adobe Photoshop.

Fisher's version of the Digital Zone System (2012, p. 77) is essentially a workflow utilising ETTR and luminosity masks to separate different regions in the image based on tonality and manipulating them individually. A luminosity mask creates a mask for image pixels that lie within a certain brightness range. Jimmy McIntyre (2018) also uses the same approach in his postproduction workflow.

McIntyre (2018) has also created a toolset called "Raya Pro" that automatically creates luminosity masks for image inside Adobe Photoshop.

Johnson (2012, p. 177) states that there is no simple solution available for capturing a moving subject where the contrast is over 10 stops that it can be frustrating for photographers looking to do "very, high-contrast photography of candid, moving subjects" using the digital medium (Johnson 2012, p. 177).

Fisher dismisses the case against HDR not being able to produce realistic results, or, HDR not requiring a zone system as it relies on what he calls "spray 'n' pray," where photographers use high burst rate in the hope of getting a usable image or set of images (Fisher 2012, p. 109). Fisher's HDR processing and postproduction workflow is primarily based on Adobe Lightroom and Adobe Photoshop (Fisher 2012, p. 63-93) although he does also demonstrate how to blend exposures using Photomatix and SNS-HDR (Fisher 2016, p. 105-133). Fisher uses Smart Objects in Adobe Photoshop (Fisher 2012, p. 69) in order to have a non-destructive workflow where the original image values remain intact from the operations applied to the layer (Adobe 2017).

Fisher (2016, p. 65) highlights the importance of enabling mirror lockup when using DSLR cameras to photograph exposures between ¼ second to 2 seconds as the mirror slap inside DSLR cameras can cause vibrations that result in discernable image softness at, and in between these shutter speeds.

Fisher (Fisher 2016, p. 65) started with using a 1/3 stop increment when capturing the HDR exposure brackets but after testing he found that 1 stop interval works well. He suggests that a 2 stop interval also works well but produces different results and having more than a 2 stop interval did not provide enough information for a good final result (Fisher 2016, p. 65).

Fisher (2016, p. 67) suggests that when using a HDR software (remote) to bracket the exposures, one should have the deepest shadow that requires detail be exposed set to a middle value. Similarly, the brightest highlight that one wants to retain detail in should also be exposed to be a middle value (Fisher 2016, p. 67). This approach is inconsistent when using ETTR as both these values should ideally be placed in the brightest EV in order to maximise image latitude in the final image in line with ETTR. Capturing an exposure with the brightest highlight required in the middle EV makes this exposure redundant as the desired highlight values are recorded in the middle EV of the RAW file whereas in the next exposure in the sequence, they will be pushed to a higher EV in the RAW file. Fisher recommends fixing white balance, chromatic aberrations and dust sport removal in the RAW files before merging them to HDR in order to avoid exaggerating these issues. (Fisher 2012, p. 110).

Bloch (2013, p. 145) suggests taking spot meter readings for the brightest and darkest regions in the scene and using these as the minimum and maximum bounds for the exposure stack that has a 2 EV interval. Cooper (2015, p. 44) and Davis (2012, p. 80) both suggest a similar approach but the darkest exposure speed is set 2 EVs lower and the brightest exposure speed is set 2 EVs higher than the respective values indicated by the spot meter. This approach seems to forego image latitude in favour of a reduced number of exposure brackets not capturing the darkest values of the scene in the brightest EVs of the RAW file.

Johnson (2012, p. 182) suggests simply photographing a series of exposures from the "far overexposed to drastically underexposed" and cautions against having moving objects during long exposures. He makes no mention of the exposure bracket interval but is of the view that more exposures will lead to better output (Johnson 2012, p. 182) which is not necessarily the case when dealing with moving objects. Johnson does not take this into consideration having seemingly resigned to the notion that HDR photography cannot work with moving elements in the scene.

Davis (2012, p. 80) advises photographers to decide on whether to shoot from the darkest exposure to the brightest, or, vice versa. If one starts photographing the exposure sequence by starting from the brightest exposure to the darker exposures, there is a greater likelihood of missing the Decisive Moment that may be unfolding given the extra exposure time it would take to get to the base exposure in this case. Bloch (2013, p. 151) makes a very important point of using the normal bracketing order: 0, -, + (normal exposure, underexposed exposure, overexposed exposure) so that the hero exposure happens as soon as you press the button capturing the moment so that in case of the sequence being interrupted at least one of the useful exposures would have been recorded. This ties in with the design philosophy behind Rehan's Zone System (see chapter 4).

Bloch (2013, p. 175) highlights the need for flat conversion where the highlight values are pulled down and the shadow values increased before exporting files from Adobe Lightroom to other software using plug-ins as these files get exported are TIFF files and need to have the maximum contrast detail possible. Bloch (2013, p. 176-181) also advises setting the tone curve to linear, adjusting the white balance, switching off any sharpening, fixing chromatic aberrations and vignetting, and, using noise reduction on the underexposed images before HDR processing.

The normal process for capturing HDR images for light referencing in visual effects at one of the leading visual effects companies Industrial Light and Magic (ILM) as described by Snow (Seymour 2011) is using the Canon 1Ds camera with an 8mm fisheye lens and taking 7 exposures, three stops apart with the base exposure set to 1/32 second, aperture at f/16 and ISO set to 100, and, a 2 stop neutral density filter applied for exteriors.

The impact of ETTR when defining the exposure bracketing range has not been critically examined by these practitioners and although they have defined what the exposure bracketing interval should be, it seems to be based largely on trial and error and on the cameras used.

This critical analysis demonstrates that the workflows adopted by these photographers do not provide a flexible approach that can be adapted to suit the unique needs of every landscape scene and scene lighting conditions whilst respecting the individual photographer's creative intent for the final look of the image, the camera tools at the phtographer's disposal and the photographer's craft competency.

2.13 The importance of a practice-led approach, and, craft and tool competency

2.13.1 The importance and value of practice-led research

Schön (1983, p. 39-40) argues that instead of merely focussing on problem-solving, professional practice taking place in the real-world requires practitioners to also consider "problem setting" in order to take account of the "complexity, uncertainty, instability, uniqueness, and value-conflict" of phenomena, and, to be able to construct the problem by making sense of complex, problematic scenarios. Schön's argument holds true for Landscape Photography where the photographer has to consider the changing nature of scene elements, and, the logistical, and, health and safety issues associated with the location and equipment, besides the technical craft decisions. Filmmaker Sidney Lumet (1995, p. ix) describes how, only the imagemaker involved in the making of the image, may truly know exactly why the image looks the way it does. There may be factors beyond the captured frame that may affect decisions made by the imagemaker ranging from "budget requirements to divine inspiration" (Lumet 1995, p. ix). The quality of the crafted object, therefore, not only depends on the craftsmanship but also on a range of other external factors and constraints; a better-quality lens may be in the market but may be financially out of reach, or impractical for the work - the lens may be too heavy or bulky to carry on longer photography excursions, or, it may not be weather sealed thus making it unfeasible to use in rainy or dusty weather conditions. The camera metadata can provide information on the choice of lens, aperture size and focal length etc., but it does not convey why these choices were made by the practitioner. Hence in terms of research, further commentary is provided in order to communicate practitioner insights and the context for using a particular workflow taking the problem setting into account (see Chapter 0).

Photographic image production process requires improvisation in order to adapt to the changing situations whether it is a change in weather and scene lighting, or, not being able to use a particular piece of photographic kit and having to come up with an alternative solution. These insights into alternative solutions and tehcniques used to overcome and adapt to problems and shortcomings are sometimes more profound than the work created as they encourage the practitioner to reflect-in-action (Schön 1983, p. 59). This research study uses video documentation and a non-destructive image editing workflow to document these instances (see Chapter 0).

2.13.2 The importance of tools and technology in practice and crafting images

The tools and technology available to the imagemaker can also have a profound impact on the work produced. Sennett (2008, p. 195-196) describes how the eleventh century Islamic writer Alhazen wanted to see the heavens but failed due to the unavailability of adequate glass quality. James Cameron claims to have waited fourteen years for the technology to develop that would allow him to bring to life his vision for the film "Avatar" (in Hiscock 2009). These instances highlight a key issue that practitioners face where the technology required to achieve the creative vision of the practitioner may not be developed or be adequate enough to allow the creative vision to materialise. In the context of this research study, it translates to the camera technology and functionalisty, the lenses, and, the software tools that do not yet offer the image quality or functionality required to achieve the creative vision.

2.13.3 Making the tools invisible

Another issue with certain tools is that they can leave unique imprints, such as brush strokes in a painting, alluding to the size of the brush, or, as Hockney & Falco (2000) highlight, certain lens characteristics in some Renaissance paintings alluding to the use of some optical device as a technical aid to achieve the desired look. On part of the maker, this may have been a conscientious choice, an uneasy compromise, or, an unnoticed element. There is no way of ascertaining the actual fact except via the makers themselves. Practitioners may at times be limited by what could be achieved using the tools and technology available to them, or, the discovery of a new tool, technology or method might be the catalyst (Burbridge 2015) to create novel visual outputs given the new visual insights that might be unlocked. Chapter 0 serves this function by clarifying the practitioner intent, scene constraints, as well as the tools and workflow used along with the rationale.

2.13.4 Practitioner expertise and competency

Finally, there is also the issue of practitioner competency. Sennett, describes how it took years after the scalpel had been invented for it to have standardised use in practice (2008, p. 196), highlighting the problem of practitioner competency whereby practitioners not having enough experience with a novel tool or technology, may not be able to take full advantage of it to unlock its full potential. Ben Snow highlights a another similar issue in CG where a new technology was been developed but the practitioners were reluctant to use it as they feel more competent and comfortable using the older tools and technology (Seymour 2011). This issue of the acceptance of novel tools and technology has been a recurring problem in photography, not just with the practitioners in terms of the production craft but also in terms of the novel visual output produced by these new tools and technology being accepted as an art form (Torcellini 2010).

2.13.5 New technologies allowing for new image look

Interestingly, it has been the more scientific applications of photography that have advanced and challenged the status quo in imagemaking. The lens and camera technologies not only provided deeper visual insights into what could not be seen by the human eye but also greatly facilitated the image-making process for painters (Scharf 1974, p. 1). Daniele Barbaro recommended the use of the camera obscura as an aid to visual artists in as early as 1568. (Scharf 1974, p. 1). Sennett (2008, p. 195) attributes the microscope and the telescope as being amongst the tools that challenged medieval views of humanity's place and stimulated scientific thinking. The "Revelations: Experiments in Photography" exhibition (Burbridge 2015, p. 7) showed how early scientific photography influenced modern and contemporary art, and, revealed detail and form in objects that was not apparent to the naked eye. Besides the striking quality of the photographs, the visual insights provided were rational and measureable, and, evidenced phenomena in scientific terms (Burbridge 2015, p. 7). From Fox Talbot's experiments in photomicrography to the images of the night sky created by astronomers, these early works provided novel visual insights into real world phenomena. The scientific techniques developed were adopted by amateur photographers and enthusiasts who were "concerned more with the capacities of the new medium of photography than with the external phenomena it might help to uncover or better understand" (Burbridge 2015, p. 15). Avant-garde artists made use of these new technologies in the variety of works that they produced (Burbridge 2015, p. 15). Today, whilst the look of HDR tonemapped photography is still debated and remains a point of contention in photography circles, HDR photography has been widely adopted in computer graphics (Debevec 1996; Debevec et al. 2004; McCann 2007; Reinhard et al. 2010), visual effects (Bandoh et al. 2010; Selan 2012) and scientific applications (Tamburrino et al. 2008; Bouatouch and Chalmers 2014).

It is hoped that the craft best practice and novel image looks that this research explores will serve as a catalyst and be a positive contribution to the HDR debate in the photography community. Johnson (2012, p. pg xii) and Adams (Adams and Baker 1981, p. 48) have both highlighted the importance of mastering craft skills and tools with respect to photography, in order for an unabated flow of the creative process.

The exploration of new multi-shot photographic technologies, the visual possibilities they have to offer, and how to best harness and use them, thus becomes the key part of this practice-led research. The video documentation and the non-destructive workflow used in this research study helps to document the production practice (see Chapter 0) and can be used to assess the practitioner competency with the tools taking the problem setting into account.

2.14 Summary

There is an intrinsic connection in the **craft of imagemaking and the visual look** of the picture. Historically, novel technologies have always challenged the dominent look and faced criticism in the face of the status quo. HDR Landscape Photography is no exception and has been percieved as lacking in craft and being too automated. Photographers have used a number of different tools, methods, techniques and workflows to maximise dynamic range capture. Stack-based HDR photography offers a novel solution to capture the entire dynamic range of outdoor landscape scenes. However, the motion within the scene can cause alignment issues across different exposure brackets. Ensuring acceptable dynamic range and deep focus across the entire scene as well as ensuring the image does not suffer from noticable camera sensor and lens artifacts can also be challenging. Prior to finding a solution, the reseach context and rendering intent needs to be clarified in that the goal is not to create exact reproductions of the scene but to use the painter's approach in order to emulate certain painterly looks as well as experimenting further to create a signature style. Capturing the Decisive Moment is also a key concern. A critical analysis of practitioner workflows demonstrates a lack of manual creative intervention in stack-based HDR image acquisition processes and highlights the need for a comprehensive workflow that allows greater creative control over the final image latitude, resolution, dynamic range capture, and, the ability to capture the Decisive Moment. In order to develop such a workflow and processes, it is necessary to work in the problem setting. A practice-led research approach, therefore, is critical.

3 RESEARCH STRATEGY AND RESEARCH METHOD

3.1 Introduction

This chapter explains the nature of the research and the research approach taken by the researcher-practitioner. Visualisation methods used in photography, filmmaking and visual effects are discussed and a hybrid approach to visualisation is created that allows for reflection before, during, and after action. The importance and challenges of documenting practice are highlighted that form part of the evidence-based craft practice process. The method of evaluating the research and research outcomes is also discussed at the end of the chapter.

3.2 The nature of the research study and the research approach

The nature of this research study is practice-led whereby the research questions are identified and established within the practice based on practitioner needs with the practice methods and approach of the practitioner helping to facilitate in forming and carrying out the research strategy within the practice (Gray 1998). Practice-led research is, thus, "both initiated in practice and then pursued through practice" (Bournemouth University 2018, p. 67-68).

A reflective practice approach based on Schön's (1983) model of reflection-in-action and reflection-on-action was used in the research study. Reflection-in-action occurs when the practitioner is faced with a challenging or unusual situation where they have to analyse the situation at hand and reflect on their knowledge and experience to come up with a plan of action in order to achieve the desired result (Schön 1983, p. 59). It is under these circumstances that the tacit knowledge of the practitioner is made explicit, and the practitioner has to use their know-how of the craft, and, their understanding of the situation to find a solution. Reflection-on-action is when the practitioner reflects on a past experience or future plan of action at a more relaxed time usually but not always when they are not engaged in the action (Schön 1983, p. 61).

Digital Landscape Photography can be divided into two main stages; photography and post-photography. The photography stage is time critical as the photographer has to be extremely focussed on the changes and fluctuations in the scene. This stage can be seen as a performance as it requires the photographer to constantly make sense, adapt, reflect and improvise to the changing scene in order to achieve the desired results using the available photography tools. Table 1 shows examples of the kind of questions and considerations the photographer needs to reflect upon.

Table 1: Example of typical questions/decisions made at the photography stage

Reflection before action	The scene being photographed (movement in the scene, depth, available light, wind, rain, snow) The tools available (camera sensor size and dynamic range, focal length and other lens attributes of lenses available, feasibility of using tripod) The desired look and the level of flexibility required during post production depending on the skill level of the practitioner The above questions inform: The number of exposure brackets, tiles and focus stack images to photograph
Reflection in action	Has the critical motion/phenomenon been captured, is there enough coverage (in terms of dynamic range, field of view (see Glossary) and depth-of-field)
Reflection on action	What could be improved in the next iteration? Cycles back to “Reflection before action” but with more informed results

The post-photography stage is a more relaxed time when the photographer is processing or editing the photographs on the computer. This stage allows for a more elaborate visual analysis, image comparisons and testing, as well as reflection-on-action that informs subsequent practice. Methods and practices of other photographers can also be explored at this stage in order to find the solution to any common problems. Table 2 shows examples of the kind of questions and considerations the photographer needs to reflect upon.

Table 2: Example of typical questions/decisions made at the post-photography stage

Reflection before action	The RAW material captured (How much, what quality in terms of dynamic range, field of view (see Glossary), depth-of-field) Movement between exposures The scene being photographed (movement in the scene, depth, available light, wind, rain, snow) The tools available What was the desired look initially
Reflection in action	Are there any gaps in the focus stack, field of view or dynamic range of the exposure stack? Are the HDR and

	tonemapping processes resulting in artifacts such as pronounced ghosting, misalignments, noise, haloing etc (see 2.5.7) and what alternative approaches may be used to alleviate these issues?
Reflection on action	What could be improved in the next iteration? Review and analysis of other practitioners' techniques, methods and workflows. Cycles back to "Reflection before action" but with more informed results

At any given instance in the research process across both the photography and post-photography stages, the practitioner is drawing upon their past lived experiences, reflecting and improvising in the present whilst keeping sight of how present actions will impact future processes - in case of the photography stage - and practice - in case of the post-photography stage (see Figure 22) .

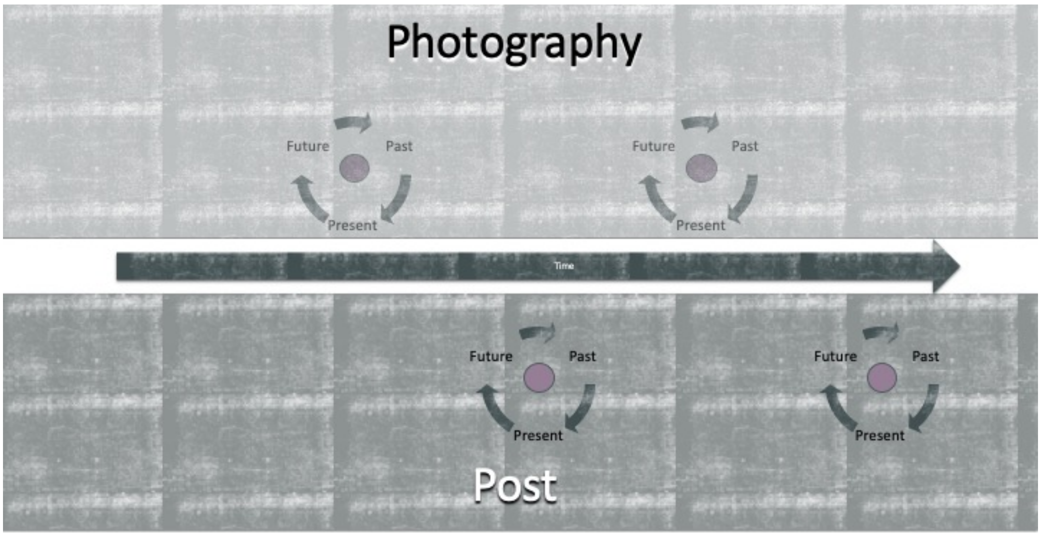


Figure 22: The image and the practice. The light grey section denotes the photography stage whilst the dark grey section denotes the post-photography stage. This illustration demonstrates how at any given instance in the research process, the practitioner has to be mindful of a) the past experiences, b) the changing scene and improvising to it, and c) how would present choices and decisions impact down the pipeline or what could be improved in the next iteration.

In order to achieve the research objectives set out (see 1.9), numerous photoshoots were conducted over the course of this PhD study in order to identify and refine photography best practices that faciliate an artifact free image look without missing out on the Decisvie Moment and recording the entire scene dynamic range. The logistical and physical constraints of different locations, availability of tools, lighting and weather conditions as well as personal physical and mental conditions of the practitioner all contribute to the choices made during the photography process.

3.3 Thesis roadmap

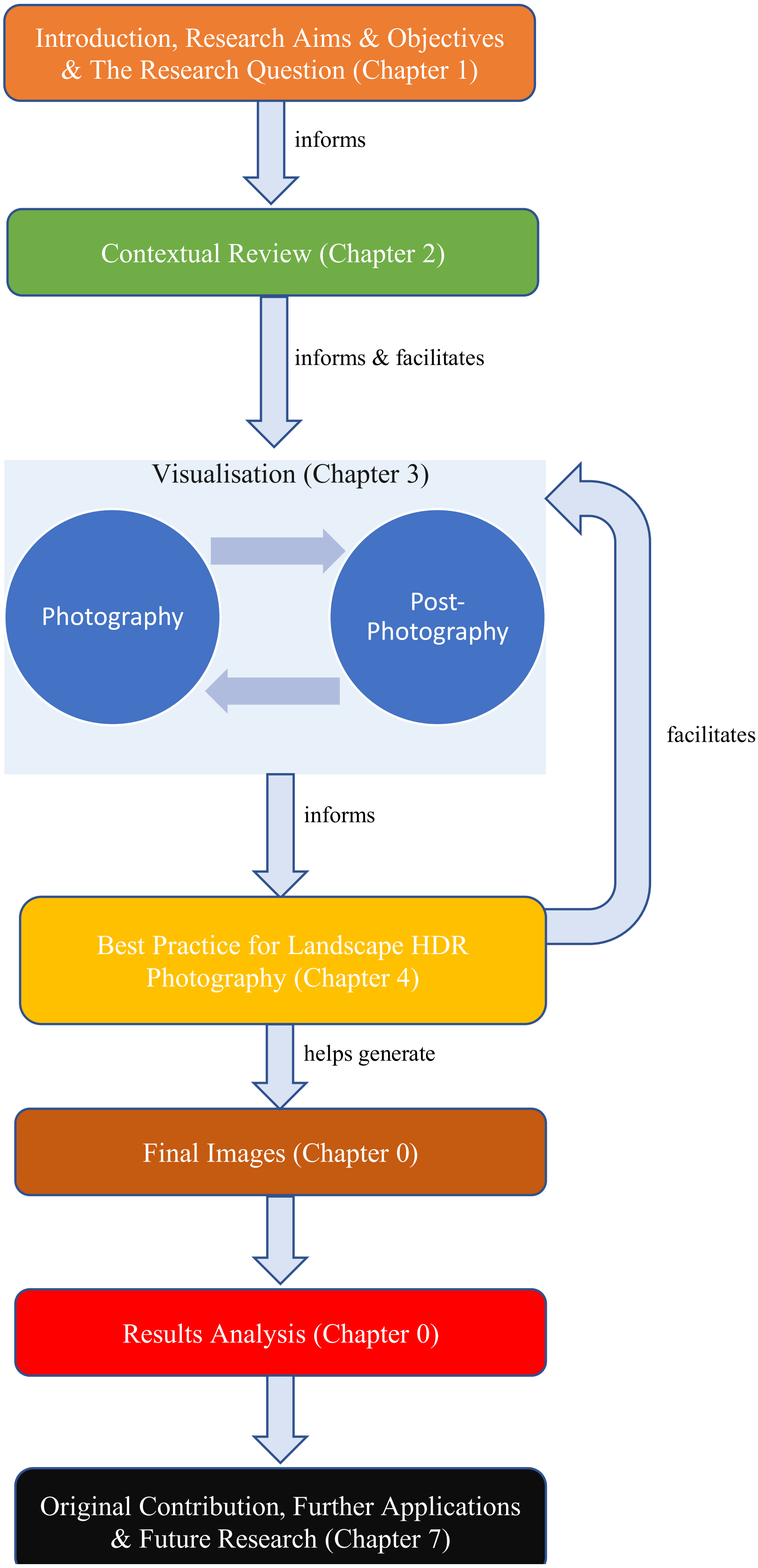


Figure 23: Thesis roadmap

Figure 23 illustrates the roadmap for this research study. The research aims, objectives and the research question (see Chapter 1) inform the contextual review (see Chapter 2). The literature on methods, techniques and workflows alongside best practices from other practitioners and the resercher-practitioner's own experience of photographic imagemaking and visual effects provide a starting point for the visualisation and craft practice process (see Chapter 3). Craft experience and insights are gained through iterative craft practice in the form of HDR landspace photography and post-production with the focus on the research aims, objectives and the research question. Insights into the techniques, methods and workflows used by other practitioners are gained to resolve specific issues encountered during the practice alongside practical insights into tools and techniques gained through lived experience. This experience and insights help to inform best practices for creating a generic workflow framework (see Chapter 4) that facilitates in achieving the research objectives. The resulting images (see Chapter 0) and feedback from exhbitions provide further material for reflection. A final analysis is conducted and expert practitioners are invited to assess the images in line with the research objectives (see Chapter 0). The practice workflow developed is employed to demonstrate further applications, and, future research areas are identified in Chapter 7.

3.4 Visualisation as a reflective craft process

A common albeit slightly nuanced approach for creating images used by photographers, filmmakers and visual effects practitioners that serves as a vehicle for the reflective practice is Visualisation.

3.4.1 Ansel Adam's visualisation approach and its limitations

In photography, Visualisation as defined by Adams (1980, p.1), largely consists of predetermining the look of the final image in the mind's eye by studying in the scene, and, developing and executing a technical plan that would allow for that preconceived look to be achieved. The problems with this approach as highlighted by Zia (2019) are that this notion of Visualisation is dependent on firstly, the photographer being able to previsualise the look of the image, secondly, the photographer having mastery over the photography tools and processes in order to predetermine what tool parameters will provide the desired results, and thirdly, this Visualisation approach does not allow the flexibility for comparing alternative image looks. The director/photographer may not have a clear vision of what look they want in the final image right from the onset and may want to explore a number of different possibilities as happens in filmmaking (Okun and Zwerman 2015, p. 40), or, the image look may evolve over the course of production (HollywoodEndingMovie 2014). Early, inexperienced practitioners not fully knowing the creative opportunities available given the image latitude, tools, techniques or workflow can find it difficult to settle on a particular look and may want to explore a range of different creative possibilities, or, may not even be aware of the issues that exist in the image (Ratcliff 2010, p.23-24). The photographs taken, therefore, need to allow for the maximum possible range of creative outputs and capturing as much information about the scene as possible for the practitioner to be able to abstract whatever values they need to explore the range of possible creative visual outputs. This requires capturing the sharpest images possible with all scene elements in focus, encompassing the entire scene dynamic range, and, devoid of camera or sensor artifacts; a sharp image can always be selectively defocused during postproduction but an out of focus image cannot be brought back into focus. Similarly, lens and sensor artifacts such as noise or chromatic aberrations can be added in postproduction but getting rid of these artifacts if they are inherent in the image, can impact the quality of the image. The combination of these factors can be challenging for novice practitioners who may not have mastered the photography craft skills to be able to make a confident judgement on what tool parameters and processes to use, and, may not have a definite idea about the specific image look they want, or even the different possibilities of image looks that can be achieved. Yet despite these issues, this Visualisation approach is immensely helpful and applicable at the photography stage when it comes to the initial survey and scrutiny of the scene and deciding upon the exposure values for each of the scene elements. Camera features such as guidelines display on the LCD screen, image histogram, digital spirit level, depth-of-field preview, live view and focus peaking can greatly help the Visualisation process at the photography stage. The camera can also be connected to a larger display such as a phone or a tablet and zoomed digitally in order to get a larger live view of the scene that can be invaluable in determining what scene elements are in focus as well as in scrutinising and reflecting upon the images previously photographed. At this stage, reflection-on-action is focussed upon decisions regarding the state of the scene, the initial emotional response of the practitioner to the scene, the tools available, the movement in the scene and how much creative control is required for post-production, i.e. is the practitioner able to visualise the final image in their mind and can they lock down the look, or, do they need to be flexible to allow for changing the look later in post. The reflection-in-action is focussed on the changing nature of, and movement in, the scene. The photographer needs to ensure that the scene elements have been photographed in the desired place at the desired time with the desired look in terms of motion blur having the tonal latitude required.

The shortfalls of Adam's Visualisation approach are largely overcome by combining Adam's Visualisation approach with that used in filmmaking and visual effects. The Visualisation process used in filmmaking, and particularly, visual effects, is slightly different in that it is more a quest for finding a suitable look than working towards a predetermined look (Katz 1991, p. 4). Visual effects practitioners may be provided with concept art, colour scripts and look-up tables (Academy 2019) but there is still an element of evolution and refinement of the look that happens during the process of visual effects creation that helps in grounding the final look of the image (HollywoodEndingMovie 2014).

3.4.2 Visualisation in film and its limitations

Film Visualisation, as defined by Katz (1991, p. 5), is the product of immediacy and reflection where the visual materials are evaluated intermittently as they are being crafted in order to compare and test different ideas. In the context of this research study, this approach is primarily used post-photography but also during photography to analyse and reflect upon images photographed, and, make any alterations to the photography approach. The limitation with the Film Visualisation is that it is does not put enough emphasis on the interpretation and instant responsiveness to the unfolding situation in the scene.

3.4.3 Visualisation approach adopted in this research study

The production approach used in this study is a combination of both of Adam's and Katz's Visualisation approaches where the desired look in general is predefined by the practitioner but the strategy involves capturing as much scene information as possible with emphasis given to the Decisive Moment in the scene to allow for greater latitude for experimentation and comparison of different image looks post-photography whilst retaining the key strength of the photographic image to capture the instant. The method, thus fuses reflective and experiential learning to facilitate the development of physical skill that, Moon (2004, p. 2) argues, is often ignored in research practice.

3.5 Documenting craft practice

An important distinction between practice undertaken as research as opposed to professional practice is that the aim of the former is to communicate significant findings and contribute to shared knowledge (Bournemouth University 2018, p. 67-68). The research strategy for this study, therefore, needed to not only facilitate in doing research but also had to be able to document and communicate novel insights related to practice without getting in the way of the practice. To this end, a non-destructive editing workflow was used during the post-photography workflow that allows for the camera RAW files to remain unaltered by writing parameter changes to sidecar or software catalogue files (Diprose and Robins 2012, p. 237). The non-destructive workflow also allowed for documentation, logging of software parameter values and visual comparison of different image looks as multiple versions can be created from the same RAW files and used to compare between and reflect on different creative possibilities for the final look of the image. Software scripts and presets can also be used as a means of communicating methods, techniques and workflow to other practitioners as is the case in visual effects (Selan 2012). The image production process has been divided into five stages. The following diagram illustrates these stages as well as the file types generated at each stage and what technical information could be derived from the files.

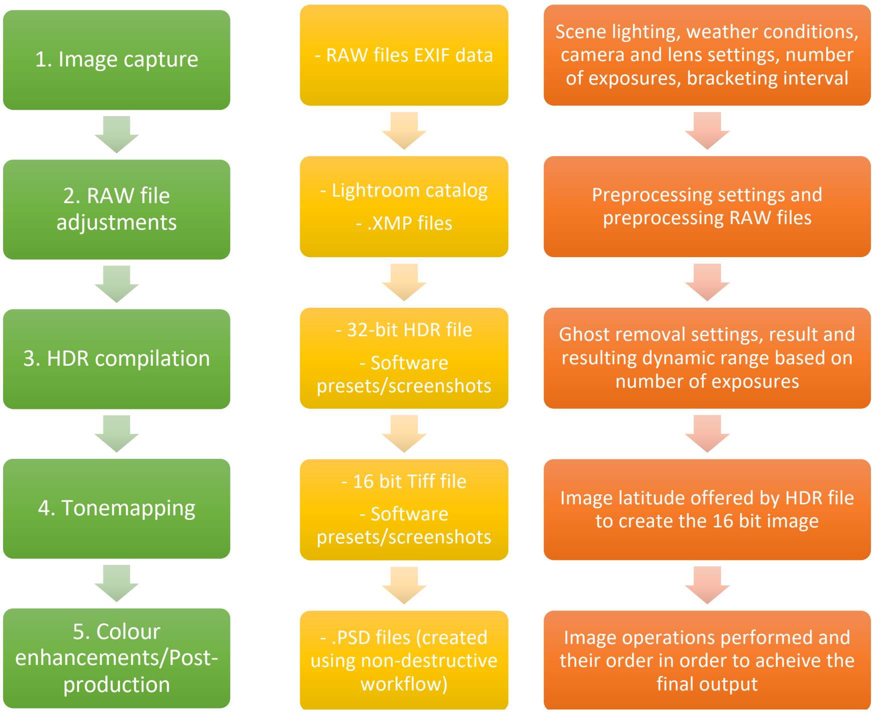


Figure 24: Image production stages, file types for documenting each stage, technical information that can be derived from files at each stage

The RAW file metadata serves as a record and evidence of the camera settings that were used for each exposure. The information contained in the RAW files includes the make and model of the camera and lenses, shutter speed, ISO, aperture, focal length and focus distance. The camera RAW files of the landscape scene serve as visual indicator for: a) the researcher-practitioner being at the location at that particular day and time when the images were photographed, i.e. proof of authorship, b) the light values that existed at the time the exposures were made including any changes of lighting during the photography, and c) the rate of change of the elements within the landscape, such as clouds, foliage, waves in the water, given the shutter speeds.

In order to document, reflect upon and the communicate practitioner thought process as well as the problem setting, a number of different approaches to video documentation were used over the course of the research study to document the photography stage in order to reflect upon the process, techniques, workflow and response of the researcher-practitioner as well as documenting the state and rate of the changing scene elements. These video documentation techniques included using a secondary DSLR camera on a second tripod, a headstrap mounted camera GoPro Hero 4 camera, a hotshoe mounted GoPro Hero 4 camera, mobile phone video recording by an assistant and finally, a hotshoe mounted Samsung Gear 360 camera. The reason for changing the different modes of video capture was to find a method that was least intrusive to the practice and provided the best value in terms of the material for reflection-on-action and communicating the photography activity. The primary purpose of these videos was to document the act of photography but also to record what was going through the practitioner's mind at the time of making the decisions by thinking aloud in order to facilitate better reflection-on-action. The second DSLR with an extra tripod proved to be too challenging to carry around on locations, especially those that involved long walks although the image quality was very good. The GoPro Hero 4 did not work very well on the head strap as it was occasionally pointing away from the region being photographed and the movement in the video was too frantic. The GoPro Hero 4 did work well in the camera hotshoe but was replaced by the Samsung Gear 360 as the latter provided a 360-degree view that included the scene being photographed as well showing the photographer's response at the time.

The video recording approach does highlight some issues of practice-led research that can adversely affect the practice; having the video camera connected to or mounted on the tripod of the camera being used in photography practice raises the risk of wind resistance and camera shake resulting in deterioration of sharpness in the photographs. The practitioner can also become self-conscious of the being video recorded. Also, whilst thinking aloud helped the reflective practice aspect, it did put additional pressure on the practitioner and diverted attention from the actual practice of photography.

Over the course of the research study, a number of photography short courses, workshops and masterclasses were also attended by the researcher-practitioner in order to gain better insights into the practice of other photographers.

Different software and camera tools were also analysed over the course of the research study to determine the image looks that could be achieved as well as the tool limitations. Initial experiments and studies included practice-based learning of the HDR production and tonemapping process (Zia 2013) and a comparison of HDR production and tonemapping approaches (Zia 2014) using Adobe Photoshop (Adobe 2014), HDRSoft Photomatix (Soft 2008) and blending of exposures using masking. The Brick Wall Project (Zia 2015) was undertaken to illustrate visual differences in the look of tonemapped HDR photographs shot at various different apertures using three different 50mm lenses. The subject of these photographs is a section of a brick wall that emphasises the resulting looks over subject matter and demonstrates the possibility for exploring different image looks irrespective of the subject in the photograph in terms of colour, contrast, tonality, sharpness, resoultion, image detail, and, camera sensor, lens and tonemapping artifacts (Zia 2015). A more advanced and comprehensive HDR photography workflow to minimise diffration and other lens artifacts whilst allowing the capture of the Decisive Moment was explored in the form of Rehan's Zone System (Zia 2018, see Chapter 5). Undertaking theses exercises allowed for better practitioner understanding and familiarity of the production tools and processes, and, their capabilities and limitations. This knowledge, combined with the review of the other practitioner workflows, informed the best practice for production.

3.6 The research process as evidence-based creative craft practice

The research process can be visualised as a form of creative evidence-based craft practice which is the culmination of practitioner expertise, best practice evidence and the creative intent of the practitioner/director/client. This evidence-based practice model is derived from the evidence-based practice model used in Health (EBP Tutorial 2019).

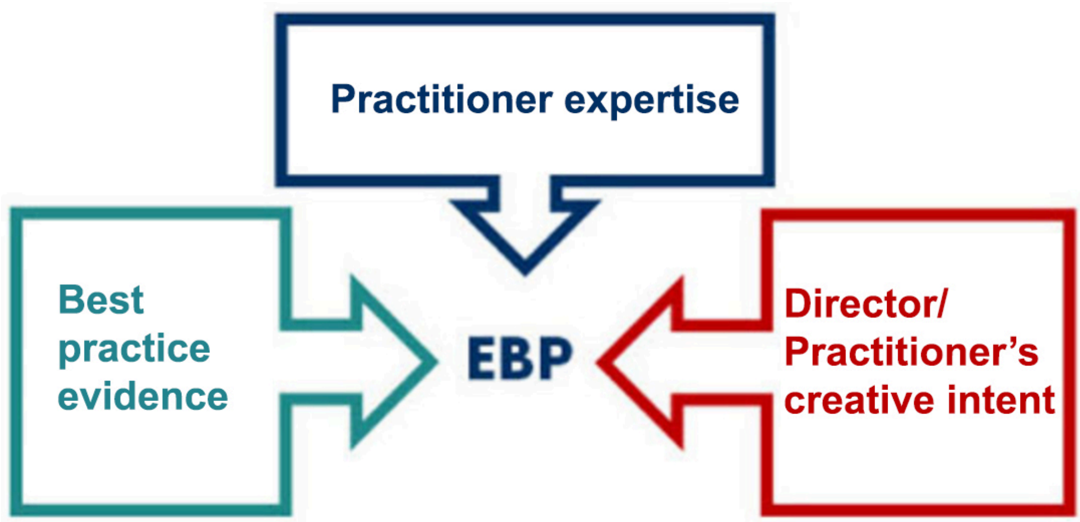


Figure 25: An overview of the Creative Evidence-Based Practice model

The video documentation of the photography process, the non-destructive workflow, and, practitioner comments provide material by which the practitioner expertise can be determined and assessed. The desired look forms the bases for the creative intent of the practitioner. The best practice evidence comes from the practice research exercises undertaken along with the analysis of other practitioner techniques and workflows. This model can be used in the wider imagemaking context by other practitioners.

3.7 Method of evaluation

In the context of this research, the criteria of success is determined by the final images that are created using the techniques, methods and best practice workflow explored in this research study and to what extent they accomplish the research objectives (see 1.9). It is important to note the context and interdisciplinary nature of this research study and that the primary domain in which this research study is conducted in is photography craft practice, not scientific imagery or computer graphics. Therefore, a visual inspection of the images by the naked eye is sufficient in determining the presence of image artifacts. The print size for the final images is 24 inches on the wider side. The evaluation of the images is done as a three step process. The images are first and foremost reviewed and analysed by the researcher-practitioner during and after creation. Brookfield (1998) suggests that the autobiography of the practitioner is the most important resource given their insights into their own practice. In the second phase, images are exhibited at various art galleries and feedback from the visitors is recorded and analysed for reaffirmation. Finally, photography experts are invited to scrutinise the images and provide their comments via questionnaires on how successful the images are in meeting the research objectives. Thirkill (2002, p. 134) has also employed a similar approach where experts were invited to visually analyse denisty ranges in negatives. The evaluation by the photography experts is the key measure of success.

3.8 Summary

This is a reflexive and reflective practice-led study that utilises a mix of film, visual effects and photography visualisation methods. Each step from the photography acquisition process through to the final print is documented, and thus the research process can be thought of as an evidence-based creative craft practice where the evidence not only comes from the photographs in how they depict the scene but also from the image operations applied. The evaluation of the research is done via visual assessment of the images by the researcher-practitioner, exhibition feedback analysis and review of the images by expert practitioners.

4 REHAN'S ZONE SYSTEM

> "One of the key advantages of working with the Zone System is that it makes it very easy for artists to photograph the world as they *imagine* it, rather than the way it appears to be. The goal is for photography to become an open creative process with many possible outcomes" - Johnson (2012, p. 194)

4.1 Introduction

This chapter focusses on the best practice methods, techniques and workflow that have been developed to enable the practitioner to achieve high dynamic range photographs whilst minimising the lens, camera sensor and processing artifacts and being able to capture the Decisive Moment unfolding in the scene. Based on the notion of Ansel Adam's Zone System (see 2.12), a novel zone system has been created that incorporates stack-based HDR photography, focus stacking and digital panorama techniques. This new zone system allows much greater flexibility to practitioners by enabling them to greater choice over the focal lengths, ISOs, apertures and shutter speeds.

4.2 Importance of acquiring good image quality photographs

In film photography, considerable effort goes in ensuring that the film negative is properly exposed and developed as the photographer generally gets a single opportunity to get these values correct, and, because the negative provides the raw material for all subsequent image prints (Adams 1981, p. 1). Even though the printing process allows for considerable flexibility with its trial-and-error approach of creating work-prints, one cannot create technically good craft prints from a negative having insufficient tonal detail, or, artifacts (Adams 1981, p. 2). A photograph in which a subject is out of focus cannot be processed later to bring the subject back in focus. Similarly if the captured image has considerable moise, denoising it results in image detail softening and reduction and abrupt changes in regions of graduated tones, known as posterization (Bilissi and Langford 2013, p. 243). Simiarly, chromatic abberations (Bilissi and Langford 2013, p. 58-59), lens distortion and diffraction (see Glossary) artifacts can be difficult to minimise or eliminate during postproduction. It is therefore, of utmost importance that these issues are addressed at the time of photography and the images captured have good image detail, resoultion and sharpness and minimal artifacts.

4.3 Aims of the Zone System developed

One of the main aims of this research study (see 1.7)was to develop an approach to stack-based HDR photography that would allow for the maximum scene dynamic range to be captured without missing the Decisive Moment unfolding in the scene. In addition to this, the approach should also allow for minimising artifacts whilst allowing good resolution, depth of field and image detail (see 4.1).

In digital photography, the camera RAW file becomes the film negative counterpart as it is from the camera RAW file that the final image is created. In stack-based HDR photography, each exposure captures a certain tonal slice of the scene dynamic range. In order to allow maximum image editing latitude, it is important to ensure that each of these tonal slices record the best data samples with the least amount of noise and lens artifacts possible. It is also important to ensure that there are no gaps in the scene dynamic range recorded and that the Decisive Moment in the scene is captured. To this end, a Visualisation approach (see 0) and a Zone System (henceforth referred to as Rehan's Zone System, or RZS) (Zia 2018) were developed and refined over the course of this research study.

The idea behind RZS was to create a method of image capture that: a) allowed the capture of scene elements at the best possible samples, b) was not camera or lens dependant, c) allowed flexibility to increase or decrease the range of scene dynamic range captured based on individual photographer needs, and d) allowed better control over the exposure brakcet shutter speeds.

4.4 Pre-testing to determine acceptable EV range

Prior to using RZS, it is necessary for photographers to conduct some tests with their cameras in order to identify what they deem to be acceptable range of usable stops, or acceptable EV range, in a camera RAW file at a given ISO, as well as acceptable ISOs that the photographer is able to use during postproduction. This is particularly important for the lower end of the exposure range in the photographic exposure ((Okun and Zwerman 2015, p. 234) There are three ways that can help photographers reach a conclusion. Firstly, as suggested by Fisher (Fisher 2016, p. 69), photographers can look at the test data for their respective cameras for the point at which the sensor dynamic range starts to drop by 1 stop for a 1-stop ISO increase and ensure that the chosen ISO stays below this point. Secondly, a grey card can be photographed at normal exposures at different ISOs. The noise at each ISO can be visually analysed by the practitioner to see if it is deemed acceptable. The exposure for each image can be adjusted up and down to determine the amount of latitude available at each ISO. It should be noted that the tonemapping process can greatly exaggerate noise and therefore tests should also be conducted with exposure stacks. Thirdly, and most preferably, the photographer can photograph different high contrast landscape environments at different ISOs and process and edit the images to determine what ISOs and EV range is acceptable in his or her respective workflow. Although camera manufacturer may advertise the dynamic range of a camera sensor being 13 stops, for example, but the photographer may not be able to use the lower 5 stops when it comes to their postproduction workflow as increasing the values in this range might introduce noise or banding artifacts. The photographer may thus only be able to use the brightest 7 stops during his postproduction workflow. The acceptable EV range is affected by the camera sensor latitude, and, the creative intent of the photographer and how extreme the postproduction workflow is; if the photographer does not push the image values up excessively, the acceptable EV range may be greater.

4.5 Determining the exposure range, number of exposure brackets and the bracketing interval

In order to provide maximum latitude and flexibility during postproduction, RZS captures each scene element value at what is considered to be Zone V in Ansel Adam's Zone System, ensuring all elements across the scene retain good textural detail and latitude for postproduction. Spot meter readings are taken for the brightest and darkest regions in the scene as described by Bloch (2013) and Fisher (2016). These spot meter readings however, place the values at the mid-grey, or, Zone V of the Zone System. In order to maximise image latitude for postproduction, RZS offsets these values so that they lie in the brightest EV of the respective camera RAW exposures. The resulting shutter speeds are used as the bounds for the HDR bracketing range and the acceptable EV range is used as the bracketing interval. The bracketing sequence is generally photographed starting from the brightest exposure going down to the darkest exposure. The rationale for this is based on the fact that generally in a landscape scene, the scene elements exposed to the light are also more likely to be exposed to the wind and thus are more susceptible to movement. The darkest values are usually cracks and crevasses in rocks, shadows under the base of the trees/foliage, gaps within the foliage or the ground which are either completely stationary, or have very little movement. Starting the exposures from the brighter end provides the photographer a greater probability of capturing the Decisive Moment in the scene as the photographer has more control over the start of the exposure sequence than the finish and can delay the start till the occurrence of the Decisive Moment. The shutterspeeds for the brighter exposures are also faster and thus more exposures can be made during the Decisive Moment. The ISO is generally kept as low as possible in order to keep the ISO noise to a minimum and only increased if faster shutterspeeds are required for the exposure stack from the range of acceptable ISOs.

Neutral density graduated (ND Grad) filters can be used in front of the lens to reduce the exposure values for the sky. This reduces the number of exposure brackets required, thus reducing the overall time it takes to photograph the exposure stack adding to the probability of capturing the Decisive Moment. Whilst ND Grads may bring the dynamic range of the scene down to what can be captured in a single camera RAW file, this compressed scene dynamic range is still likely to be wider than the acceptable EV range. Therefore, given the emphasis of RZS on flexibility and latitude available in postproduction, HDR bracketing would still be necessary.

Having each scene element captured within the acceptable EV range provides the photographer flexibility to postvisualise the shot and explore a range of different creative looks. RZS provides photographers maximum latitude to place the exposure values for each scene element where they chose when creating the final 8-bit image output for print or screen.

4.6 Adding the spatial and temporal dimensions

RZS builds on the idea of The Zone System developed by Ansel Adams and Fred Archer (Adams and Baker 1981) and adds a spatial and a temporal dimension offering a flexible framework for landscape photographers to previsualise and postvisualise the final image based on the problem setting, the creative intent of the photographer and the tools available at hand whilst prioritising the capture of the Decisive Moment in the scene. Rehan's Zone System (RZS) provides a method for the visualisation and capture of multi-shot HDR Landscape Photography and integrates it with two other multi-shot photography techniques; focus stacking and digital panorama/gigapixel image creation. Focus stacking is a technique that allows the photographer to shoot, using a fixed camera, a number of photographs with the lens set to different focus distances. The resulting pictures, that have different regions of the subject in focus, can then be combined using software to create one image that comprises of all the sharpest regions from each exposure combined together. The focus stack also provides the photographer a control mechanism to manipulate specific regions in the final image based on depth by manipulating the respective exposures where that area is in focus. This is similar to the depth compositing approach in visual effects production (Okun and Zwerman 2015, p. 824-826) where image adjustments can be made based on the relative distance of the scene element from the camera. Digital panoramas and gigapixel photographs are created by capturing different views of the scene with sufficient overlap between one image and the next, and, digitally stitching them together in image editing software. The individual digital panorama exposures are known as 'tiles'. 360-degree HDR panorama photography is a common approach in visual effects for generating scene light references (Seymour 2011), however, it is mostly done using fish-eye lenses to capture the lighting in the real-world scene and lighting the CG scene rather than direct image creation from the images.

Based on the photographer's requirements, camera tools available and the scene to be photographed, the photographer can choose between a combination of stack-based HDR, gigapixel, and/or, focus stacking techniques – even a single technique may suffice depending on the creative intent of the photographer. Focus stacking requires the lens focus to be changed for the different focus stack exposures. Once the focus has been shifted, it can be extremely difficult to bring it back exactly to where it was previously. Therefore, before changing the focus, the photographer needs to ensure that any exposure brackets or panorama tiles that need to be photographed have been captured. Similarly, once the camera pans from one framing to the next for gigapixel/panorama capture, it can be difficult to return to the previous framing unless using the more expensive tripods that lock at set intervals during panning. It is important to photograph all the exposure brackets for a particular panorama tile before panning the camera to photograph the next corresponding tile.

The exposure bracketing sequence starting with the base exposure, is photographed first in order to ensure similar approach as Bloch (2013, p. 151). Capturing landscape photographs under low light whilst being able to freeze the motion or capture a fast moving/changing element within the scene whilst having a wide depth-of-field can be challenging. The use of focus stacking allows for wider apertures to be used enabling the use of faster shutter speeds whilst and low ISO and diffraction artifacts. This allows for freezing motion and reducing or eliminating motion blur in the scene elements whilst keeping noise and diffraction low. Focus stacking can be more light efficient and reduce the overall photography time that is required using a smaller aperture to cover the same depth-of-field as evidenced by Hasinoff and Kutulakos (2011). The use of focus stacking also allows for better improvisation during photography as any issues with the depth-of-field volume being photographed can be corrected and changes in the scene lighting can be quickly accommodated by changing the aperture size over different depth-of-field volumes to accommodate for the changing light. Any depth-of-field volumes that are problematic can be reshot in a shorter period of time than it would take to correct and reshoot a photograph spanning the combined depth-of-field. Focus stacking allows for more extensive control based on the depth slices during postproduction similar to depth compositing and deep compositing in visual effects production. Using focus stacking also means that changes to the noise or motion in the scene elements can be avoided due to not having to change the shutter speed or ISO which would impact the look of the final image in terms of motion blur or noise.

4.7 RZS in practice

The following pseudo-code sums up the order of precedence for stack-based HDR, focus stacking and gigapixel photography as concieved in RZS:

```
For each focus distance of the focus stack:
{       For each panorama tile:
        {       Photograph exposure/exposure brackets required;
        }
}
```

In the landscape, the photographer needs to analyse the motion of the scene elements in the landscape and identify the critical motion within the scene that brings about the Decisive Moment, i.e. the key moving element(s) in the scene that brings balance/drama to the composition. In the context of a landscape scene, it could be a natural phenomenon such as a volcanic eruption, a crashing wave on the beach, a completely still pond, the sun as it breaks through the clouds, or, movement of an object, animal or person.

The photographer needs to visualise what the spatial bounds of the region of critical motion in three-dimensional space would be, and how they may map across different depth-of-field volumes of the focus stack, and, different panorama/gigapixel tiles. At the same instance, the photographer also has to consider how much control would be required post-photography which would help inform the number of depth-of-field volumes and gigapixel tiles. This visualisation stage can be thought of as filling the scene with imaginary boxes where each box gives the photographer individual control over the scene elements that it contains. The region of critical motion needs to be prioritised and photographed first so that the critical motion could be captured and in the desired state (see Figure 26**Error! Reference source not found.**). This is a similar approach to the Brenizer method developed by Ryan Brenizer (B and H 2011) where he creates a gigapixel image using a wide aperture telephoto lens to create depth compression, shallow depth-of-field and bokeh effects not achievable with wide angle lenses for the same framing. Brenizer photographs the people first, as they are most likely to move before proceeding to photograph the rest of the scene.

Figure 26 "Lulworth Cove Panorama" by Rehan Zia (2013) - The region of critical motion in this image is identified to be the area highlighted in red where there are people moving about. The panorama tiles and depth-of-field volume that overlaps with this region should be photographed first.

The region of critical motion helps inform the widest aperture that can be used to photograph it given the depth-of-field has to be sufficient to cover this entire region. Dividing this region further across depth-of-field volumes or tiles can increase the chances of ghosting, and, missing the Decisive Moment due to the time it takes to change focus and/or framing. The region of critical motion needs to be photographed first in order to increase the probability of capturing the Decisive Moment. All other scene depth volumes and gigapixel tiles can subsequently be photographed. The photographer needs to ensure that there are no gaps in the combined depth-of-field across the focus stack and that there is sufficient overlap across tiles. The size of the depth volumes and the apertures used to photograph each of the depth volumes do not need to be the same and can be set based on the control required in the postproduction workflow. However, care should be taken to ensure that there is not too much disparity between apertures as this affects the shutter speeds used for each depth volume and may result in discrepancy in motion blur across the final image. When using focus stacking in conjunction with the HDR, each depth volume can be considered a separate scene in that the brightest and darkest values within each depth volume can be measured and set independently of the other depth volumes. There is a correlation between number of depth slices photographed and the shutter speed used; the faster the shutter speed required, the wider the aperture would need to be resulting in shallower depth-of-fields and a higher number of depth slices.

Focus distances and panorama tiles where the critical motion takes place are prioritised and photographed first to ensure the Decisive Moment is captured. This is in line with Bloch's approach (2013, p. 151) to exposure bracketing, where the normal or middle exposure is photographed first so that if anything goes wrong in subsequent exposures, the movement in the scene that takes place can be captured, or quickly recaptured, in at least one middle exposure. The tiles for an entire depth volume must be photographed first before moving on to the next depth volume. This order of operation ensures that focus changes are kept to a minimal. When using gigapixel photography in conjunction with the HDR, the exposure stack for each tile is photographed first, before moving on to the next tile. This order of operation is necessary because once the camera has been panned or tilted (in case of gigapixel photography), and the framing has changed, it is very difficult to get the same framing. When using gigapixel photography in conjunction with both the HDR and focus stacking, the focus is set for a particular depth volume and exposure brackets are photographed for this particular depth volume for the first tile before moving on to the next tile of the same depth volume. Once all tiles and the exposure stack for one depth volume have been photographed, the photographer moves on to the next depth volume. The region of critical motion takes precedence and the depth volume and tiles that this region falls under should be photographed first. Gigapixel photography allows the photographer to capture a wide field of view (see Glossary) using normal or telephoto lenses and minimise distortion that wider focal length lenses may generate, as well as rendering depth compression. The gigapixel tiles also allow for the isolation and capture the region of critical motion first, providing an opportunity to the capture of the rest of the scene at a more leisurely pace that allows for reflection.

In the context of RZS, focus stacking enables the use of faster shutterspeeds that may be required to freeze the motion in the scene that may otherwise not be possible without increasing the ISO to an undesirable level, or, using smaller aperture given the depth-of-field required. Focus stacking can limit diffraction artifacts within the final image by not having to resort to smaller apertures as well as allowing for greater depth-of-field in the final image that may otherwise not be possible to achieve. Focus stacking also allows the photographer to use the sharpest aperture or the sweet spot of the lens which may otherwise not be possible as the depth-of-field generated at this aperture may not be enough to cover the scene. Focus stacking also helps reduce the likelihood of camera shake that can happen when using long exposure under windy conditions given the shorter exposure times and provide the ability to quickly reshoot a specific exposure or set of exposures if camera shake is introduced by a strong gust of wind, for example. Hasinoff and Kutulakos (2011) have demonstrated that a focus stacking approach using wider apertures can be more time efficient than using a smaller aperture to cover the same combined depth-of-field, and, therefore this approach can allow a better chance of capturing the Decisive Moment.

In practice, however, given the moving elements in the scene, focus stacking can be a very complex technique to execute as aside from the movement contained within the depth-of-field volume, the cross over between different depth-of-field volumes and the edge details of overlapping scene elements also have to be considered along with the parallax.

4.8 Processing and postproduction

The main advantage of RZS is that it is flexible and easily adaptable to the problem setting, practitioner requirements and camera tools available to the practitioner at the time of photography. The focus of this method has been on the photography aspect rather than the post-photography processes. The post-photography workflow is also non-destructive and allows for experimentation with, and comparison of, different image looks and outputs. In order to accommodate any changes later down the production pipeline, the image bit depth is retained as much as possible and any intermediary image files are stored in lossless formats such as OpenEXR or TIFF which are both standard file formats in the visual effects industry.

The motivation behind RZS has been to allow the photographer maximum level of control over the final image during post production whilst still being able to capture the Decisive Moment. This enables the photographer to delay making some of the decisions regarding composition and previsualisation till the postproduction stage allowing them to focus on other important aspects of the scene during photography such as changing light, moving elements within the scene, and, weather.

When combining the images together, the first step is to preprocess the images by removing any lens distortion or chromatic abberations. The latter, in particular, can be compounded during the HDR blending and tonemapping process making it difficult to address later in the pipeline. White balance and sharpening may also be adjusted at this stage. The exposure brackets can then be combined in the preferred software of choice. A number of image blending techniques have been used to combine the exposure brackets ranging from manually masking the unwanted regions for each camera RAW exposure to creating HDR files using Adobe Photoshop, Adobe Lightroom and HDRSoft Photomatix and subsequently tonemapping them in software or using Adobe Camera RAW. Adobe Lightroom has been the primary software used to copy the image files from the memory card to the hard disk and importing or adding it in the Adobe Lightroom catalogue. Any metadata that needs to be added such as the location where the images where photographed can be done during the time of import. Adobe Lightroom uses a non-destructive approach to image editing and any parameter changes to the image files can be stored as .XMP sidecar files. Adobe Lightroom also allows for a considerable level of camera RAW file editing as well as merging exposure brackets directly to a tonemapped image file, and, stitching multiple panorama tiles together. Some panorama ties, however, did not stitch properly and had to be exported to Adobe Photoshop which was found to be more successful in terms panorama stitching.

Creating tonemapped images directly from Adobe Lightroom can be limiting as well given that Lightroom does not offer localised control for ghost removal or the option to generate a 32-bit HDR file prior to the creation of the tonemapped image. Adobe Lightroom was used to create quick previews of what the final image could look like and experiment with the image look. In most cases, where there were not ghosting issues, these results were demed sufficient to be outputted as the final images. In cases where localised ghosting control was required, HDRSoft Photomatix was used. HDRSoft Photomatix is specialist HDR blending and tonemapping software and allows considerable localised custom control over ghosting prior to HDR creation. Tonemapping in HDRSoft Photomatix was found to be relatively aggressive accentuating noise, softening fine details and creating localised halos as opposed to tonemapping in Adobe Photoshop. HDRSoft Photomatix was therefore, more successful in creating a painterly look where the fine details in the image were softer and blended more with the neighbouring pixels (Figure 27). It is also possible to save 32-bit HDR images from HDRSoft Photomatix that can be imported into Adobe Lightroom for further tone and colour adjustments. Adobe Photoshop also allows for HDR file creation but there is no localised control over ghosting. The tonemapping in Adobe Photoshop using Adobe Camera RAW utility can be useful for creating more photorealistic image looks (see Figure 28) as opposed to HDRSoft Photomatix.

Figure 27: "The Curves of Kimmeridge" by Rehan Zia (2012)

Figure 28: "Swing by the lake" by Rehan Zia (2016)

Adobe Photoshop and Helicon Soft Helicon Focus were used for focus stacking operations. Whilst Helicon Focus produced better results in terms of minimising artifacts, Adobe Photoshop offered better local control for intervention given the layer masks generated for each of the exposure brackets where regions fell out of focus. An example of this issue can be found in section 5.3.4.

4.8.1 Postproduction control flow

When photographing using HDR, gigapixel photography and focus stacking techniques, the order of combining the images together is to combine exposure brackets for each of the gigapixel/panorama tiles, then digitally stitch the panorama tiles together for each focus stack. Finally, the resulting gigapixel/panoramic images for each focus stack are combined together. This is because panorama stitching results can be slightly different and if the stitching for each exposure bracket is done prior to HDR processing, the resulting image may produce issues where elements in the differently exposued panorama images do not line up. HDR processing per tile also does not require as much processing power as processing the entire panorama. Focus stacking can be done per tile once the images have been tonemapped but this can be a laborious process and since focus staking even with large panoramas does not take much time to process, it is just more convenient to do this at the end.

4.9 Step by step guide to the RZS with examples

4.9.1 Basic setup for stack-based HDR photography whilst maximising data sample quality in each exposure and having a greater chance of capturing the Decisive Moment

The following steps outline the procedure for capture of stack-based HDR photography where panorama stitching or focus stacking is not required.

1. Test and define the acceptable EV range for each ISO – this only needs to be done once for the camera being used by the practitioner prior to photography. The acceptable EV range informs the bracketing interval and also the amount of shifting of the entire exposure range to the right in order to have the acceptable level of data samples across each stop of the HDR image.
2. The darkest and brightest points in the scene should be measured using an in-camera spot meter that would provide the slowest and fastest shutter speeds for the exposure stack's brightest and darkest exposures respectively. However, these exposure times are for mid-grey exposure levels that may not provide the best data samples and therefore all exposures in the exposure stack need to be increased by the acceptable EV range. Figure 29 shows a hypothetical scene dynamic range that spans 15 EVs with the darkest point in the scene denoted by dark green and the brightest point in the scene denoted by light green. Supposing a single photograph can record 10 EVs but the acceptable range at a given ISO is 3 EVs, the bracketing interval should be set to 3 EV and 3 EVs should be added to the exposure time for each exposure bracket to ensure acceptable data samples across the entire dynamic range of the resulting HDR image.

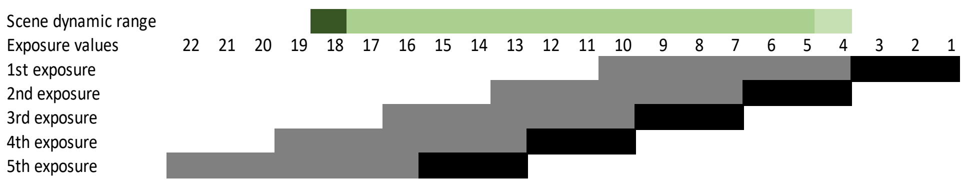


Figure 29: Stack-based photography with ETTR and bracketing interval based on the acceptable EV range.

3. At the scene, identify the region of critical motion and what exposure range is needed to capture the elements within that volume. The exposure bracket(s)

for this tonal range should be photographed first when the critical motion takes place. The exposure brackets for the other regions can be photographed subsequently. This ensures a greater chance of success in capturing the Deceive Moment. The tonemapped image shown in Figure 33 has been created by blending 3 exposure brackets together. The key element bringing about the Decisive Moment in this picture was the shape and density of the fog. Therefore, the underexposed exposure bracket shown in Figure 30 was captured prior to capturing the middle exposure for the lighter regions of the ground in Figure 31 and the darker regions of the landscape as show in Figure 32. Photographing the exposure brackets in this order allowed for timing the key element in the precisely desired form and space as well as good exposure in terms of data samples. The other elements were not as time critical given that they either did not have discernible motion given the focal length used and the relative distance from the camera, or, had localised, ambient, repetitive motion such as leaves waving in the wind.

4. The image exposures can be blended together using any HDR blending software.

Figure 30: Underexposed exposure bracket photographed first capturing details in the fog and the stream. Priority has been given to the capture of the passing fog to capture the specific pattern of the fog

Figure 31: Middle exposure bracket capturing details in the lighter part of the landscape

Figure 32: Brighter exposure bracket showing details in the darker part of the landscape photographed last

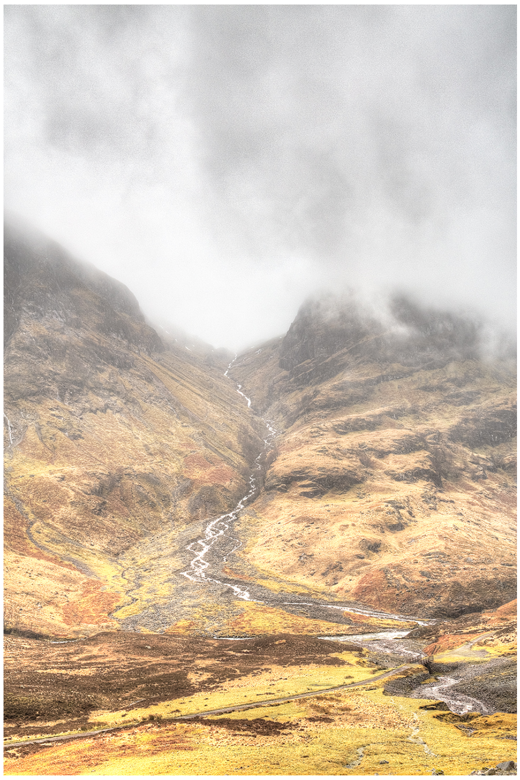


Figure 33: Final tonemapped image showing good texture and shading detail across all the elements in the image whilst capturing the passing fog pattern

4.9.2 Advanced setup for a wider field of view, higher resolution and/or depth compression

The digital panorama technique can be utilised in conjunction to the basic stack-based HDR photography setup discussed in section 4.9.1. Using this technique, photographers can create a higher resolution image using a longer focal length, photographing multiple HDR panorama tiles and stitching them together compared to using a wider focal length to get the same final image field of view. Longer lenses can also provide depth compression that may be part of the practitioner's desired look for the image. Wider focal lengths can result in considerable lens distortion as well and using this method can help alleviate this issue.

1. Decide whether a single framing would suffice or whether multiple panorama/gigapixel tiles would be required to acquire the desired resolution and depth compression, and, minimise lens artifacts in the final image.

2. Choose a panorama tile framing that covers the top, bottom, left and right bounds of the region of critical motion. Photograph the exposure brackets for this panorama tile first using the process described in section 4.9.1.
3. Photograph all other panorama tiles ensuring there is 25-50% overlap between the framing of one panorama tile to the next.
4. During postproduction, the exposure brackets for each panorama tile should be blended together first to create 32-bit, 16-bit or 8-bit images as required and then these tonemapped tiles can be stitched together using panorama stitching software. Figure 34 illustrates an example of this process showing individual brackets for each exposure of each panorama tile and the tonemapped images for each tile. Figure 35 shows the final stitched panorama image.

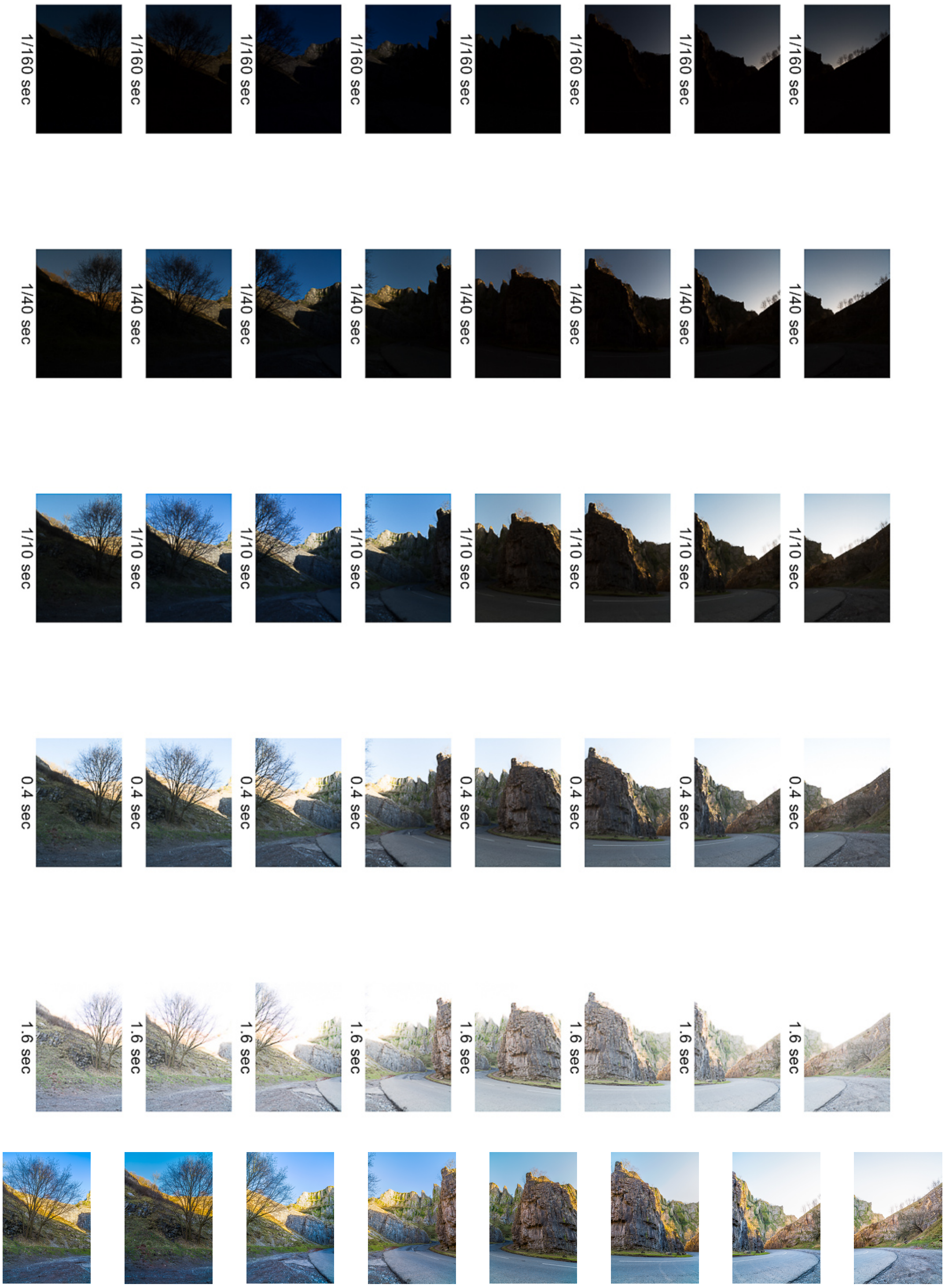


Figure 34: Given that it was not possible to fit the entire landscape in the frame of the widest lens (21mm) available, this image of Cheddar Gorge was created by photographing 8 tiles each comprising of 5 exposure brackets 2 stops apart. These images along with the exposure times are shown in the first 5 rows. The exposure brackets for each tile were used to create a tonemapped image for each tile as shown in the bottom row. These tonemapped tiles were then stitched together to create the final panorama image.

Figure 35: "Cheddar Gorge" by Rehan Zia (2016)

4.9.3 Advanced setup to minimise ISO noise, reduce diffraction and/or allow faster shutter speeds

The use of focus stacking allows for wider apertures to be used that can allow for lower ISOs and faster shutter speeds to be utilised minimising ISO noise and freezing action respectively. This technique can also reduce diffraction artifacts apparent at smaller apertures.

1. Choose an acceptable aperture that provides sufficient depth of field to cover the entire near to far distance of the region of critical motion. If there is overlapping motion in the foreground and background elements, these regions should also be included in the region of critical motion.
2. Start with photographing all required exposure brackets for the region of critical motion first at the chosen aperture using the steps described in section 4.9.1.
3. The exposure brackets for each focus stack should be blended to create a HDR or tonemapped image first and the resulting images can then be focus stacked.
4. If photographing for a panorama, without changing the focus, photograph all the other panorama tiles using the process described in section 4.9.2. This will greatly reduce the need for refocussing multiple times for each tile.
5. Once all the exposure brackets for each panorama tile of this focus distance have been captured, this process can be repeated for each of the focus distances of the focus stack in order to render extensive depth of field across the entire

scene. If using both focus stacking and panorama, photograph all panorama tiles at each focus distance before moving on to the next focus bracket.

6. The exposure stacks with the same focus distance and framing should be combined first to create HDR or tonemapped images. These HDR or tonemapped images for each focus distance should be stitched together first and then the resulting panoramas for each focus distance can be focus stacked. The individual exposures for "View from The Shard" (see 5.3.6) illustrate this example; Figure 36 shows the exposure brackets for the foreground panorama tiles with the focus set to the foreground, Figure 37 shows the exposure brackets for the midground and background panorama tiles with the focus set further away, Figure 38 shows the tonemapped tiles. Figure 51 shows the final HDR panorama.

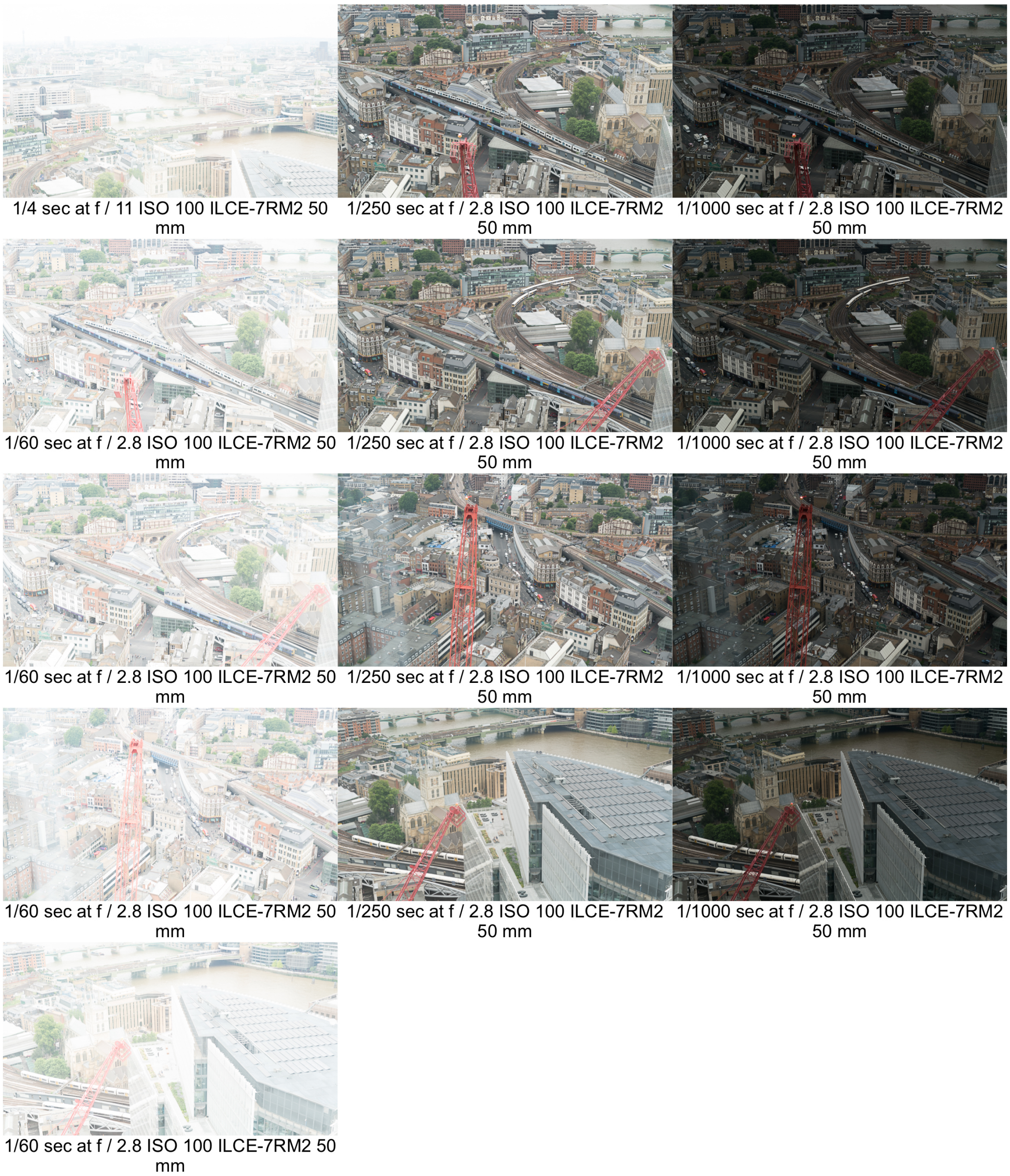
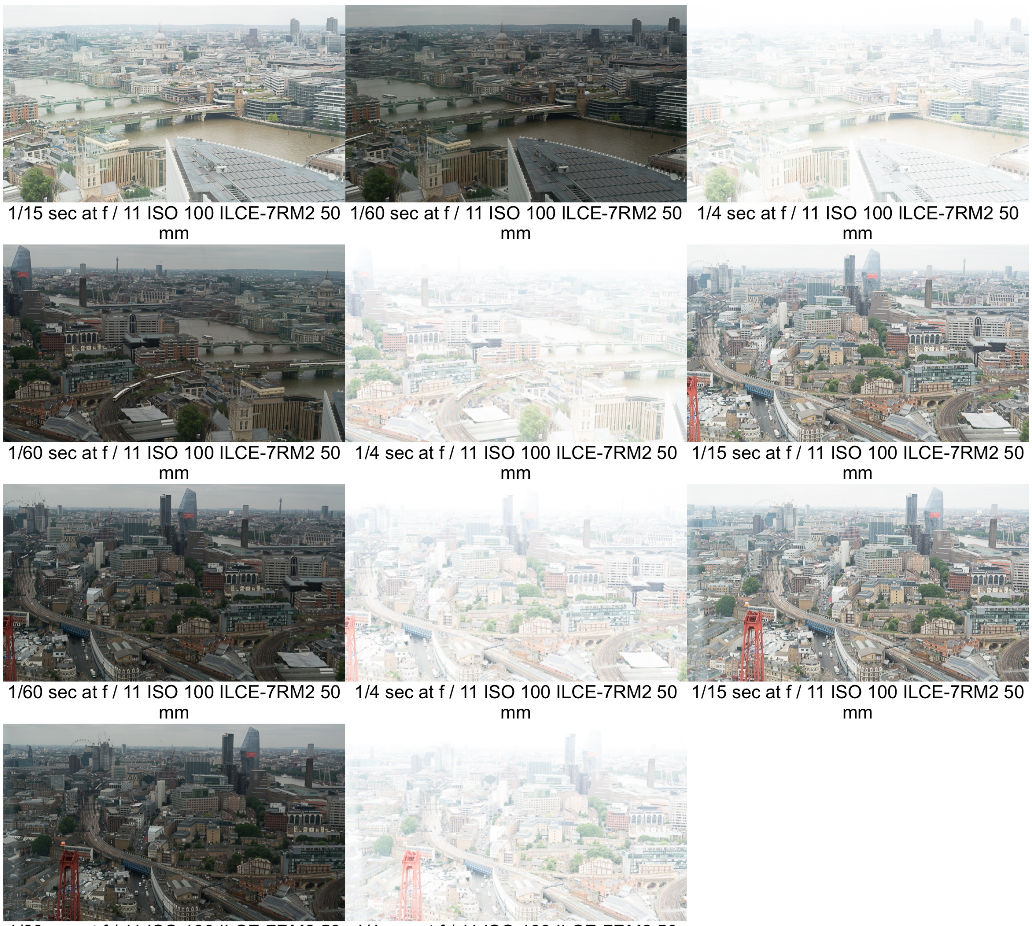


Figure 36: Exposure brackets for the foreground



1/15 sec at f / 11 ISO 100 ILCE-7RM2 50 mm | 1/60 sec at f / 11 ISO 100 ILCE-7RM2 50 mm | 1/4 sec at f / 11 ISO 100 ILCE-7RM2 50 mm

1/60 sec at f / 11 ISO 100 ILCE-7RM2 50 mm | 1/4 sec at f / 11 ISO 100 ILCE-7RM2 50 mm | 1/15 sec at f / 11 ISO 100 ILCE-7RM2 50 mm

1/60 sec at f / 11 ISO 100 ILCE-7RM2 50 mm | 1/4 sec at f / 11 ISO 100 ILCE-7RM2 50 mm | 1/15 sec at f / 11 ISO 100 ILCE-7RM2 50 mm

1/60 sec at f / 11 ISO 100 ILCE-7RM2 50 mm | 1/4 sec at f / 11 ISO 100 ILCE-7RM2 50 mm

Figure 37: Exposure brackets for the midground and background

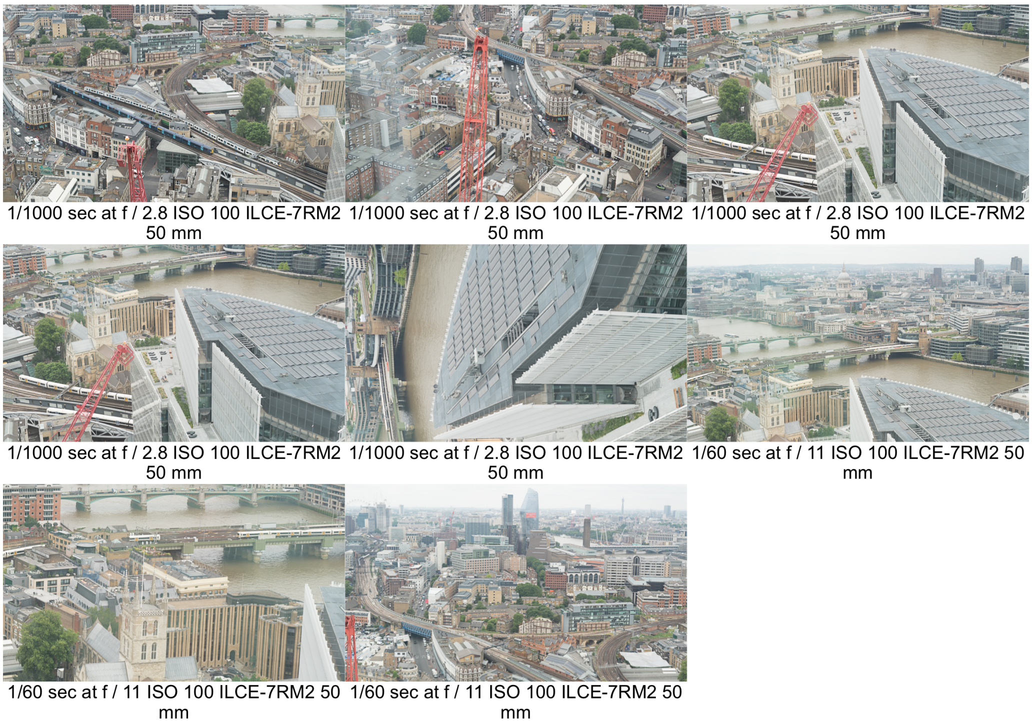


Figure 38: Tonemapped panorama tiles

4.10 Critical analysis of RZS

The individual exposure brackets and focus stack images allow for a more extensive control during postproduction as adjustments can be made based on exposure values, and, scene depth whilst the use of digital panorama technique allows for greater resolution using longer focal lengths.

RZS requires a high number of exposures to allow for better flexibility in post. Capturing these exposures takes more time and considerable space on the memory cards and on disk. The blended HDR files, stitched panoramas and stacked final results can take up even more disk space and also require considerable processing power and memory. As the workflow relies on taking a large number of exposures photographed over time, the number of exposure brackets, focus brackets and panorama tiles should be considered carefully as misalignments will create ghosting errors. The sheer number of images captured can also be daunting to work with especially when these needs to be processed and combined before one can see the final result.

4.11 Summary

The best practice workflow developed in the form of RZS provides greater flexibility to practitioners to be able to use wider apertures, faster shutter speeds, lower ISOs and longer focal lengths whilst still being able to capture the Decisive Moment and minimising lens, camera sensor and HDR processing artifacts. RZS facilitates this by providing the practitioner, the ability to capture HDR images based on the practitioner's choice of acceptable exposure values and ISOs. A number of different multi-shot photography techniques can be employed to allow photographers to achieve the optimal results based on their creative intent, craft expertise, and, tool, logistical and situational constraints.

5 RESULTS

5.1 Introduction

The images presented in this chapter are a small selection of the works created as part of this research study. A wider selection of work was presented at the viva exhibition. Larger size versions of these images along with the histograms showing the dynamic ranges are provided in the Portfolio.

The images presented in this chapter are in chronological order of the practice-led research study.

5.2 Postproduction methods used

Adobe Lightroom was the key software for importing files from memory cards to disk, creating an image catalogue and RAW file adjustments. As a starting point, Adobe Lightroom was also used for blending the exposure stacks together for all of the images presented as well as stitching the tonemapped panorama tiles, except in the case of "Lulworth Cove Panorama" (see 5.3), "Splash!" (see 5.3.4), "View from Shard" (see 5.3.6) for which Adobe Photoshop was used. In case of "Lulworth Cove Panorama" , this was mainly due to Adobe Lightroom not being installed on the computer I was using at the time. Adobe Lightroom has been the primary software used for importing and copying files from memory cards to the hard disks and doing preliminary image blending. Adobe Photoshop was utilised for the blending of focus stacks for "Splash!" and "View from Shard" due to a higher level of localised user control being required when blending the focus stacks. Adobe Lightroom was used for preliminary postproduction processes and tonemapping in both these cases.

If the results of this initial exposure blending require further control over regions due to ghosting or misalignments, then the exposure brackets are exported from Adobe Lightroom to HDRSoft Photomatix. HDRSoft Photomatix offers much finer controls to fix ghosting artifacts including a manual selection mode that lets users select regions with discernible ghosting. HDRSoft Photomatix does however produce images that have more localised haloing and softness in rendition of fine details than Adobe Lightroom or Adobe Photoshop. The overall image look therefore tends to be slightly more painterly than photorealistic given the local softening of fine details.

5.3 Images

5.3.1 Lulworth Cove Panorama

Figure 39 "Lulworth Cove Panorama" by Rehan Zia (2013)

Camera: Canon EOS 5D Mark II
Lens: Canon 24-70mm F/2.8 II USM at 24 mm
Number of exposures brackets: 3
Aperture: F/18
ISO: 100
Shutter speed(s): 1/60th of a sec., 1/250th of a sec., 15th of a sec.
Number of panorama tiles: 6

5.3.1.1 Introduction

Lulworth cove is one of the early HDR panoramas that was created as part of this research and was fraught with challenges in terms of both the high scene dynamic range, and, the movement within the scene. The creative intent behind the image was to show a grand vista and with an uplifting atmosphere that reflected the mood of the environment on this sunny day. The emotion I wanted to convey in this image is similar to that of "Bathers at Asnières" by Georges Seurat (1884) albeit with the texture details and sense of tonality found in the paintings of John Constable in terms of detail in the shadows, water and sky.

5.3.1.2 Image capture

The image was photographed as a HDR panorama with the camera in vertical orientation on a tripod that did not have a nodal head starting from the left of the image and panning to the right for each HDR panorama tile. Given the bright light, relatively faster shutter speeds could be utilised even when using a small aperture to cover the entire depth of field of the scene. Focus stacking was not used as I was not very familiar with this technique and had not tested it in the landscape setting.

5.3.1.3 Processing and postproduction

The final image was created using Adobe Photoshop as I did not have access to Adobe Lightroom on the computer at the time. Exposure brackets for each panorama tile were blended to create 16-bit tonemapped images that were digitally stitched to create the panoramic image (see Figure 40).

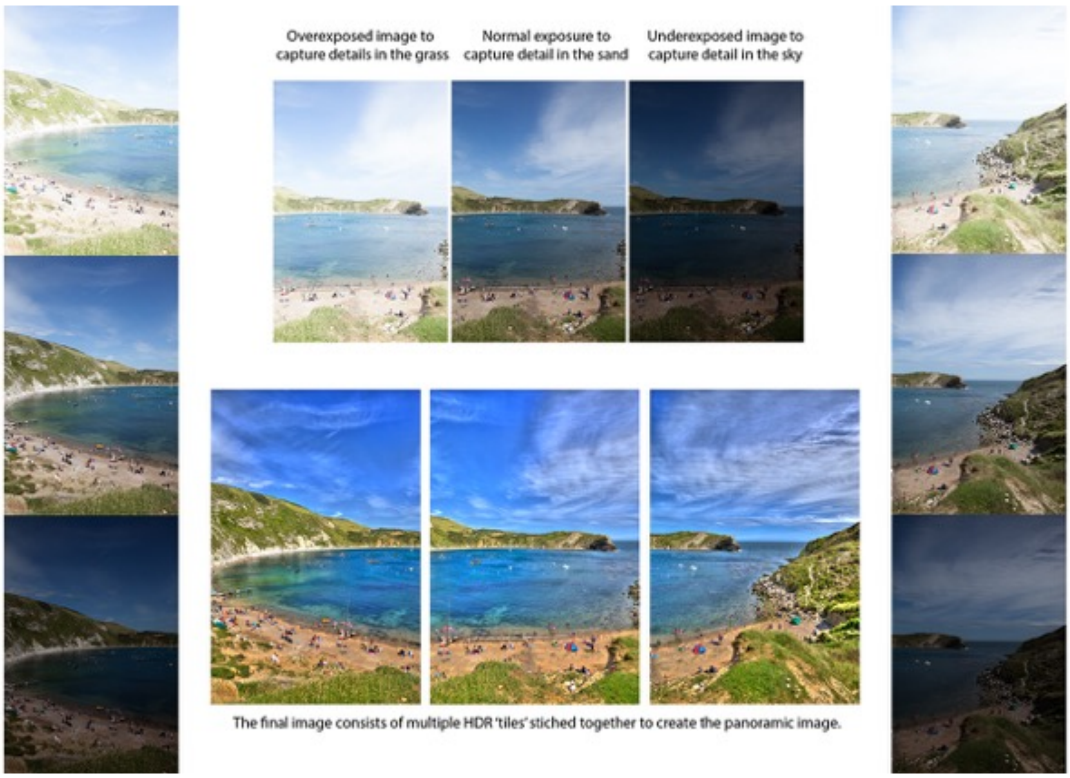


Figure 40 An illustration of the constituent images used to create "Lulworth Cove Panorama"

5.3.1.4 Reflection

Given the number of people on the beach moving around, the movement of the sea and the sky, the dynamic range of the scene and the fact that in order to create the previsualised framing, I had to resort to a digital panorama that made ghosting and stitching errors in this image extremely challenging to clean up in postproduction. The earlier version had a four-armed boy stepping into the water and a number of other 'ghosts'. Having gone through the postproduction clean up process, it is evident that the most difficult area is that of the beach where the people are moving around and create HDR ghosting and panorama stitching issues.

On hindsight, it would have been useful to isolate this region using focus stacking and photograph this region first to minimise ghosting issues. The clouds and water were more forgiving when it came to layering and blending of multiple exposures and digital panorama stitching, and therefore, this setting would have been a good candidate for focus stacking with one depth-of-field volume that covered the beach section with the people and the other starting from the middle of the cove and covering everything up to the horizon. Having the focus blending taking place in the middle ground would have helped a smooth transition and kept any focus staking artifacts small enough given the parallax to not be too apparent.

5.3.2 Sligachan Bridge

Figure 41: "Sligachan Bridge" by Rehan Zia (2014)

Camera: Canon EOS 5D Mark III
Lens: Canon EF 28mm f/1.8 USM
Number of exposures: 7
Aperture: f/16
ISO: 400
Shutter speed(s): 1/1250 sec., 1/320 sec., 1/80 sec., 1/20 sec., 1/5 sec., 0.8 sec.

5.3.2.1 Introduction

This image is an example of the earlier phase of the research that aimed to emulate the painterly look which was the first aim of the research (see 1.7).. The photography took place on an overcast day when the scene dynamic range was low. The colours in the final tonemapped image were enhanced during postproduction to see how far they could be pushed. It is interesting how the lack of contrast in the background due to the mist rendered the mountains as flat surfaces adding to the effect. The water has not too problematic when it came to ghosting issues. However, there were some chromatic aberration issues that became more prominent when the colours were pushed. In the later version, however, lens correction was applied as a pre-process that rectified this issue. The colour palette is similar to that found in David Hockney's paintings. shows the more naturalistic colours that were there in the scene.

Figure 42: One of the exposure brackets for "Sligachan Bridge" with the highlights and exposure slightly reduced

5.3.2.2 Image capture

The image capture process was very straight forward with six exposure brackets shot two stops apart. The gentle mist added to the overcast environment bringing down the overall contrast of the scene.

5.3.2.3 Processing and postproduction

The tonemapped image was created by blending the exposures in Adobe Lightroom. Selective colour manipulation as well as the basic exposure, shadow, highlights, contrast, saturation, vibrance and clarity parameters were used to create the final look.

5.3.2.4 Reflection

In the first version of the image, there were noticeable chromatic aberrations in the small white waves in the foreground. These were eliminated in the latest version by using chromatic aberration removal on each of the individual RAW exposures prior to generating the tonemapped image.

5.3.3 Masjid Wazir Khan

Figure 43 "Wazir Khan Masjid Panorama" by Rehan Zia (2017)

Camera: Canon EOS 5D Mark III
Lens: Zeiss ZF 21mm f/2.8 T* Distagon
Number of exposures brackets: 3
Aperture: f/8
ISO: 1600
Shutter speed(s): 1/1600th sec., 1/400th sec., 1/100th sec.
Number of panorama tiles: 9

5.3.3.1 Introduction

I had never visited Majid Wazir Khan before and was immediately taken by the architecture and fine engravings everywhere on the building. I was allowed to go up one of the minarets on the condition that I would not be using the tripod. This panorama was thus created using a hand-held camera supported on the small minaret wall edge to reduce camera shake.

I wanted to have sufficient depth-of-field to cover the entire building as well as the other buildings visible in the background as well as the tonal range to cover the scene dynamic range.

5.3.3.2 Image capture

Given that a tripod could not be used, it was challenging to keep the camera stable across the exposure brackets. Therefore, a high ISO setting of 1600 was used. The use of a wide-angle lens reduced the number of panorama tiles required to cover the entire previsualised framing. It does, however, result in considerable distorttion in the stitched panorama which is not ideal. There were a number of people moving in the courtyard but it has not resulted in too much ghosting. In this particular case of photographing without a tripod, the use of focus stacking would not have been possible as it would have increased the number of total panorama tiles required by double or treble depending on the number of focus distances photographed, as well as increasing the chances of misalignments. The soft, wide light of the sun was also changing fast and required fast action to be able to capture it before it faded.

Given the fact that a tripod could not be used, supporting the camera on the wall and use of a wide-angle lens worked well in terms of documenting the environment but was not fully successful given the distortion apparent in the panorama. This was a difficult choice as using a longer lens would have required more time to photograph the increased number of panorama tiles to capture the same panorama framing. The increase in the number of tiles would also have increased the probability of misalignments and ghosting. Also, the longer the lens is, the less forgiving it is to the slightest camera movement. Without being able to use a tripod, it was risky to resort to a longer focal length. The scene dynamic range captured was enough to render the creative vision for the image look and given that there are no ghosting issues, this image is a good technical acheivement under the circumstances.

Figure 44 This image illustrates the handheld but supported camera method used to photograph "Wazir Khan Masjid Panorama" from the top of one of the minarets. Tripods were not allowed.

5.3.3.3 Processing and postproduction

The exposure brackets for each panorama tile were blended to create 16-bit tonemapped tiff images inside Adobe Lightroom. The final panoramic image was also created in Adobe Lightroom by digitally stitching the tonemapped images together.

5.3.3.4 Reflection

Given the logistical tool constraints of not being able to use the tripod and as a consequence, a normal or telephoto lens, the final image has noticeable distortion. Interestingly, this look fits quite well with the circular motif of the domes of the mosque and therefore no effort was put in trying to undistort the panorama tiles before stitching.

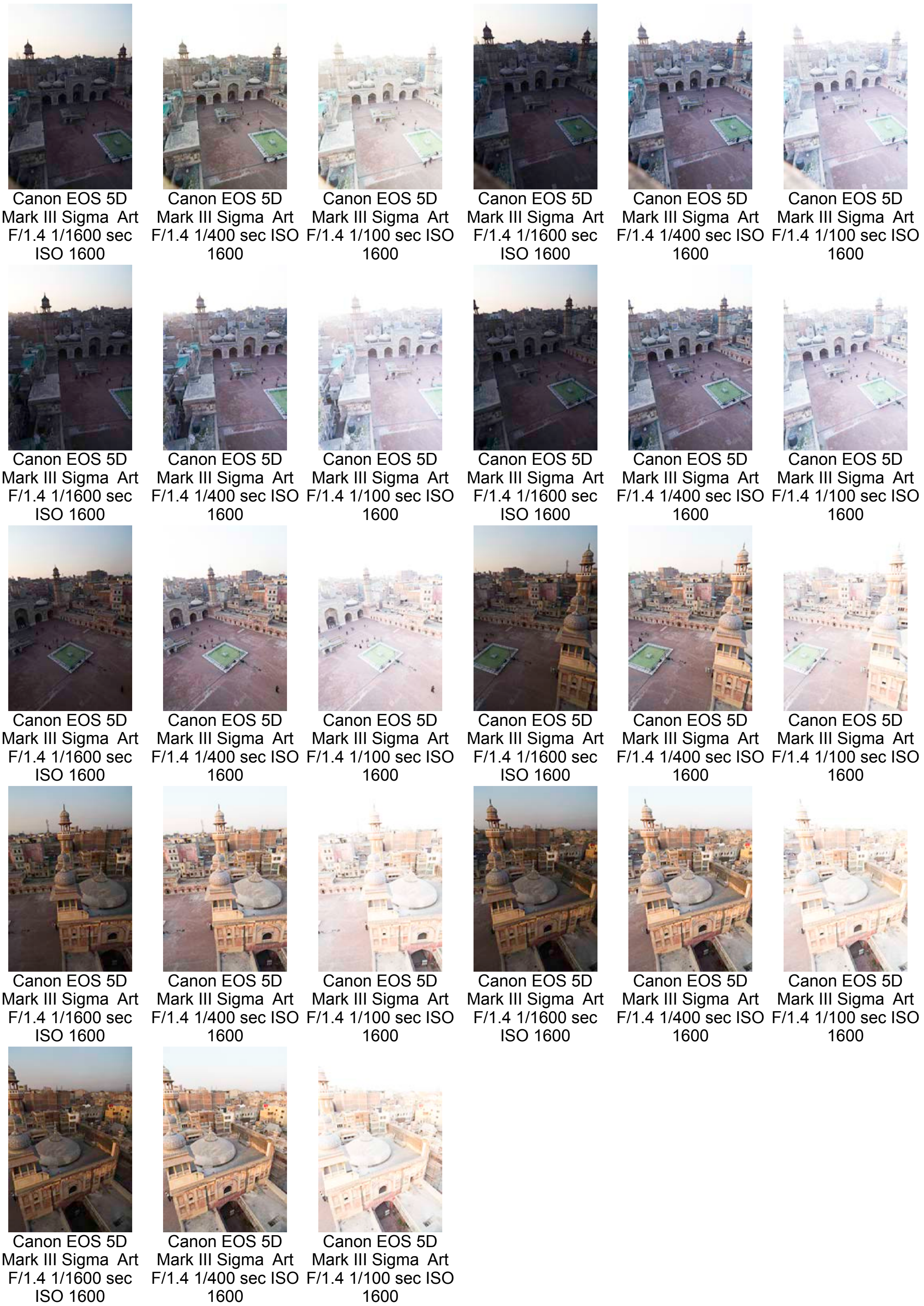


Figure 45 This image shows the individual exposures photographed to create "Wazir Khan Masjid Panorama"

5.3.4 Splash!

Figure 46 "Splash!" by Rehan Zia (2018)

Camera: Canon 5D Mark III
Lens: Sigma 35mm f/1.4 Art
Number of exposures brackets: 3
Aperture: f/1.4
ISO: 400
Shutter speed(s): 1/250th of a sec., 1/1000 sec., 1/4000th sec. for each of the focus distances photographed

5.3.4.1 Introduction

This image was created as an exercise to test the RZS and whether faster shutter times can be utilised by incorporating focus stacking to capture a key moment when the wave breaks. A combination of focus stacking and high dynamic range photography has been utilised for this image. Focus stacking allowed for the use of a wide aperture and faster shutter speeds for the motion of the wave to be frozen along with an extended depth-of-field ensuring foreground to background scene elements to be in sharp focus. This, otherwise, would not have been possible, given the low natural light available. The use of focus stacking also ensured no diffraction artifacts were introduced. HDR brackets were photographed for each focus distance that allowed greater tonal range and latitude during postproduction.

5.3.4.2 Image capture

The images were photographed using a Canon 5D Mark III camera with a Sigma 35mm f/1.4 Art lens. The exposure brackets were shot at 1/250th of a second, 1/1000 of a second and 1/4000th of a second, at f/1.4, ISO 400. A cable remote as well as HeliconSoft Remote (2018) app on a Samsung Note 8 (Android) phone was used to control the camera. The low number of brackets ensured the Decisive Moment of the breaking wave was captured without any ghosting issues. The wide exposure bracketing interval allowed for extended tonal range but reduced tonal overlap in order to minimise ghosting. The aperture at f/1.4 provided just enough depth-of-field to cover the breaking wave when the lens was focussed at that distance. Once the motion of the breaking wave was photographed using the exposure bracket values specified using the camera burst mode, the camera was connected to an Android phone running Heliconsoft HeliconRemote software. HeliconRemote allows photographers to specify near and far focal distance range in the scene and the software photographed all in between focal lengths required for focus stacking, along with the exposure brackets for each focal distance.

5.3.4.3 Processing and postproduction

The exposure brackets for each focus distance were first tonemapped and then focus stacked in Heliconsoft HeliconFocus. HeliconFocus provides significantly better blending results for focus stacking compared to Adobe Photoshop, however, does not have the layer masking tools and control over localised adjustments that Adobe Photoshop offers. Therefore, the images for the focus distance where the wave broke were substituted for the manually photographed exposures of the breaking wave but there was also some fine tuning required which was done in Adobe Photoshop by masking certain focus brackets and revealing others.

Whilst the widest aperture was perfect for isolating the scene depth where the wave broke and worked for the background, it was not necessary for the foreground region which could have been photographed using relatively smaller apertures such as f/2.8 or f/4 which would not have reduced the number of focus distances photographed and resolved some of the issues that resulted from the shallow depth-of-fields and the number of focus distances stacked. This goes to show that you need to plan the shoot by critically analysing the elements in the scene. Whilst focus stacking can work quite well and provide greater flexibility and control during postproduction, you have to decide the granularity by carefully considering the overheads which comes through practice.

Figure 47: This image shows a tonemapped image with just about the area of the crashing wave in sharp focus

5.3.4.4 Reflection

This workflow and the resulting image proved to be a successful experiment. The fury of the breaking wave was rendered as a moment frozen in time by utilising focus stacking that in turn allowed for faster shutter speeds to be used. On hindsight, the amount of focus brackets could have been reduced by using a narrower aperture producing greater depth of field for the beach elements. All of the stones and sand on the beach was stationary and therefore there was no point in using multiple focus brackets for this region. Given that none of the foreground elements are moving, slower shutter speeds would could have been used to compensate for use of a smaller aperture. However, given the use of the remote triggering software, there was no option available to the user to allow for customisation to this level where the closer focus distance brackets could be shot with a smaller aperture and slower shutter speed, and, the middle and far distance brackets could be shot with a wider aperture and faster shutter speed.

5.3.5 Bournemouth in Snow

Figure 48 "Bournemouth in snow" by Rehan Zia (2018)

Camera: Sony A7R II
Lens: Canon 135mm f/2 L USM
Number of exposures brackets: 3
Aperture: f/8
ISO: 100
Shutter speed(s): 1/60th of a sec., 1/250th of a sec. and 1/15th of a sec. for each of the two focus distances photographed
Number of panorama tiles: 17 (6 for foreground, 11 for background)

5.3.5.1 Introduction

Snowfall in Bournemouth does not happen very often and I had been wanting to create this panorama for a number of years. It snowed on four days in early 2018 and every single day I tried to get to Hengistbury Head but on the first two days found the fallen snow not dense enough whist on other two days, it was so slippery that I could not even get across the car park. I finally got a chance on the last day as the light was fading.

I wanted to show a highly detailed panoramic view of Bournemouth at twilight/dusk that captured the dynamic range and fine image detail but was free of diffraction issues, and, camera and lens artifacts. The issue I found with this particular view from Hengistbury Head was that the foliage can look a bit dull at this time of the day and given that it covers the foreground and midground, it can take the emphasis away from the view of Bournemouth in the distance.

The main challenge was to ensure extensive depth-of-field whilst keeping diffraction issues such as noise and starburst effects to a minimum whilst also capturing a high dynamic range.

5.3.5.2 Image capture

Six panorama tiles were used to photograph the foreground with the lens aperture set to f/16 and eleven tiles were used for the background with the aperture set to f/8. Three exposure brackets were used that were two stops apart.

5.3.5.3 Processing and postproduction

The images were combined to HDR and tonemapped in Photomatix using batch automation. The images were then focus stacked in Adobe Photoshop. The resulting images were first tonemapped and stitched for the foreground and background respectively. The resulting background and foreground panoramas were then focus stacked in Adobe Photoshop and colour matched as there was a colour discrepancy owning to the change of light over time when these two focus distances were photographed.

Digital panorama stitching allowed for the use of a telephoto lens and higher detail and resolution in the image than would be possible in a single framing using a wide-angle lens. Focus stacking helped minimise diffraction artifacts and high dynamic range photography enabled a wider scene tonal range to be captured.

5.3.5.4 Reflection

Whilst the dynamic range is good, I feel one more underexposed exposure bracket would have been useful to bring a little more detail to the lights. Splitting the background depth volume into two – one for the midground and one for the background – would have helped open the aperture wider to reduce what little remains of the starburst effect in the lights. These are, however, minor points that can be improved but the image still works and is in line with the creative intent.

Figure 49: This image shows the depth-of-field difference between the two focus distances used as well as the change of colour with the passage of time

Figure 50: This image shows a 100% zoom of the final image showing the fine image details in the background

5.3.6 View from The Shard

Figure 51: "View from The Shard" by Rehan Zia (2018)

Camera: Sony A7R II
Lens: Sigma 50mm F/1.4 Art
Foreground focus:

- Number of exposures brackets: 3
- Aperture: f/2.8
- ISO: 100
- Shutter speed(s): 1/250th of a sec., 1/1000th of a sec., 1/60th of a sec.,
- Number of panorama tiles: 3

Mid and background focus:

- Number of exposures brackets: 3
- Aperture: f/11
- ISO: 100
- Shutter speed(s): 1/15 of a sec., 1/60th of a sec., 1/4th of a sec.
- Number of panorama tiles: 4

5.3.6.1 Introduction

This image was created from one of the restaurants inside The Shard as a conference demonstration for Rehan's Zone System. The intention was to show a panoramic view of London with some foreground interest by photographing the trains as they crossed across the railway tracks.

5.3.6.2 Image capture

In order to get the best possible scene dynamic range and freeze the motion of the trains without any motion blur, the trains were photographed first using a wide aperture that allowed for faster shutter speeds and a low ISO. The rest of the cityscape was photographed around the first image. The panorama tiles for the foreground were photographed at an aperture value of f/2.8 whilst the panorama tiles for the background were photographed at an aperture value of f/11.

5.3.6.3 Processing and postproduction

Interestingly, all the background and foreground tiles blended together when the image was digitally stiched without any need for the focus stacking operation as whatever overlap there was in the scene features across the images was in relatively sharp focus. The fact that this is a cityscape with hard, solid structure and very little scene elements such as trees or foliage up close to the camera where the motion of the scene element would be more apparent also helps. One of the issues in this image were the moving cranes that appeared in different positions in multiple different tiles of the HDR panorama over the course of photography. This issue was overcome by just being patient and waiting for an opportunity when they were stationary.

5.3.6.4 Reflection

This examples illustrates that focus stacking, if used intelligently and across larger depth-of-field volumes, can reduce diffraction without causing too many misalignment issues. Another interesting insight is that if relatively good depth of field is used in a landscape setting with linear perspective so that each tile has all the elements in focus, it elimanates the need for focus stacking when stitching the panorama.

5.3.7 Flowers by the sea

Figure 52: "Flowers by the sea" by Rehan Zia (2018)

Camera: Sony A7R II
Lens: Sigma 50mm F/1.4 Art
Foreground focus:
    Number of exposures brackets: 3
    Aperture: f/16
    ISO: 50
    Shutter speed(s): 1/3rd of a sec., 1/25th of a sec., 2.5 sec.
    Number of panorama tiles: 3
Background focus:
    Number of exposures brackets: 3
    Aperture: f/2.8
    ISO: 200
    Shutter speed(s): 1/320th of a sec., 1/2500th of a sec., 1/40th of a sec.

5.3.7.1 Introduction

This image was created as a study to test two regions of motion – the plants and the sea - that overlapped. The focus stack consisted of two points of focus – one for the foreground plants and the other for the sea in the background. The intent was to capture an image that displayed a high dynamic range, tonepped as well as a deep depth-of-field whilst freezing the motion in the waves.

5.3.7.2 Image capture

The foreground was photographed using the smallest aperture on the lens, f/16 in order for the depth-of-field to fully encompass the plants at such a close focus distance. The use of relatively longer shutterspeeds was possible given that there was not much movement in the plants. The lowest ISO available was used in order to ensure that there was no noise in the foreground given how much space the foreground element covered in the image composition (see Figure 53). The background was photographed using a relatively wide aperture, f/2.8, that allowed for a faster shutterspeeds to be used in order to render the waves without too much motion blur. The ISO was pushed to 200 to further facilitate the faster shutterspeeds.

5.3.7.3 Processing and postproduction

The main issue when focus stacking the tonemapped foreground and background images was the region where the silhouette of the plants intersected the sea given that there was some motion blur in both the foreground and background elements (see Figure 53 and Figure 54). This was resolved to a great extent using HeliconFocus Method C (Pyramid).

Figure 53: Tonemapped image with the plants (foreground) in focus

Figure 54: Tonemapped image with the sea (background) in focus

5.3.7.4 Reflection

This example demonstrates to what extent overlapping regions of motion can be resolved. The final image has considerable detail in tones and texture with both the plants and the sea in sharp focus. However, this are still some ghosting and compositing issues where the plants in the foreground intersect with the sea in the background.

5.4 Discussion

Over the course of the research study, the craft processes were iteratively refined in order to meet the research objectives (see 1.9).

5.4.1 Tool constraints

A range of tool constraints were identified whilst engaging with the practice that proved to be an obstacle to the smooth creative flow and compromised creative control over the images.

The customisation control available to photographers when using exposure and focus bracketing on most digital cameras, for example, is restricted to the number of brackets and a set bracketing interval in between but the ability to set different intervals between different brackets is lacking. For example, the photographer may need a 2 stop interval between the first and second exposure bracket and a 5 stop interval between the second and third bracket. The ability to use combinations of super resolution, exposure bracketing and focus bracketing in conjunction are also not available.

Given that the domain of this research study was craft practice and not tool development, a number of workarounds had to be found in order to overcome these tool constraints.

5.4.2 Location constraints

In addition to the tools constraints, the practical and logistical challenges of the scene locations also had to be circumvented. Each scenario, therefore, presented a unique challenge based on the tools available, the location constraints and the available light and weather at the time as well as the level of practitioner expertise that developed over the course of the study.

5.4.3 Best practice workflow

A best practice workflow emerged in the form of a method of visualisation (see 3.4) and an image capture process and workflow (see Chapter 4) that was tested and refined over the course of this practice-led research study. The processing and postproduction method (se 4.8) allowed for greater localised control.

The results achieved using the RZS were a success in that they met the research objectives outlined in section 1.9. The RZS in itself has developed into a robust and advanced system and whilst it may not appeal to novice practitioners (see 4.10), it can certainly benefit more advanced users in the areas of photography and visual effects in terms of efficient scene dynamic range capture with high data samples, minimal artifacts and greater chance of capturing the Decisive Moment.

5.4.4 Limitations of earlier methods

The methods and workflows employed by HDR practitioners (see 2.12) relied on measuring the scene dynamic range and setting the exposure range accordingly. Whilst some practitioners have considered exposing to the right (see 2.12.4), this has not been implemented across the entire exposure stack compromising the data samples in the darker regions and the latitude available during postproduction. Critical analysis of motion within the landscape, best practice for photographic capture to ensure minimal ghosting using stack-based HDR photography and consideration for capturing the Decisive Moment when using stack-based photography techniques has also been missing in the earlier methods (see 2.12).

5.4.5 The image looks

The results presented in this chapter and the portfolio are only a small subset of the 27 prints exhibited in thesis exhibition. These images have demonstrated a wide range of image looks - ranging from the photorealistic (see 5.3.6) to the painterly (see 5.3.2) - that have been made possible with the visualisation method (see 3.4.3) and image production workflow (see Chapter 4) that evolved over the course of this research study.

5.5 Summary

Overcoming the physical, logistical and tool constraints is important in being able to capture the photograph that corresponds to the visualised look in the mind's eye of the practitioner.

This chapter has presented a selection of the range of image looks that have been made possible by utilising the visualisation method and production workflow developed. Larger versions of the final images are provided in the accompanying portfolio volume that show image details in higher resolution. Practitioner insights into the creative intent, tool and scene constraints, and, production and postproduction processes have been discussed along with reflection on each of the selected images. These details combined provide a holistic overview of behind creative decision-making, and to what extent, the situational constraints were overcome, demonstrating how the RZS can be modified to work across different circumstances.

6 ANALYSIS

6.1 Introduction

The image look and the craft techniques used to create the image are intrinsically interlinked (see 2.3). This research study has sought to find means of emulating image looks produced by older technologies using the latest camera and software tools (see 2.5) and going further to create a more distinct creative look (see 2.13.5). The workflow devised to allow for the capture of the images with the acceptable range of data samples in the form of RZS (see Chapter 4) proved successful given the results (see Chapter 5) produced that are in line with the creative intent and research aims (see 1.7).

The Visualisation method and the RZS photography and postproduction workflow is similar to Ansel Adam's three stp process:

> "Adams' described a three step process: measuring scene dynamic range, adjusting image capture to record the entire scene range, and locally manipulating the print exposure to render the high-range scene into the low-range print." - (McCann and Rizzi 2012, p. 7)

A key difference is the non-destructive workflow that is made possible in the digital realm allowing for reverting back to the original data for reimagining the image look.

This chapter analyses the workflow and image looks created, and, provides the evaluation feedback by expert practitioners.

6.2 Workflow analysis

The visualisation method (see Chapter 3) and Zone System (see Chapter 4) developed over the course of this research study have proved to be a succuss in that they have allowed for maximising the capture of the scene dynamic range whilst allowing for the capture of the Decisive Moment. Furthermore, the Zone System developed has allowed for the use of lens apertures that produce the sharpest focus with the least amount of diffration and chromatic aberrations, faster shutter speeds as well as allowing for low ISOs. The exposure stack captured incorporates ETTR (see 2.12.4) and hence improves the data samples captured reducing noise in the shadows and providing greater latitude during postproduction. This is evident in the final resulting images produced as part of this research study (see Chapter 0).

The non-destructive workflow has allowed for keeping the original image data intact. This has been of great benefit as newer versions of the final images could be created with reduced image artifacts as the software technology improved over time.

The flexibility of the overall workflow developed has allowed for greater experimentation with the image looks, comparison between multiple image looks of the same image, as well as updating of the image look and creating new versions of the images over time as the practitioner craft competency and knowledge of the software tools improved, or, the rendering intent for the image look changed.

It can be argued that the number of individual exposures photographed using RZS is high requiring considerable computing power and storage space on disk (see 4.10), however, as the camera technology improves, some of the overheads in terms of the number of exposures could be reduced by only photographing the brackets required rather than the enitre range at even set intervals (see 5.4.1).

The RZS has received positive peer reviews (see Appendix D).

6.3 Image look analysis

The scene dynamic range captured in the final phase of the research study using the RZS were found to have excellent latitude for postproduction and allowed for a considerable degree of freedom to push the paramters to extremes without incurring issues such as noise or banding. All images produced contain good global contrast in across the landscape. Local contrast has been manipulated to suit the creative intent depending on the creative intent for each image. The earlier works suffered from noise, chromatic aberrations and diffraction issues but the images created in the later phase of the research study presented in Chapter 5 are mostly free of these artifacts owing to the use of the craft workflow developed and perfected over the course of this research study (see Chapter 4). The developed workflow has allowed for the capture of the Decisive Moment unfolding in the scene to be captured whilst also maximising the capture of the scene dynamic range.

6.4 Meeting the research objectives

6.4.1 Maximising dynamic range capture across all relevant scene elements

The first research objective was met by utilising ETTR within the RZS in order to maximise dynamic range across the scene. Offsetting the entire dynamic range of the exposure stack by the acceptable EV range and using the acceptable EV range as bracketing interval allowed for data samples to be captured that would facilitate image latitude during postproduction in line with practitioners' creative intent and allow them to create, and experiment with, different image looks.

6.4.2 Eliminating or minimising image artifacts

By pre-testing what ISO and lens aperture values are acceptable to the image look that the practitioner wants to create, a list of acceptable ISOs for the camera and aperture values for each lens can be generated (see 4.4). The use of focus stacking in conjunction with stack-based HDR photography (see 4.6) allows practitioners to use lowers ISOs and wider apertures whilst still being able to have the enitre scene in focus as demonstrated in Chapter 0. The use of the middle apertures helps to reduce diffraction artifacts as well as producing sharper images that have minimal chromatic aberrations.

6.4.3 Capture the Decisive Moment whilst utilising stack-based HDR photography

The combination of focus stacking and digital panorama techniques allows for breaking down the entire scene into smaller, more managable pieces. The region where the critical motion takes place that brings about the Decisive Moment can be prioritised in terms of exposure brackets, focus brackets and panorama tiles (see 4.7), thus allowing for a greater chance of success in capturing the Desicive Moment unfolding in the scene when all the exposure brackets, focus brackets and panorama tiles are put together (see 4.8). The use of focus staking also allows for a greater choice over shutter speeds and hence better control over the capture of the critical motion.

6.5 Evaluation

The images produced over the course of this research have ranged from the more painterly look (see 2.7) to the more straight photography look (see 2.8). Given that the focus of this research study was craft practice, the evaluation process (see 3.7) comprised of a visual analysis using the naked eye by the researcher-practitioner, exhibtion feedback by viewers as well as a final evaluation of the images at the thesis exhibition by three expert practitioners (see Appendix E). Two of the photography experts were from a technical production background whilst the third was from a fine arts photography background. All three experts were in agreement that in most cases there were no chromatic aberrations present in the image. One expert observed minimal chromatic aberrations in a couple of the images but states that in these cases they added to the look of the image. No diffraction, noise, ghosting, banding, inverse tonemapping or misalignment issues were observed by the experts. One expert mentioned some “barely noticable” haloing on the edge of the rock in “Flowers by the sea” (see 5.3.7) and another image. This issue has already been highlighted in section 5.3.7.3. All experts agreed that the depth of field coverage of the scenes in all the images was good and that the Decisive Moment had been captured in each of these cases in terms of the mood and movement in the scene. The local and global contrast was also found to be good by two of the experts.

The exhibition feedback reaffirms the success of the creative intent of the wider practice (see 1.5) with a number of comments and observations around the notion of fantasy/other-worldly look (see Appendix C).

6.6 Limitations

As is evident in “Flowers by the sea” (see 5.3.7), overlapping areas of movement in the scene can be problematic to capture and any such areas should be photographed using an aperture that generates enough depth-of-field to encompass the entire region of overlapping motion. Such instances of overlapping motion that is discernable, however, are uncommon.

Other issues relate to the complexity of the workflow, the memory overheads and processing power. These have already been discussed in Chapter 4 (see 4.10).

6.7 Summary

The workflow developed over the course of this research study in the form of a visualisation method and Zone System has been a success given the results produced. These results fulfil the research objectives and provide a satisfactory response to the research question that has been validated by expert practitioners.

7 DISCUSSION AND FUTURE RESEARCH

7.1 Introduction

This chapter explores the value of craft practice in HDR photography making a case for HDR photography practice to be recognised in its own right given that HDR photography and other multi-shot photography methods can reveal a clearer view of the world that Group F.64 photographers sought to photograph (see 2.8 and 2.9). Limitations of the photography tools are identified and highlighted that counter the narrative of HDR photography being an automative process and lacking in craft (see 2.9). This leads to a discussion on the notion of considering the HDR photograph and all its constituent image files as a virtual craft object (see 7.3).

The original contribution is highlighted in section 7.4. Methods for dissemination of knowledge that have been used are discussed in section 7.5. Further applications with examples are discussed in section 7.6.1. The chapter concludes with the identification of areas for future research.

7.2 The craft in digital HDR photography

> "What craft means to me is the making part, the how you make, and this is an exchange with materials - what you give to a material, and what it gives back. This exchange can be awkward, it can be a struggle, or one party can dominate, but if it is a productive exchange, then that's when it's worth looking at. But ultimately, it is the extra something that makes it special." - Caroline Broadhead (Museum 2015)

> "Making close contact with materials, technical skills plus imagination, tangible results in the form of things, sometimes pushing at the outer limits of function, taking the material for a walk." - Christopher Frayling (Museum 2015)

7.2.1 Digital photography in its own right

Ritchin (2010, p. xi-xx) states that we are rediscovering the meaning of photography from a more open discourse of opinion rather than the previous notion of objectivity. Ritchin highlights the issue of digital photography still being compared and evaluated by the standards of its film predecessor when digital photography is a totally different medium, and, could turn out to be as different from film photography, as film photography was from painting.

7.2.2 Embracing novel image looks and craft practices new technology brings to see a clearer picture

The technical craft of Landscape Photography is seen as the challenge in capturing the real-world landscapes in all their glory to produce the clearest rendition of the scene in the tradition of Group F.64 (Hostetler 2004a). The notion of Straight Photogaphy and the works of great photographers such as Ansel Adams have been a huge influence on the look of the Landscape Photography genre (see 2.8). Whilst Landscape Photography competitions and bodies have come to accept HDR photography and other multi-shot photography techniques in terms of technique and workflow, they still hesitate from the accepting the wide dynamic range in terms of the tonemapped look that has to offer. Revealing more details than what the eye can see is seen as a 'manipulation' (see 2.9).

The Group F.64 (Hostetler 2004a) photographers wanted to convey a clearer view of the world – a view that was beyond the reach of the human eye but could be made possbile using the camera (see 2.8 and 2.9). High dynamic range photography allows the capture of the entire scene dynamic range which can then be compressed to show us what we could not see through our naked eye. Similarly, focus stacking in the context of Landscape Photography allows us to create images that are clearer by reducing diffraction and allowing the use of a greater range of shutter speeds. The frozen or motion blurred scene elements also allow us to see more than what we can see with our own eyes; the picture of a rain drop suspended in air as it falls allows us to scrutinise the shape, size, reflection, texture and form. The motion blurred waves on the shore give us an indication of the movement of the water over time compressed to a single image. Panoramic images can show great landscape vista views that are beyond are field of vision compressed down to a couple of feet that fits within our field of vision and is close enough to allow scrutiny.

Photography in the past has served as a mechanism in providing answers to controversial questions such as whether a horse may at any point during trotting or running, have all four feet up in the air and not be touching the ground (see 2.9). Muybridge constructed a special exposing apparatus and workflow to investigate this question (Muybridge 2000) and demonstrated "photography's capacity to dissect time and space into minute sections, and to reveal the hidden nuances of motion." (Burbridge 2015, p. 14). Muybridge's notebook provides the exact date of exposure and time-intervals between plates that can be used to find the approximate time of the stride if multiplied by the number of phases in the stride (Muybridge 2000, pg 9-10). The exposures from a HDR, focus stack or gigapixel sequence can similarly reveal details across time. The exposure details can be used to assess the amont of light in the scene as well as the surface luminosity of the scene elements. The exposure stack captures movement in the scene across time in each exposure and rendition of movement in each of these exposures can be be compared to the rendition of movement across other expousres respectively to get a better idea of the overall movement in the scene elements.

Perhaps it is because in revealing extra details in the shadows and highlights can make the photograph more akin to a painting in appearance (see 2.7) and starts to become derivative of painting? But then HDR photography does not stop where the painters would have given the painters' were guided thus limited by their Human Visual System. HDR photography, however, is able to record beyond what the human eye can see. In this respect, HDR photography has a clear advantage. And having this advantage, the photographer can take light, the material of this world, and craft it to create images that belong to both this world and to the practitioner's imagination. As Adams said:

> "Photography is more than a medium for communication of reality, it is a creative art." - (Adams 1981, p. ix)

7.2.3 Crafting the look

Whether the final look is closer to the real world (see 2.8) or closer to the practitioner's imagination (see 2.6), the photographed exposures have to be the same in that they have to capture the maximum scene dynamic range, and, the Decisive Moment (see 2.11.1), and, minimise artifacts.

Capturing more than what the eye can see, and indeed what the digital camera can capture in a single exposure, requires craftsmanship (see Chapter 4). For indeed, the true power of the photographic image lies in its immediacy in capturing the Decisive Moment. What the camera is actually capturing when it photographs is the response to light and in order to make a good photograph we cannot capture just any response to light. As Cartier-Bresson stated:

> “It is essential to cut from the raw material of life – to cut and cut, but cut with discrimination.” - (Cartier-Bresson and Sand 1999, p. 24)

The craft in HDR Landscape Photography is not just about capturing all the scene dynamic range but it is also about capturing the Decisive Moment unfolding in the scene in the best detail possible without incurring any artifacts of the tools or the process. Only then can the clearest vision of the real-world scene be created – atleast in terms of dynamic range.

However, there are limitations that come in the way. These limitations in terms of craft relate to: a) the tools, b) our own competency, and c) the environment or problem setting (see Chapter 0). Ritchin (2009, p. 15 - 16) talks about how the perception today is that technology is smarter than the humans. The hi-tech camera and software tools that we use today still have great limitations and unlike the mechanical age where the practitioner could relatively easily adapt the technology they worked with and improvise it, practitioners today do not have that option given the complex digital camera technologies and limited or no access to the manufacturer’s software development kit. The one-size fits all approach with technology is becoming problematic given the lack of customisation available to the practitioner and is thus stifling the craft:

“If we fail to comprehend the medium, or relinquish our control to automation of one kind or another, we allow the system to dictate the results instead of controlling them to our own purposes.” (Adams 1998, p.2)

Digital cameras today come with an autobracketing feature that allows photographers to photograph the same number of exposure brackets either side of the set exposure at an exposure interval of their choice (see 5.4.1). The requirements, given the scene being photographed and the desired look of the photographer, may be different and require an uneven number of brackets either side of the normal exposure. Similarly, the photographer may only want certain exposures to have mirror lock-up on DSLR cameras enabled. These are just two examples of how practitioners are unable to bend their will despite the advancements in technology. This sort of ‘automation’ then, certainly puts a mark on the craftworthiness of HDR photography (see 2.11) when the practitioner has to resort to the more automatic means as dictated by the tools rather than taking full control of the process.

This research study was conducted to find ways to work around this problem - if the tool will only perform the function in a certain way, could the practice and method be adapted to get the desired result (see 5.4)? The outcome was the evolution of Rehan's Zone System (see Chapter 4) that allowed the necessary flexibility required by the practitioner to achieve his creative goals.

7.3 The Digital Photograph as a craft object

What is the digital photograph? Is it the unprocessed camera RAW file, or the JPEG file uploaded to the web? Or, is it the print created from the digital photograph? The digital photograph has a highly mutable quality that its film counterpart did not; it can be developed from the RAW file into countless different versions, and using non-destructive image editing, it can be mixed, unmixed and remixed in a multitude of different ways. The digital photograph is a vastly different medium from its film counterpart and as such needs to be understood and recognised in its own right (Ritchin 2010).

7.3.1 Data as scene description

The camera RAW file exists as data. It is this data that visually illustrates the scene photographed. The digital photograph thus provides a visual scene description. We can add to the scene description by having more data but in order to have an accurate scene description we need to ensure that the data we capture is as error free as possible. Having enough photographs of the real environement, visual effects practitioners can recreate them in CG software and apply different visual effects to them, or, film them in a way that is practically not possible (Bielik 2017). These CG environments can be indistinguishable from the footage of their real world counterparts.

Rather than viewing the digital photograph as an image, therefore, a more approporate view of the digital photograph would be that of an object, or a container for the data that is genereated as a response to light, the scource material for the image. The digital data can thus be seen as the virtual material for our craft.

7.3.2 The virtual raw material

Unlike physical raw material, this virtual material can be crafted into different forms but can return back to its original form when needed – courtesy of the non-destructive workflow (see Chapter 0). This material can also document each and every operation it went through to get whatever its present state may be (see 3.6). As such, it can serve as a means for evaluating practitioner competency if the creative intent of the practitioner were known and why the practitioner performed the operations they did, and, why in that particular order.

The virtual material of light, has to be picked at the right time – too early and it is not ripe and the drama in the scene has not reached its pinnacle, too late and it rots - the opportunity for capturing the drama in its glory is gone forever. It is only by combining the right ingredients in the right quantity and in the right order that the perfect recipe is created. And whilst getting all scene elements perfect in a single exposure may be considered great craftsmenship, having a larger supply of each of the ingredients allows the photographer to test different recipies. For when it comes to post-photography processes, the recipe can be undone and reattempted till the desired taste is achieved - courtesy of the non-destructive workflow (see 3.6). The critical element, however, is the raw material - when and how much and how fine a quality of it is collected.

7.3.3 Polymorphic data and mutable looks

The numerous versions that can be created from a single RAW image and even more so from HDR gigapixel images raises the question of what constitutes as 'the photograph' as Ritchin (2009) writes: "the digital copy of the digital photograph is indistinguishable so that "original" loses its meaning. If we consider all the camera RAW files, 32-bit HDR images, preset files and the final published image as a craft object, we can start to make some sense of this multi-faceted beast for from within this object, we can extract the details that suit our application and needs. For documentary, forensic or survey purposes, we can extract the untouched prints. For our creative appetite, we can manipulate and twist the values before we pull them out. Any print that is created from this virtual object, thus only shows one facet of this multi-faceted object. The print, therefore, cannot ever be truly representative of the virtual object in its entirety.

If we consider the digital photograph as a craft object, or a collection of data and a collection of removeable operators applied to that data, issues of integrity, manipulation of the image (Parkin 2018) post-photography can be easier to deal with as the craft object contains the source, the intermediary processes and the result.

7.4 Original contribution

The original contribution of this research is:

a) Realisation of new design solution and new subject specific method in the form of Rehan's Zone System - a method for the acquisition of digital HDR photography combined with digital panorama and focus stacking techniques that allows practitioners a greater chance of capturing the Decisive Moment in the scene (see Chapter 4).
b) Aesthetic development in the form of an exploration of a range of different creative possibilities with regards to the final look of the image that can be achieved using high dynamic range photography, along with practitioner insights into the context, creative intent, production challenges, as well as critical reflection on the process and images (see Chapter 0).
c) Generic methodological innovation in the form of Visualisation combined with video documentation, and a non-destructive production workflow for self-reflection practitioners and researchers to produce, experiment and reflect upon different creative outputs beyond the point of capture. This approach has further served to highlight the tensions that exist in documenting practice (see Chapter 0).

   New theoretical development in terms of the craft of digital multi-shot photography (see Chapters 0) and the notion of the digital photograph as a craft object (see 7.1 and 7.3) resulting in a new understanding of the digital photograph.

7.5 Dissemination of Knowledge

Dissemination of knowledge has taken place in the form of confrerence presentations and demonstrations, exhibitions of work, invited lectures, photography workshops, and, newspaper/magazine articles. Based on the success of these methods, I will continue to use them in the future. I also hope to publish a book on the production method (RZS) and a compilation of my landscape images respectively. I will also be publishing a selection of videos and all image and software files for a selection of images produced on my website after the examination viva.

The impact of this research is evident from the influence on other practitioner's practice (see Appendix A) and exhibition feedback (see Appendix C). Additionally, the exhibition sales also demonstrate viewer appeal and a positive response by the viewers to the image looks created.

> "Personally, I applaud anyone who is able to sell their work, no matter the price tag. It just proves an ability to connect with and inspire an audience – which is one of the main purposes of art. And not an easy feat." - Peter Lik (in Harris, 2015b)

7.6 Further applications and future research

7.6.1 Further applications

Rehan's Zone System can be used in a number of other disciplines that require photographs to be shot under high contrast, time critical situations using available light. It can be used to create HDR high resolution gigapixel landscape and weather surveys using faster shutter speeds to freeze motion to observe specific natural phenomena. Using Rehan's Zone System, images of high contrast, fast motion in the landscape, such as volcanic eruptions can also be photographed with extensive depth-of-field, higher resolution and high dynamic range whilst also capturing the key moments, such as the peak of a volcanic eruption. HDR photography has value in engineering documentation as shown by Karr et al. (2014) who have shown how HDR video can be used in engineering for the documentation of rocket launches.

The photographic image no matter how lacking in quality it may be, still serves a documentary purpose (Bazin and Gray 1960) and therefore, despite the image colour and contrast changes, the images produced can still have documentary value. The HDR landscape images produced as part of this research can be used by geologists, geographers and historians to document the landscape, weather, lighting and smog and/or visibility. Landscape photographs have been used in geological and geographical survey (The Golden Age of Western Photography William Henry Jackson n.d.). Fairchild (2007) mentions how the works of some photographers have even influenced government policy and helped conservation efforts.

Breashers has created high dynamic range digital panoramas in the Himalayas and Karakorum mountain ranges to recreate film panoramas that were photographed at these precise locations over a century ago to compare and illustrate the changes in these landscapes and highlight glacial recession over the years to create awareness amongst researchers and the public (Bloch 2013, p. 508). Landscape paintings have provided insights into the lighting and weather conditions at a particular time and place

(Thornes 2000) and landscape photographs can provide a similar function. The landscape images and camera RAW files created as part of this research can serve this documentation function providing insights to geologists, geographers, meteorologists and historians. For example, Figure 55 is a tonemapped HDR image showing good global contrast in the stone cavern, stalactites and stalagmites inside Khewra mines in Pakistan. Irrespective of the different coloured lights installed inside the mine, the form of the structures as they appears in the photograph that was taken in 2017 can be used in the future to make comparisons and provide insights into the speed, formation and/or degradation of the stalactites and stalagmites.

Figure 55: "Khewra" by Rehan Zia (2017)

RZS (see Chapter 4) can also be applied for photographing large interiors where the scene contrast is high as illustrated in Figure 56 that was captured using a combination of stack-based HDR photography, focus stacking and digital panorama techniques.

Figure 56: "Poole Gateway Building Atrium" by Rehan Zia (2020)

RZS can also be used for outdoor portraits where the scene dynamic range, and, the contrast difference between the subject and the scene may be considerable as illustrated in Figure 57 captured using a combination of stack-based HDR photography, focus stacking and digital panorama techniques.

Figure 57: "Self Portrait in the Sun" by Rehan Zia (2020)

Fairchild (2007) has created a database of HDR photographs, camera RAW files and detailed luminance information for non-commercial research purposes. These images have been used in a number different research projects (Fairchild 2007). The camera RAW images, scene files and final images of a number of images produced as part of this research will be made available in a similar spirit for non-commercial research and educational purposes. It is hoped that these images would help photographers, visual effects practitioners and digital artists to get better insights into the workflow used as well as providing an opportunity to experiment and make changes different parameters to create their own unique image outputs. Similar to Fairchild's (2007) "The HDR Photographic Survey", these images may also be used for visual and psychophysical experiments and evaluation, and, for testing and evaluation of HDR displays and algorithms.

Image removed due to copyright restrictions

Figure 58 Screenshot of a section from "View from Inside 'Yellowknife Bay'" by NASA/JPL-Caltech (2013). The panorama is a combination of three mosaics captured by the Mars rover "Curiosity". The area photographed is from 10 feet to about 100 feet from the rover. The texture details in the shadows are not visible. The interactive image file can be viewed at: https://mars.nasa.gov/msl/multimedia/deepzoom/PIA16701/ [Accessed: 4 June 2018] [Copyrighted image for examination purposes only]

Albanese and Montes (2011) demonstrate how HDR photography, in conjunction with near infrared photography, can be used to detect latent forensic evidence. The example that they use is a strip that does not have much depth showcasing how the actual evidence may not be on a flat surface. Rehan's Zone System can enhance this method of capture by allowing for the photography to be conducted at the crime scene; macrophotography can be used for higher resolution combined with Rehan's Zone System to allow for greater depth-of-field and higher resolution.

Radford et al. (2011) have demonstrated how HDR photography can be useful when taking photographs of 3D anatomical forms under hard lighting of the operating theatre to reveal fine details whilst retaining a sense of dimensionality that, using flash photography would not be possible. Using Rehan's Zone System can provide better latitude and faster shutter speeds given the ETTR approach and focus stacking respectively.

Santella and Milner (2017) have shown how focus stacking can be coupled with photogrammetry to illustrate small fossil teeth. The zone system described in this thesis can provide the ability to conduct macrophotography during or directly after excavation on location irrespective of the scene lighting conditions. Fossil textures can be tonemapped prior to the photogrammetry process in order to create neutral textures with minimal scene lighting influence.

7.6.2 Future research

Future research will explore:

a) multi-camera setups using both mirror and side-by-side stereo camera rigs for both HDR photography and video that make use of both focus stacking and exposure bracketing.
b) local adaptation using masking to allow practitioners to make the ISO or a filter in front of the sensor/lens, more or less sensitive.
c) global adaptation methods for exposure bracketing, especially for long exposures, to compensate for changing light in the scene.
d) how research can affect the practice

7.7 Summary

The digital photograph needs to be understood and appreciated in its own right. This can only be done if we begin anew to explore what digital photography is rather than seeing it in light of its film predecessor. The digital photograph is mutable and multi-faceted. Rather than considering it as an image, a better understanding can be gained by thinking of the digital photograph as a craft object.

Contemporary multi-shot digital photography techniques are capable of capturing an unprecedented level of detail. The Zone System developed as part of this research study can be used in a number of disciplines to create a clearer and more detailed view of the world and beyond by minimising camera and lens artifacts and prioritising the Decisive Moment.

8 CONCLUSION

8.1 Introduction

Capturing the entire dynamic range in the landscape scene has been a significant craft challenge in Landscape Photography. Stack-based high dynamic range photography allows photographers to capture the entire dynamic range of the scene by photographing a series of different exposures and blending them together. However, given the multi-shot nature of this technique, moving elements within the scene can result in ghosting and misalignments. It can also be challenging to capture the Decisive Moment across all the exposures as it unfolds in the scene whilst having a large depth-of-field to cover the entire scene. This research study has explored best practice for producing landscape photographs using high dynamic range photography, digital panoramas and focus stacking under a variety of different lighting and weather conditions across different locations that offered unique challenges given the range of different scene elements.

Digital stack-based high dynamic range photography has been popular for over a decade. This research defines the image acquisition workflow by critically examining the exposure range and exposure interval required to capture the full dynamic range of the scene at the optimal exposure values of the camera RAW files that work for the individual practitioner's creative intent and workflow and takes the camera's usable dynamic range into account.

8.2 Outcomes of the research

This research study has explored best practice for creating a unique look that is specific to HDR photography as well as a method for the capture process and a visualisation approach that facilitates the practitioner in achieving the desired look.

This research provides a novel method and workflow for Landscape Photography that utilises high dynamic range photography, digital panorama photography and focus stacking to enable photographers to previsualise and postvisualise the final look of the image whilst still being able to capture the Decisive Moment in the scene. It enables photographers to make better use of the natural light available in the scene and capture scene values in a way that provides better latitude for postproduction based on the individual creative needs of the photographer, and, the camera sensor latitude available. It also allows the photographer to delay making certain decisions with regards to the composition of the image and tonal values of elements in the scene till the postproduction stage, where a range of different creative possibilities can be explored for the final look of the image.

The images produced as part of this thesis provide visual insights into the creative possibilities of high dynamic range Landscape Photography that this workflow brings as well as contextualising the need for this workflow. The practitioner commentary on these images provides insights into specific processes used, the creative intent for the final image, as well as the constraints, limitations and issues encountered during production.

The non-destructive workflow has been used not just as a method of production but also as a method of reflection and proved to be an intuitive method that other practitioners can use.

The camera RAW files provide a record of the camera settings used during photography, the natural light values and weather conditions in the scene at the time of photography, as well as the state of the landscape when it was photographed. The software and image sidecar files provide a record and insights into the specific processes used and the parameters manipulated in order to achieve the final look for the images. Camera RAW files, software presets and final image files of a selection of images produced as part of this research have been made available in order to facilitate other practitioners to get a better understanding of the workflow as well as to explore and experiment with other creative possibilities. Researchers, practitioners and educators from other disciplines may also be able to benefit from these files (see sec. 7.6).

The debate on what HDR photography should look like has resulted in the polarisation of the image look. This research has explored the common ground between the painter’s truth, HDR photography, and, straight Landscape Photography. However, rather than prescribing the look, the research explores and demonstrates what new creative possibilities for what the image looks could be as well as best practice for creating these looks in terms of the tools, techniques and workflow.

GLOSSARY

Aperture: Opening inside the lens through which light passes to reach the camera sensor or film

Auto-bracketing: In-camera function that allows for photographing multiple other exposures either side of the set exposure at specified intervals

Bracketing interval: The difference between two exposure brackets

Chromatic aberration: When light waves of different colours are focussed on different areas of the focus plane resulting in noticeable colour fringing around the edges objects and surfaces in the scene.

Contrast ratio: See Dynamic range

Decisive Moment: The moment when elements in a scene are at the height of drama or creating a dramatic or aesthetically pleasing juxtaposition

Depth of field: The scene volume in front of the camera that is in acceptably sharp focus in the photograph

Diffraction: When light travels through a narrow aperture, it bends around the corners resulting in softening of image detail and noise in the background.

Dynamic range: The range of light values that exist within an image or scene

Exposure: The amount of light that reaches the camera sensor or film

Exposure bracket: A photograph in a sequence of photographic images captured using auto-bracketing

Exposure stack: Set if varied exposures of the same object or scene taken sequentially

Field of view: Observable area that can be seen through the eyes or optical device

Focal length: Distance between the centre of the lens and the camera sensor

Focus stacking: A technique where photographs taken at multiple different focus distances can be combined to generate a greater combined depth of field

Focus stack: Set of photographs with varying focus distances

High dynamic range: Dynamic range that is greater than is available in a single photographic exposure

Highlights: The brighter exposure values in an image

Histogram: Representation of pixel values in the form of a histogram with the number of pixels on the vertical axis and the range of brightness from dark to light on the horizontal axis

Latitude: Extent to which image pixel values can be manipulated without incurring undesirable artifacts

Lens distortion: Wide angles lenses can make straight lines curvy resulting in an overall distorted look to the image.

Low dynamic range: Limited exposure range found in photographs taken from a non-HDR camera

Midtones: The middle exposure values in an image

Panorama: Images created by digitally stitching multiple photographs to create greater fields of view than are possible in a single exposure using the same lens

Shadows: The darker exposure values in an image

Shutter speed: Refers to the amount of time the shutter is open for

Tile: One of the multiple framings used for creating a digital panorama

Tone: The range of light values in the scene or image

BIBLIOGRAPHY

Academy, K., 2019. Color scripts, *Khan Academy* [online]. Available from: https://www.khanacademy.org/partner-content/pixar/art-of-lighting/introduction-to-virtual-lighting/v/colorscripts [Accessed 17 May 2019].

Adams, A., 1980. The Camera, The Ansel Adams Photography Series. *Little, Brown and Company*, 1981 , 1983.

Adams, A., 1981. The Print, The Ansel Adams Photography Series 3. *Little, Brown and Compagny*

Adams, A., 1983. *Examples: the making of 40 photographs*. Bulfinch.

Adams, A., 1998. *The Camera, The Ansel Adams Photography Series I*. Little, Brown & Company (Canada) Limited.

Adams, A. and Baker, R., 1981. *The Negative*. 2nd edition. Little, Brown.

Adamus, M., (n.d.) No Title, *Marc Adamus* [online]. Available from: https://www.marcadamus.com/page/bio/ [Accessed 19 May 2019].

Adobe, 2014. Adobe Photoshop. Adobe Systems Incorporated. Retrieved from http://www.adobe.com/products/photoshop.html?promoid=JOLIW

Adobe, 2017. Nondestructive editing in Photoshop, Available from: https://helpx.adobe.com/photoshop/using/nondestructive-editing.html%0A [Accessed 4 December 2017].

Adobe, 2020. Dodge or burn image areas in Photoshop, *Adobe* [online]. Available from: https://helpx.adobe.com/uk/photoshop/using/dodge-burn-image-areas.html [Accessed 10 September 2020].

Ae, H., 2017. Lecture Cityscape Photography, Available from: https://www.youtube.com/watch?v=cBHHTMTfb6w [Accessed 18 May 2019].

Albanese, J. and Montes, R., 2011. Latent evidence detection using a combination of near infrared and high dynamic range photography: an example using bloodstains. *Journal of Forensic Sciences*, 56 (6), 1601–1603.

Alien Skin Exposure | Film Emulation and Photo Effects, 2015. *Alien Skin Software* [online]. Available from: http://www.alienskin.com/exposure/ [Accessed 29 September 2015].

Alinder, M. S., 2014. *Group F. 64: Edward Weston, Ansel Adams, Imogen Cunningham, and the Community of Artists who Revolutionized American Photography*. New York: Bloomsbury Publishing USA.

B and H, 2011. The Brenizer Method: Bokeh Panorama, Available from: https://www.youtube.com/watch?v=UsMnRxmeJ74 [Accessed 20 May 2018].

Bandoh, Y. (Ntt), Qiu, G. (University of N., Okuda, M. (University of K., Daly, S. (Sharp L. of A., Aach, T. (Rwth A. U. and Au, O. C. (Hong K. U. of S. and T., 2010. Recent advances in high dynamic range imaging technology. *ICIP 2010 (IEEE International Conference on Image Processing)*, 3125–3128.

Banterle, F., Artusi, A., Debattista, K. and Chalmers, A., 2011. *Advanced high dynamic range imaging: theory and practice*. CRC press.

Bazin, A. and Gray, H., 1960. The Ontology of the Photographic Image. *Film Quarterly*, 13 (4), 4–9.

Benovsky, J., 2011. Three kinds of realism about photographs. *The Journal of Speculative Philosophy*, 25 (4), 375–395.

Bielik, A., 2017. "Angels & Demons": Vatican VFX on Steroids, *Production, AWN Profiles | VFXWorld* [online]. Available from: https://www.awn.com/vfxworld/angels-demons-vatican-vfx-steroids [Accessed 17 May 2019].

Bilissi, E. and Langford, M., 2013. *Langford's Advanced Photography*. CRC Press.

Bloch, C., 2013. *The HDRI handbook 2.0: high dynamic range imaging for photographers and CG artists*. Rocky Nook, Inc.

Bouatouch, E. K. and Chalmers, A., 2014. HDRi 2014. *SME Workshop on HDR Imaging*

Bournemouth University, 2018. *8A Code of Practice for Research Degrees (Policy , Procedure and Guidelines)*. Bournemouth

Brookfield, S., 1998. Critically Reflective Practice. *The Journal of Continuing Education in the Health Professions*, 18 (1st), 197–205.

Brooks, R., 1967. *In Cold Blood*,. USA

Burbridge, B. (Ed.), 2015. *Revelations: Experiments in Photography*. First edit edition. Mack.

Cartier-Bresson, H. and Sand, M. L., 1999. *The mind's eye: Writings on photography and photographers*. Aperture New York.

Cheong, D., 2019. Daniel Cheong Photography, Available from: https://www.danielcheongphotography.com/About-Me [Accessed 19 May 2019].

Cole, D. and Ranger, A., 2018. Exploring the Suffolk Coastline, *Landscape Media Limited* [online]. Available from: https://www.onlandscape.co.uk/2018/05/suffolk-coastline-photography/ [Accessed 19 May 2019].

Cooper, T., 2015. *HDR Photography: From Snapshots to Great Shots*. Peachpit Press.

Coughlan, S., 2019. Why do we like magic when we know it's a trick?, *BBC* [online]. Available from: https://www.bbc.co.uk/news/education-47827346 [Accessed 19 May 2019].

Davis, H., 2012. *Creating HDR Photos: The Complete Guide to High Dynamic Range Photography*. Random House LLC.

Debevec, P. E., 1996. *Modeling and Rendering Architecture from Photographs*. University of California at Berkeley Retrieved from http://portal.acm.org/citation.cfm?id=237191

Debevec, P., Reinhard, E. and Ward, G., 2004. High Dynamic Range Imaging.

Diprose, G. and Robins, J., 2012. *Photography - The New Basics: Principles, Techniques and Practice*. Thames & Hudson.

Dodgson, N., Patterson, J. and Willis, P., 2010. What's up prof? Current issues in the visual effects & post-production industry. *Leonardo*, 43 (1), 92–93.

EBP Tutorial, 2019. *The Duke Medical Center and the Health Science Library at the University of North Carolina at Chapel Hill* [online]. Available from: https://tutorials.mclibrary.duke.edu/ebpintro/ [Accessed 19 May 2019].

Emerson, P. H., 1890. *Naturalistic Photography For Students of the Art*. 2nd editio edition. London: Sampson Low, Marston, Searle and Rivington Limited.

Fairchild, M., 2007. The HDR photographic survey. *CIC15 (IS&T/SID 15th Color Imaging Conference)*, 233–238.

Falco, C. M., 2016. Optics and Renaissance Art BT - Optics in Our Time. *In*: Al-Amri, M. D.,, El-Gomati, M., and Zubairy, M. S., eds. . Cham: Springer International Publishing, 265–283.

Fisher, R., 2012. *The Digital Zone System: Taking Control from Capture to Print*. Rocky Nook, Inc.

Fisher, R., 2016. *The Anti-HDR HDR Photography Book: A Guide to Photorealistic HDR and Image Blending*. Taylor & Francis.

Fraser, B., 2004. Raw Capture, Linear Gamma, and Exposure, Available from: https://wwwimages.adobe.com/content/dam/Adobe/en/products/photoshop/pdfs/linear_gamma.pdf [Accessed 10 September 2017].

Gallo, O. and Sen, P., 2016. Stack-Based Algorithms for HDR Capture and Reconstruction. *In*: Dufaux, F.,, Callet, P. Le,, Mantiuk, R., and Mrak, M., eds. *High Dynamic Range Video: From Acquisition to Display and Applications*. 1st editio edition. London: Elsevier Ltd, 85–119.

Glassman, A., McCarthy, T. and Samuels, S., 1992. *Visions of Light*,. USA

Gorman, M., 2003. Art, optics and history: New light on the Hockney thesis. *Leonardo*, 36 (4), 295–301.

Gray, C., 1998. Inquiry through practice: Developing appropriate research strategies. *No Guru, No Method? Discussions on Art and Design Research*, 82–95.

Green, G., 2018. Michael Kenna Interview, *Landscape Media Limited* [online]. Available from: https://www.onlandscape.co.uk/2018/01/michael-kenna-interview/ [Accessed 19 May 2019].

Gurieva, N., 2014. Complete Digital Workflow for HDR Photography. *International Circular of Graphic Education and Research*, (7), 14–23.

Harris, G., 2015. October 2015, Peter Lik. *Digital Camera*, 84–90.

Harris, G. and Waite, C., 2017. Charlie Waite: How to shoot award-winning landscape photography, *TI Media Limited* [online].

Hartmann, S., 1904. *A plea for straight photography American Amateur Photographer, No. 16*

Hasinoff, S. W. and Kutulakos, K. N., 2011. Light-Efficient Photography. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 33 (11), 2203–2214.

HDRSOFT.COM, 2015. Version history Photomatix Pro for Windows, Available from: http://www.hdrsoft.com/download/history/pmpwin.html [Accessed 1 January 2015].

Hiscock, J., 2009. James Cameron interview for Avatar, *Telegraph.co.uk* [online]. Available from: http://www.telegraph.co.uk/culture/film/6720156/James-Cameron-interview-for-Avatar.html [Accessed 30 September 2015].

Hockney, D., 2001. *Secret knowledge: Rediscovering the lost techniques of the old masters*

Hockney, D. and Falco, C. M., 2000. Optical Insights into Renaissance Art. *Optics and Photonics News*, 11 (7), 52–59.

Hockney, D. and Falco, C. M., 2004. The Art of the science of Renaissance painting. *In*: *Proceedings of the Symposium on 'Effective Presentation and Interpretation in Museum*

Hockney, D. and Falco, C. M., 2005. Quantitative analysis of qualitative images. *In*: *Human Vision and Electronic Imaging* 326–336.

HollywoodEndingMovie, 2014. LIFE AFTER PI (Official), Available from: https://youtu.be/9lcB9u-9mVE?t=351 [Accessed 19 May 2018].

Hostetler, L., 2004.a Group f/64, *The Metropolitan Museum of Art* [online].

Hostetler, L., 2004.b Pictorialism in America, *The Metropolitan Museum of Art* [online]. Available from: https://www.metmuseum.org/toah/hd/pict/hd_pict.htm [Accessed 18 May 2018].

Hunter, D., 2017. Natural Moments, *Landscape Media Limited* [online].

Johnson, C., 2012. *The Practical Zone System for Film and Digital Photography: Classic Tool, Universal Applications*. Taylor & Francis.

Karr, B., Debattista, K. and Chalmers, A., 2014. High Dynamic Range Digital Imaging of Spacecraft. *In*: Kadi Bouatouch, A. C., ed. *HDRi2014 - Second International Conference and SME Workshop on HDR imaging*. Sarajevo, Bosnia and Herzegovina

Katz, S. D., 1991. *Film directing shot by shot: visualizing from concept to screen*. Gulf Professional Publishing.

Livesey, N. and Griffith, M., 2016. Nick Livesey - Featured Photographer, *Landscape Media Limited* [online]. Available from: https://www.onlandscape.co.uk/2016/11/nick-livesey-featured-photographer/ [Accessed 19 May 2019].

Lumet, S., 1995. *Making movies*. 1st edition. New York: Vintage Books.

Mäkelä, M., 2007. Knowing Through Making: The Role of the Artefact in Practice-led Research. *Knowledge, Technology & Policy*, 20 (3), 157–163.

McCann, J. J., 2007. Art, science, and appearance in HDR. *Journal of the Society for Information Display*, 15 (9), 709.

McCann, J. J., 2016. Rendition techniques for HDR scenes in painting, photography, and electronic imaging. *In*: *Image Processing (ICIP), 2016 IEEE International Conference on*. IEEE. 874–878.

McCann, J. J. and Rizzi, A., 2012. *The art and science of HDR imaging*. Chichester: John Wiley & Sons.

McIntyre, J., 2018. Essential Luminosity Mask Tutorial For Beginners - Photoshop Guide, Available from: https://www.youtube.com/watch?v=myIzxxlx7Do [Accessed 19 May 2018].

Moon, J. A., 2004. *A handbook of reflective and experiential learning: Theory and practice*. Psychology Press.

Museum, V. and A., 2015. What is Craft?, *Victoria and Albert Museum* [online]. Available from: http://www.vam.ac.uk/content/articles/w/what-is-craft [Accessed 28 March 2015].

Muybridge, E., 2000. *Animals in motion*. Dover Publications Inc.

Nelson, R., 2013. *Practice as research in the arts: principles, protocols, pedagogies, resistances*. Palgrave Macmillan.

Newhall, B., 2009. *The history of photography: from 1839 to the present*. Fifth edit edition. New York: Museum of Modern Art.

Okun, J. A. and Zwerman, S., 2015. *The VES handbook of visual effects: industry standard VFX practices and procedures*. 2nd editio edition. Focal Press.

Outdoor Photographer of the Year, 2018. *GMC Publications Ltd* [online]. Available from: https://www.opoty.co.uk/pages/faq/ [Accessed 19 May 2018].

Parkin, T., 2018. Realism and Honesty in Photography - FEELINGS OF DECEPTION AND MANAGING EXPECTATIONS, *Landscape Media Limited* [online].

Peck, T., 2017. Thomas Peck's Critiques - MARC ADAMUS, *Landscape Media Limited* [online].

Radford, P. D., Rollin, M. and Patel, K. S., 2011. High dynamic range photography for intraoperative imaging: how we do it. *Archives of Facial Plastic Surgery*, 13 (5), 362–363.

Ratcliff, T., 2010. *TOP 10 MISTAKES IN PROCESSING AND HOW TO FIX THEM - TREY RATCLIFF*. eBook edition. Trey Ratcliff.

Reinhard, E., Heidrich, W., Debevec, P., Pattanaik, S., Ward, G. and Myszkowski, K., 2010. *High dynamic range imaging: acquisition, display, and image-based lighting*. Morgan Kaufmann.

Ritchin, F., 2009. *After photography*. London: WW Norton & Company.

Ritchin, F., 2010. *In our own image*. 20th-Anniv edition. New York: Aperture Foundation, Incorporated.

Santella, M. and Milner, A. R. C., 2017. Coupling Focus Stacking With Photogrammetry To Illustrate Small Fossil Teeth. *Journal of Paleontological Techniques*, (18), 1–17.

Savedoff, B. E., 2010. Escaping Reality : Digital Imagery and the Resources of Photography. *The Journal of Aesthetics and Art Criticism*, 55 (2), 201–214.

Schaefer, D. and Salvato, L., 2013. *Masters of light: conversations with contemporary cinematographers*. Univ of California Press.

Scharf, A., 1962. Painting, photography, and the image of movement. *The Burlington Magazine*, 104 (710), 186–195.

Scharf, A., 1974. *Art and photography*. Penguin.

Schön, D. A., 1983. *The reflective practitioner: How professionals think in action*. United States of America: Basic Books, Inc.

Selan, J., 2012. Cinematic color. *ACM SIGGRAPH 2012 Posters on - SIGGRAPH '12*, 1–54.

Sennett, R., 2008. *The craftsman*. Yale University Press.

Seymour, M., 2011. Ben Snow: the evolution of ILM's lighting tools, *FXGUIDE.COM, LLC* [online]. Available from: https://www.fxguide.com/featured/ben-snow-the-evolution-of-ilm-lighting-tools/ [Accessed 18 May 2018].

Soft, H. D. R., 2008. Photomatix.

SpheronVR, 2013.a SPHERON-VR LAUNCHES SCENECAM 2.0, Available from: https://www.spheron.com/media/news-press-releases/detail/spheron-vr-launches-scenecam-20.html [Accessed 10 September 2020].

SpheronVR, 2013.b Spheron VR | Home, Available from: https://spheron.com/home.html [Accessed 10 September 2020].

Studio, L., 2016. charlie waite at the photography show 2016 part 1, Available from: https://www.youtube.com/watch?v=A_5Q-OWLRBs [Accessed 18 May 2018].

Take a view - Landscape Photographer of the Year, (n.d.) *2018* [online]. Available from: https://www.take-a-view.co.uk/competition-rules/

Tamburrino, D., Alleysson, D., Meylan, L. and Süsstrunk, S., 2008. Digital camera workflow for high dynamic range images using a model of retinal processing. *In*: *IST/SPIE Electronic Imaging: Digital Photography IV*

Tate, 2019.a John Constable - Cloud Study - 1822, *Tate* [online]. Available from: https://www.tate.org.uk/art/artworks/constable-cloud-study-n06065 [Accessed 19 May 2019].

Tate, 2019.b Landscape – Art Term | Tate, Available from: https://www.tate.org.uk/art/art-terms/l/landscape%0A [Accessed 19 May 2019].

The Golden Age of Western Photography William Henry Jackson, (n.d.) *Andrew Smith Gallery, Inc.* [online]. Available from: https://www.andrewsmithgallery.com/exhibitions/misc/western/jackson.html [Accessed 31 May 2018].

Thirkell, P., 2002. The Integration of Digitally Mediated Imaging Techniques with 19th Century Continuous Tone Printing Processes., (July 2000)

Thornes, J. E., 2000. A brief history of weather in European landscape art. *Weather*, 55 (10), 363–375.

Torcellini, D., 2010. Painting and photographing the sunlight. A comparison between old-school and avant-garde techniques. *In*: *CREATE Conference* 353–358.

Ward, D., 2012. Am I a Landscape Photographer?, *Landscape Media Limited* [online]. Available from: https://www.onlandscape.co.uk/2012/05/am-i-a-landscape-photographer/ [Accessed 31 May 2018].

ZeitgeistMinds, 2012. The World We Design- Trey Ratcliff Zeitgeist Americas 2012, Available from: https://youtu.be/DBFY1wCT0K4?t=53 [Accessed 19

May 2019].

Zia, 2018. Rehan’s Zone System. *In*: *Electronic Visualisation and the Arts (EVA 2018)*. London: BCS Learning & Development Ltd.

Zia, R., 2013. Corfe Castle - In a Different Light. *In*: *Electronic Visualisation and the Arts (EVA 2013)*. London: BCS Learning &Development Ltd. 51–52.

Zia, R., 2014. Tonemapping Multi-shot Digital Photographs of Real World Environments. *In*: *Electronic Visualisation and the Arts (EVA 2014)*. London: BCS Learning &Development Ltd.

Zia, R., 2015. The Brick Wall Project. *In*: *7th Annual Postgraduate Conference 2015*. Bournemouth: Bournemouth Unviersity.

Zia, R., 2019. Visualisation for Digital Multi-Shot Photography. *In*: *Electronic Visualisation and the Arts (EVA 2019)*. London

APPENDICES

Appendix A: Email from Peter Tate (Amateur photographer)

Dear Rehan
You were the person that rekindled my interest in photography. I saw your work in Rollington Barn in 2013 and 2014, later that year I persuaded you to take me out and show me the basics of your methodology. You introduced me to smart object use in Photoshop and how to bracket and then combine several images. Subsequently my wife Judy and I came to exhibitions of your work at Bournemouth University and you helped me again with a photography class at Arne during PAW 2016.
I attach some of the HDR images that your teaching helped me create. I continue to experiment and follow you on Facebook. Although badly done HDR gets a bad press, your work is inspirational, thoughtful, and subtle in its complexity.

Appendix B

List of conference presentations and publications

*Zia, R., (2019). Visualisation for Digital Multi-Shot Photography. *In*: *Electronic Visualisation and the Arts (EVA 2019)*. London

*Zia, R. (2019). The Digital Photograph as a Craft Object. In *Fourteenth International Conference on the Arts in Society*. Lisbon, Portugal.

Zia, R. (2018). Rehan's Zone System. In J. P. Bowen, J. Weinel, G. Diprose, & N. Lambert (Eds.), *EVA*. BCS. Retrieved from http://ewic.bcs.org/category/19337

Zia, R. (2018). New technologies, same look - Crafting high dynamic range photographs to create a classical oil painting look. In *Thirteenth International Conference on The Arts in Society*. Vancouver B.C.

Zia, R. (2015). The Brick Wall Project. In *7th Annual Postgraduate Conference*. Bournemouth University Talbot Campus.

Zia, R. (2014). Tonemapping Multi-shot Digital Photographs of Real World Environments. In K. Ng, J. P. Bowen, & S. McDaid (Eds.), *EVA*. BCS. Retrieved from http://ewic.bcs.org/category/18204

Zia, R. (2013). Corfe Castle - In a Different Light. In K. Ng, J. P. Bowen, & S. McDaid (Eds.), *EVA*. BCS. Retrieved from http://ewic.bcs.org/category/17656

List of exhibitions

Zia, R. (2016, December 6). *LandEscapes - Treading the line between fantasy and realism* (No. Of Pieces: 35) [Exhibition]. Bourne Lounge, Bournemouth International Centre BH2 5BH.

Zia, R. (2016, May 28). *Purbeck Art Weeks 2016* (No. Of Pieces: 26) [Exhibition]. Rollington Barn, Studland Road, Corfe Castle BH20 5JG.

Zia, R. (2016, May 27). *Rehan Zia Landscape Photography* (No. Of Pieces: 15) [Photographic prints]. RSPB Arne.

Cameron, J. (2016, May 27). *Cameron & Talbot Gallery Exhibition* (No. Of Pieces: 20) [Exhibition]. The Old Blacksmiths/Grange Rd, Wareham BH20 5DG.

Zia, R. (2016, January 23). *From Top to Bottom - Material Differences* (No. Of Pieces: 3) [Exhibition]. Poole Lighthouse.

Zia, R. (2015, February 13). *Landscape Photography exhibition* (No. Of Pieces: 20) [Exhibition]. Poole Lighthouse.

Zia, R. (2015, January 17). *The Brick Wall and Beyond* (No. Of Pieces: 41) [Photographic prints]. The Atrium Gallery, Bournemouth University Talbot Campus.

Zia, R. (2014, May 24). *Dorset Landscapes* (No. Of Pieces: 5) [Photographic prints]. Lavish Life, 14 Westbourne Arcade, Bournemouth BH4 9AY.

Zia, R. (2013, May 25). *Purbeck Landscapes* (No. Of Pieces: 25) [Exhibition]. Corfe Castle Tea Rooms, The Square, Corfe Castle, Wareham BH20 5EZ.

Zia, R. (2013, May 25). *North of Hadrian's Wall* (No. Of Pieces: 25) [Photographic prints]. Corfe Castle Tea Rooms, The Square, Corfe Castle BH20 5EZ.

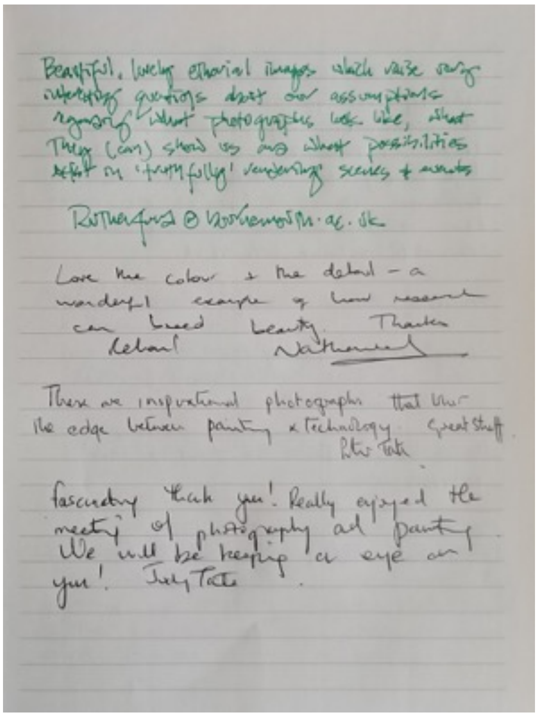
Zia, R. (2013, May 25). *Dorset Landscapes* (No. Of Pieces: 6) [Photographic prints]. The Greyhound Inn, The Square, Corfe Castle, Wareham BH20 5EZ.

Online newspaper tutorial article:

Zia, R., (2018). How to do Landscape Photography like a professional, *Dawn* [online]. Available from: https://www.dawn.com/news/1385622 [Accessed 31 May 2019].

Appendix C: Exhibition feedback

<u>The Brick Wall and Beyond Exhibition:</u>



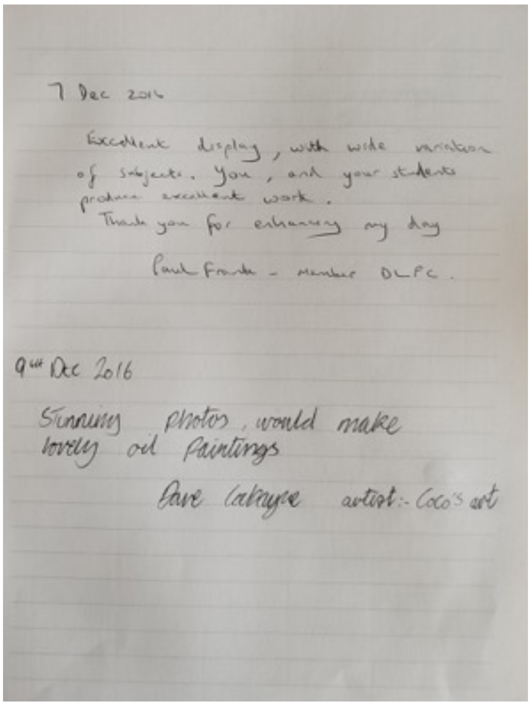
Beautiful, lovely etherial images which raise some interesting questions about our assumptions regarding what photographs look like, what they (can) show us and what possibilities exist in 'truthfully' rendering scenes + events

[illegible] @bournemouth.ac.uk

Love the colour + the detail – a wonderful example of how research can breed beauty. Thanks Rehan! Nathaniel

These are inspirational photographs that blur the edge between painting & technology. Great stuff. Peter Tate

Fascinating thank you! Really enjoyed the meeting of photography and painting. We will be keeping an eye on you! Judy Tate



7 Dec 2016

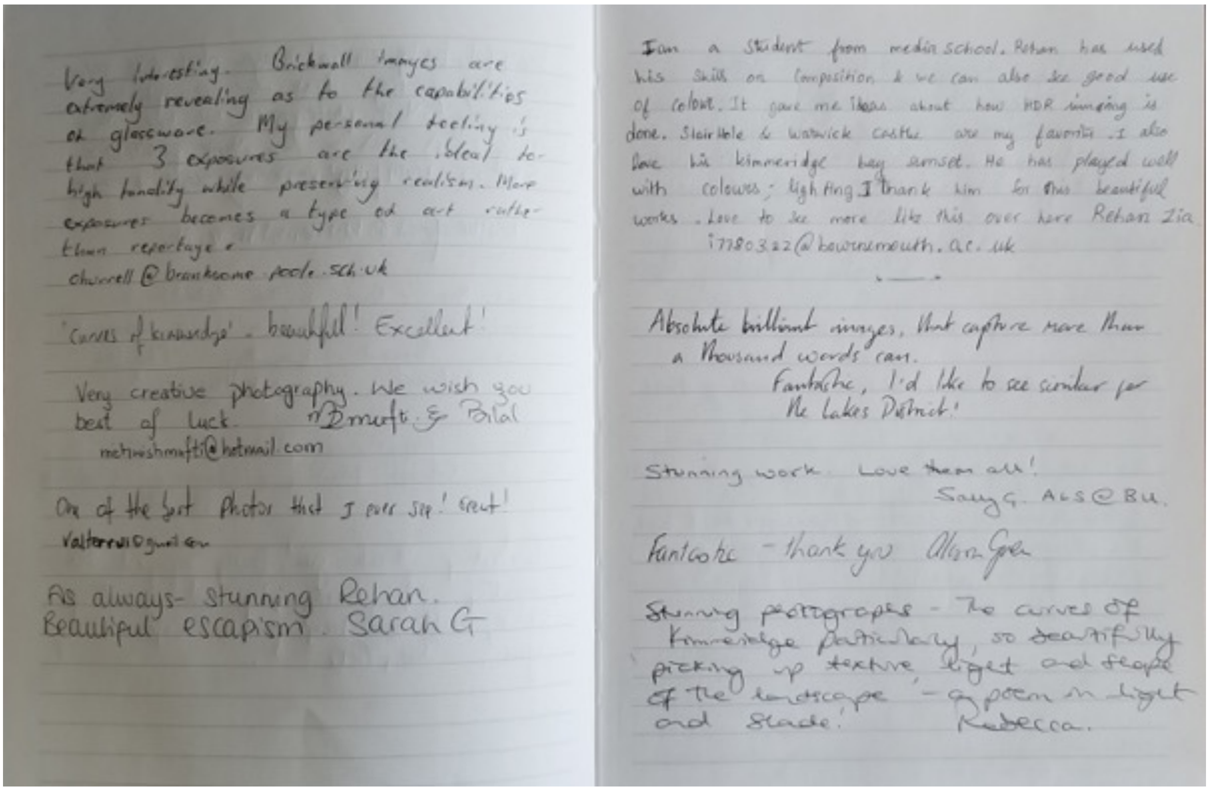
Excellent display, with wide variation of subjects. You, and your students produce excellent work.
Thank you for enhancing my day

Paul Franks – Member DLPC.

9th Dec 2016

Stunning photos, would make lovely oil paintings

Dave Calmyre artist:- Coco's art



Very interesting. Brickwall images are extremely revealing as to the capabilities of glassware. My personal feeling is that 3 exposures are the ideal to high tonality while preserving realism. More exposures becomes a type of art rather than reportage.
churrell@branksome.poole.sch.uk

'Curves of Kimmeridge'. beautiful! Excellent!

Very creative photography. We wish you best of luck. M Mufti & Bilal
mehwishmufti@hotmail.com

One of the best photos that I ever see! Great!
[illegible]@gmail.com

As always – stunning Rehan. Beautiful escapism. Sarah G

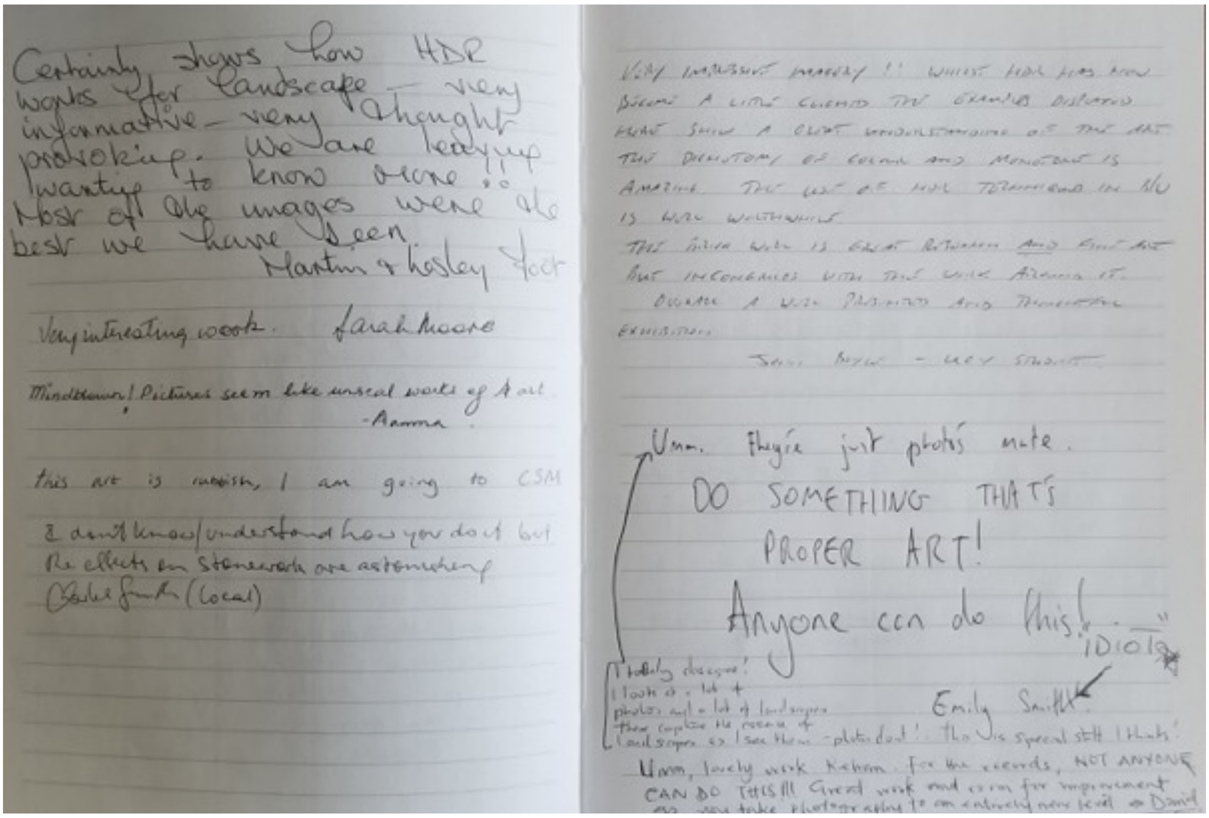
I am a student from media school. Rehan has used his skills on composition & we can also see good use of colour. It gave me ideas about how HDR imaging is done. Stair Hole & Warwick Castle are my favorite. I also love his Kimmeridge bay sunset. He has played well with colours; lighting. I thank him for this beautiful works. Love to see more like this over here Rehan Zia
i7780322@bournemouth.ac.uk

Absolute brilliant images, that capture more than a thousand words can.
Fantastic, I'd like to see similar for the Lakes District!

Stunning work. Love them all!
Sally G. ALS@BU.

Fantastic – thank you Alan Green

Stunning photographs – the curves of Kimmeridge particularly, so beautifully picking up texture, light and shape of the landscape – a poem in light and shade! Rebecca.



Certainly shows how HDR works for landscape – very informative – very thought provoking. We are leaving wanting to know more!! Most of the images were the best we have seen.
Martin & Lesley Foot

Very interesting work. Farah Moore

Mindblown! Pictures seem like unreal works of Art.
-Aamna

this art is rubbish, I am going to CSM

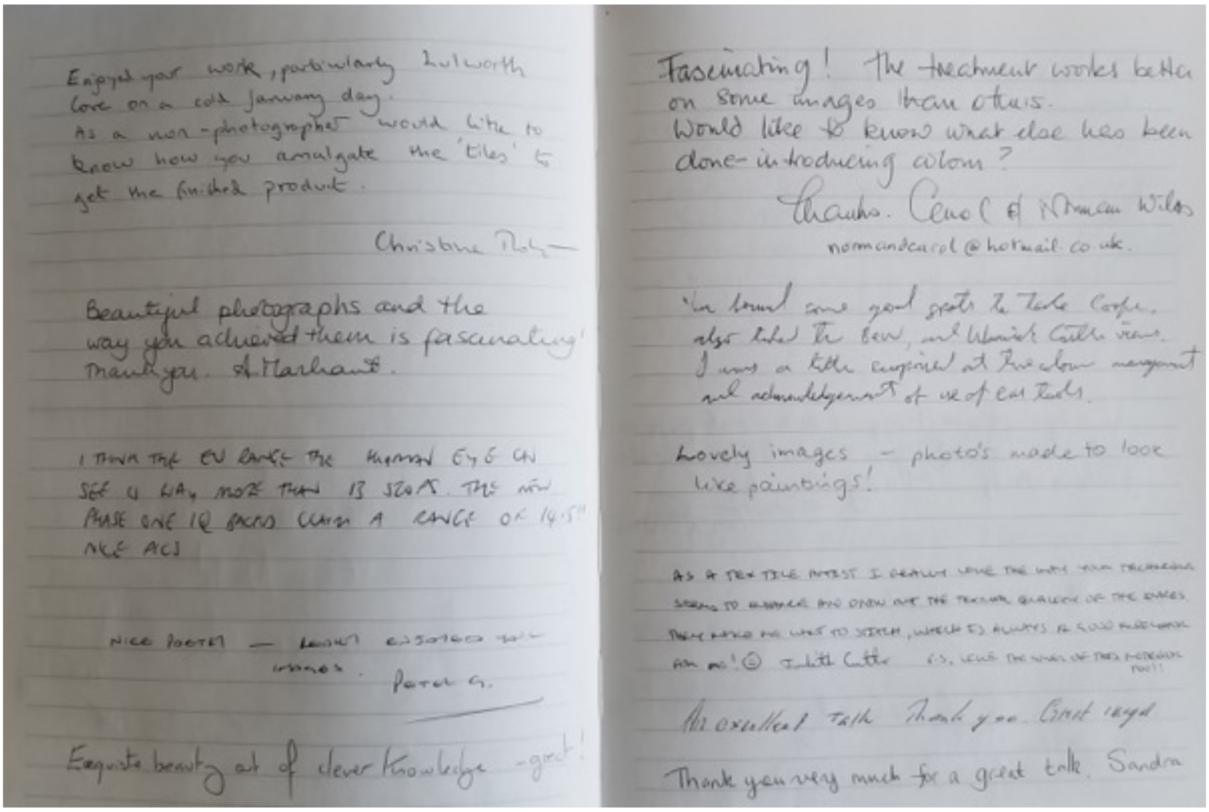
I don't know/understand how you do it but the effects on stonework are astonishing
(local)

Umm. They're just photo's mate.
DO SOMETHING THAT'S PROPER ART!
Anyone can do this! – " IDIOT

Emily Smith

Totally disagree! I took a lot of photos and a lot of landscapes. They capture the essence of landscapes as I see them – photos don't! This is special stuff I think!

Umm, lovely work. For the records, NOT ANYONE CAN DO THIS!!! Great work and room for improvement as you take photography to an entirely new level. David



Enjoyed your work, particularly Lulworth Cove on a cold January day.
As a non-photographer would like to know how you amalgate the 'tiles' to get the finished product.
Christine

Beautiful photographs and the way you achieved them is fascinating! Thank you. A Marchant.

I THINK THE EV RANGE THE HUMAN EYE CAN SEE IS WAY MORE THAN 13 STOPS. THE NEW PHASE ONE IQ BACKS CLAIM A RANGE OF 14.5 NICE ACS

NICE POETRY – ENJOYED THE IMAGES. Peter G.

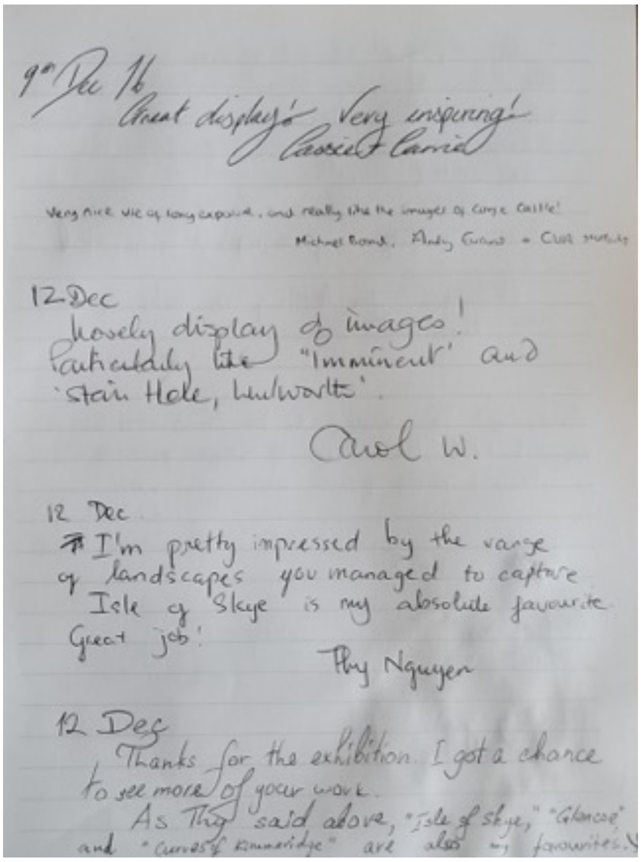
Exquisite beauty art of clever knowledge – great!

Fascinating! The treatment works better on some images than others.
Would like to know what else has been done – introducing colour?
Thanks. Carol & Norman Wilds
normandcarol@hotmail.co.uk

Lovely images – photo's made to look like paintings!

An excellent talk. Thank you.

Thank you very much for a great talk. Sandra



9th Dec 16
Great display! Very inspiring!
Cassie Carrie

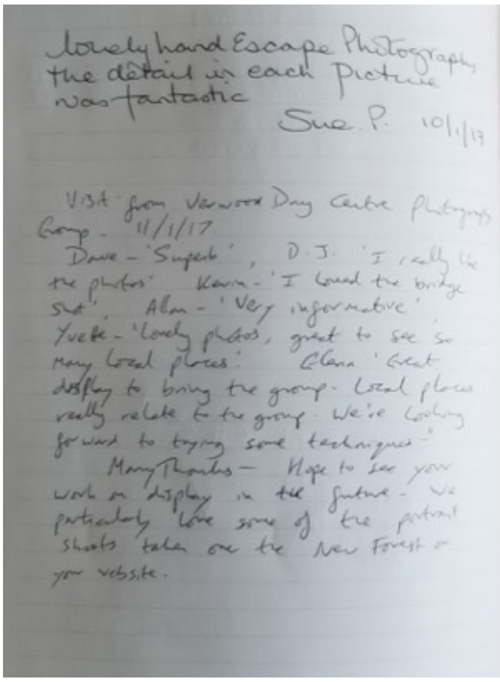
Very nice use of long exposure, and really like the images of Corfe Castle!
Michael Bond, Andy Grant + CUA students

12 Dec
Lovely display of images!
Particularly like "Imminent" and
'Stair Hole, Lulworth'.
Carol W.

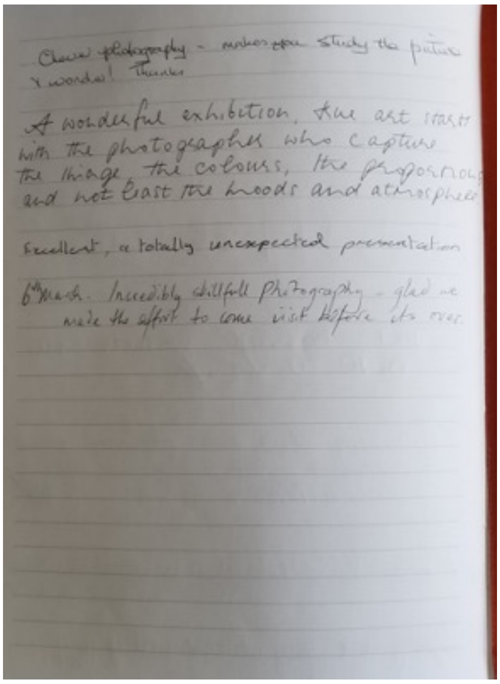
12 Dec
I'm pretty impressed by the range
of landscapes you managed to capture
"Isle of Skye" is my absolute favourite.
Great job!
Thy Nguyen

12 Dec
Thanks for the exhibition. I got a chance
to see more of your work.
As Thy said above, "Isle of Skye," "Glencoe"
and "Curves of Kimmeridge" are also my favourites.

<u>LandEscapes exhibition</u>


Lovely LandEscape Photography the detail in each Picture was fantastic
Sue P. 10/1/17

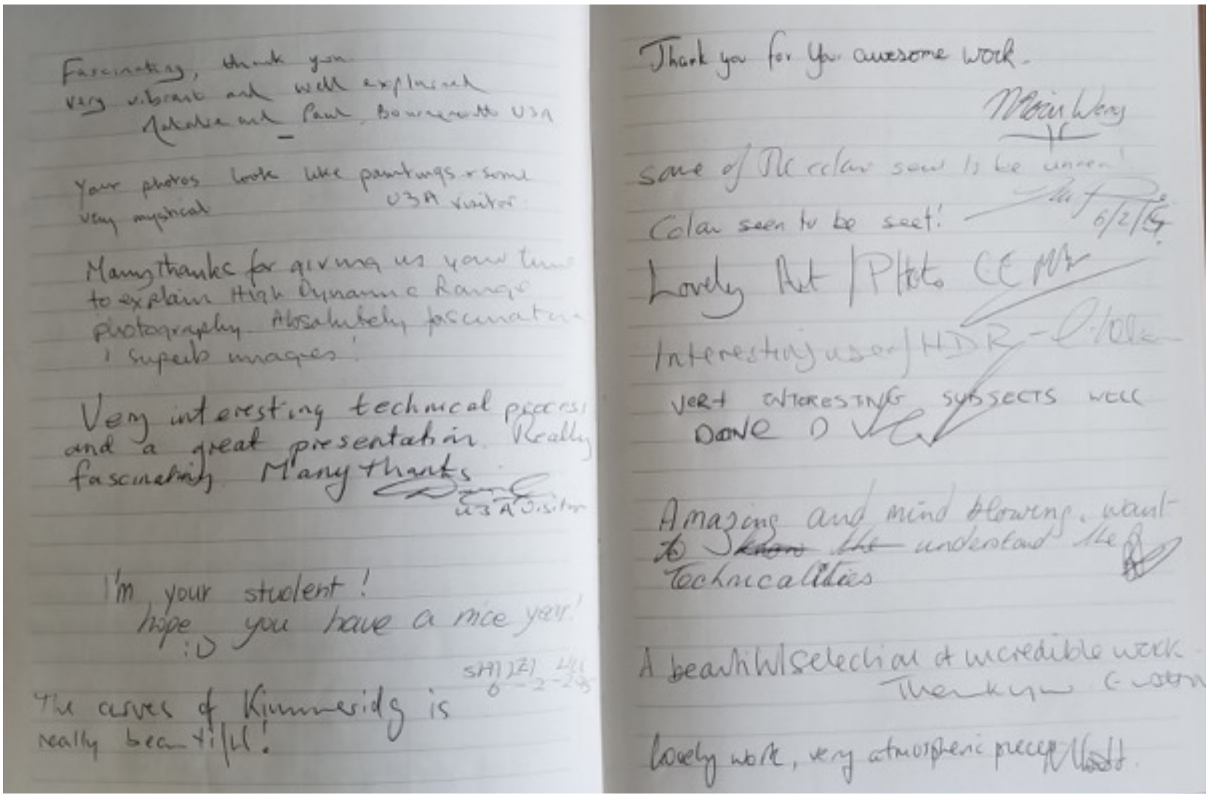
U3A from Verwood Day Centre Photography Group. 11/1/17
Dave – 'Superb', D.J. 'I really like the photos' Karen – 'I loved the bridge shot', Alan – 'Very informative' Yvette – 'Lovely photos, great to see so many local places.' Elana 'Great display to bring the group. Local places really relate to the group. We're looking forward to trying some techniques'
Many Thanks – Hope to see your work on display in the future. We particularly love some of the portrait shots taken over the New Forest on your website.


Clever photography – makes you study the picture & wonder! Thanks

A wonderful exhibition, true art meets with the photographer who captures the image, the colours, the proportions and not least the moods and atmosphere

Excellent, a totally unexpected presentation

6th March. Incredibly skillfull Photography – glad we made the effort to come visit before its over.


Fascinating, thank you. Very vibrant and well explained
Natalie and Paul, Bournemouth U3A

Your photos look like paintings & some very mystical
U3A visitor

Many thanks for giving us your time to explain High Dynamic Range photography. Absolutely fascinating & superb images!

Very interesting technical process and a great presentation. Really fascinating. Many thanks
U3A Visitor

I'm your student! hope you have a nice year! :D
SHIJIZI LIU 6-2-2015

The curves of Kimmeridg is really beautiful!

Thank you for your awesome work.
Mei Wong

Some of the colour seem to be unreal!
Colour seem to be seet! 6/2/15

Lovely Art / Photo

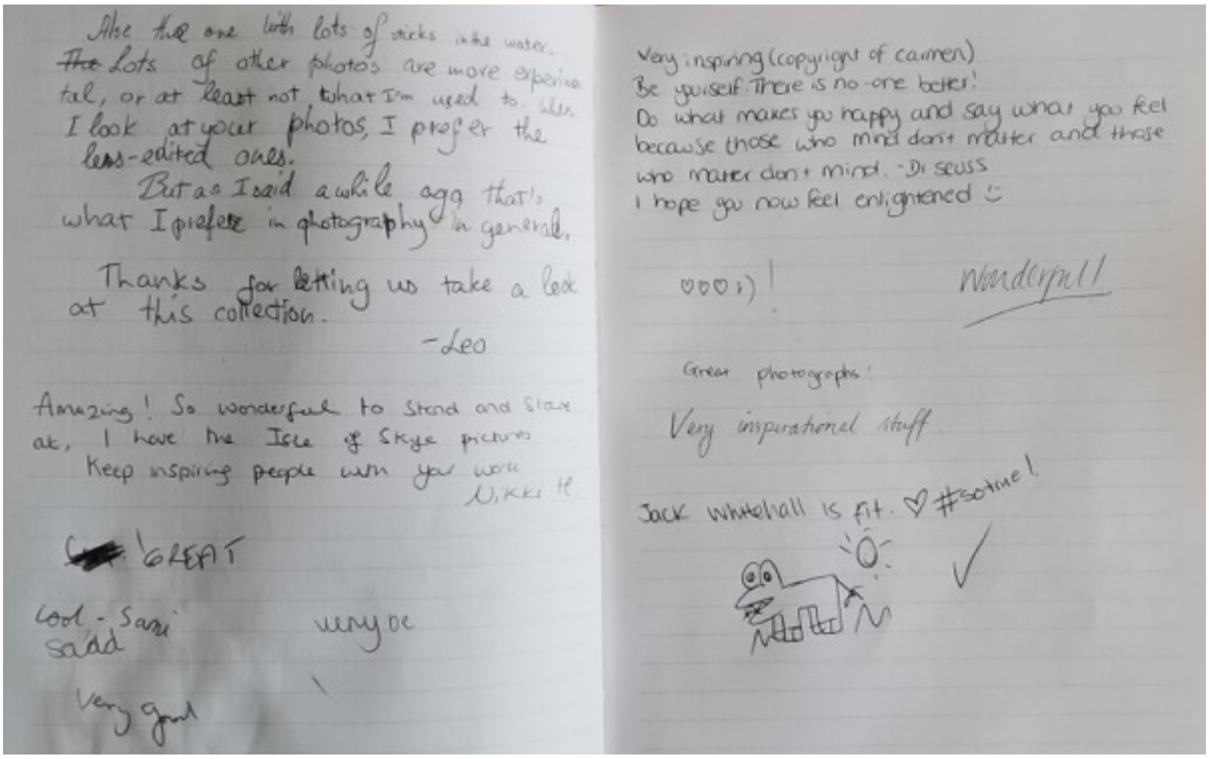
Interesting use of HDR

Very interesting subjects well done

Amazing and mind blowing, want to ~~know the~~ understand the Technicalities

A beautiful selection of incredible work Thank you

Lovely work, very atmospheric



Also the one with lots of sticks in the water.
~~The~~ Lots of other photos are more experimental, or at least not what I'm used to. When I look at your photos, I prefer the less-edited ones.
But as I said a while ago that's what I prefere in photography in general.

Thanks for letting us take a look at this collection.
-Leo

Amazing! So wonderful to stand and stare at, I love the Isle of Skye pictures
Keep inspiring people with your work
Nikki H.

[redacted] GREAT

Cool - Sami
Saad

very oc

Very good

Very inspiring (copyright of carmen)
Be yourself. There is no-one better!
Do what makes you happy and say what you feel because those who mind don't matter and those who matter don't mind. - Dr Seuss
I hope you now feel enlightened :)

♡♡♡ :) !

Wonderfull!

Great photographs!

Very inspirational stuff

Jack Whitehall is fit. ♡ #sotrue!

✓

Appendix D: Peer review – Electronic Visualisation and the Arts Conference, London 2018

----------------------- REVIEW 1 ---------------------
PAPER: 43
TITLE: Rehan's Zone System
AUTHORS: Rehan Zia

Overall evaluation: 3 (strong accept)

----------- Overall evaluation -----------
This is a very interesting and potentially valuable development at the frontier of using photography as a recording mechanism. How does one know a priori the minimum and maximum luminosity values in the scene? How can the technique be applied to spatial resolution, in order to capture all spatial information within a scene? Could it be extended to multispectral or hyperspectral imaging to capture all the spectral information in the light reaching the camera at every point in the scene? Can heuristics be provided to the photographer, based on analysis of the scene, as to the appropriate tonal range, resolution, number of spectral bands, etc?
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
Lindsay W. MacDonald PhD FRPS FBCS
Honorary Professor
Faculty of Engineering Sciences
University College London
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

----------------------- REVIEW 2 ---------------------
PAPER: 43
TITLE: Rehan's Zone System
AUTHORS: Rehan Zia

Overall evaluation: 2 (accept)

----------- Overall evaluation -----------
The demo/paper of the Zone System showcase an interesting technology extending a well established and well known photographic practice into contemporary digital imaging. Although described as a look at the system from a practical perspective, it would benefit from some connection to a wider set of theoretical understandings to understand its implications beyond the appearance of the image.

Its inclusion as a case study in the Digital Futures exhibition needs some surrounding theory, or some clearer indication of the technique's deeper impact on content and form. A simple showing of how an image is constructed seems uninteresting, and a missed opportunity to tie the work to contemporary understandings of representation.

Nonetheless, there does seem something new in this work that warrants inclusion in the programme, and would elicit some considerable interest from the EVA community.

---------------------- REVIEW 3 --------------------
PAPER: 43
TITLE: Rehan's Zone System
AUTHORS: Rehan Zia

Overall evaluation: 2 (accept)

----------- Overall evaluation -----------
This is certainly an interesting and useful innovation that will provide insights into new photographic techniques that are made possible through digital panoramas and gigapixel systems. It would be useful to see more about the creative possibilities that are realised with this system along with its technical details. If we could have more about these creative potentials as case studies, then I think this paper would be improved. As it stands it will make for a good technical studies.

---------------------- REVIEW 4 --------------------
PAPER: 43
TITLE: Rehan's Zone System
AUTHORS: Rehan Zia

Overall evaluation: 3 (strong accept)

----------- Overall evaluation -----------
The proposal covers an interesting and fairly timely extension to photographic practice through the affordances of recent digital technology. The extension of classical zone systems to time and focus is a potentially far-reaching re-examination of the ontology of the photographic 'image' - I would hope this would be part of the consideration of the system in the full paper. As always, results are all (which why I'd strongly support the demonstration and workshop being accepted alongside the paper), but this is a very strong proposal.

Appendix E: Exhibition feedback questionnaires

Version: v1
Ethics ID: 27907
Date: 19 November 2019

Bournemouth University

Participant Information Sheet

The title of the research project

Fixing it in the Present – The Decisive Moment in High Dynamic Range Photography

What is the purpose of the research/evaluation form?

Photographing landscapes can be challenging given the wide range of tonal values present in the scene that can extend beyond the range of what most digital cameras can record. Multi-shot high dynamic range photography can be used to capture the full range of scene values by photographing a range of different exposures and combining them digitally. Moving elements in the landscape such as clouds, foliage, water, and, changing light pose a challenge, as well as creative opportunities, to create distinct creative image looks based on the degree of change these elements undergo during capture of the multiple exposures. Key photographic opportunities where the elements in the scene come together to create a certain sense of balance and composition, or, the Decisive Moment, may be missed between exposures given the multi-shot nature of this workflow.

The research purpose of this research is to explore best practice for multishot landscape photography. Multi-shotStack-based high dynamic range photography can be used to capture the full range of scene values by photographing a range of different exposures and combining them digitally. The aim of this practice-led research is to take better control over the potential look of the final image by capturing all tonal values available in the scene in best possible detail, thereby extending the range of creative possibilities available during postproduction post-capture whilst also capturing the Decisive Moment.

Why have I been chosen?

You have been chosen based on your photographic and industry expertise and experience.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part, you will be given this information sheet to read. You can withdraw from participation at any time and without giving a reason, simply by not returning your completed evaluation form to the Researcher, Rehan Zia. Please note that once you have completed and submitted your evaluation form, we are unable to remove your anonymised responses from the study, unless you have chosen to be identified. Deciding to take part or not will not impact upon you.

How long will the questionnaire/online survey take to complete?

You will be asked to provide your honest opinions on the photography technique and outputs and completing the evaluation form should take no longer than 30 minutes

What are the advantages and possible disadvantages or risks of taking part?

Whilst there are no immediate benefits to you participating in the project, your responses will help in the evaluation of the research outputs (images and workflow).

We do not anticipate any risks to you in taking part in this study, you may discontinue completing the evaluation form at any point

What type of information will be sought from me and why is the collection of this information relevant for achieving the research project's objectives?

You will be asked for your expert advice and suggestions on the validity of the technique and outputs will help in the evaluation of the results/research outputs.

How will my information be managed?

Bournemouth University (BU) is the organisation with overall responsibility for this study and the Data Controller of your personal information, which means that we are responsible for looking after your information and using it appropriately. Research is a task that we perform in the public interest, as part of our core function as a university.

Undertaking this research study involves collecting and/or generating information about you. We manage research data strictly in accordance with:

- Ethical requirements; and
- Current data protection laws. These control use of information about identifiable individuals, but do not apply to anonymous research data: "anonymous" means that we have either removed or not collected any pieces of data or links to other data which identify a specific person as the subject or source of a research result.

BU's Research Participant Privacy Notice sets out more information about how we fulfil our responsibilities as a data controller and about your rights as an individual under the data protection legislation. We ask you to read this Notice so that you can fully understand the basis on which we will process your personal information.

Research data will be used only for the purposes of the study or related uses identified in the Privacy Notice or this Information Sheet. To safeguard your rights in relation to your personal information, we will use the minimum personally-identifiable information possible and control access to that data as described below.

Publication
You will not be able to be identified in any external reports or publications about the research without your specific consent. Otherwise your information will only be included in these materials in an anonymous form, i.e. you will not be identifiable.

Research results will be published

Security and access controls
BU will hold the information we collect about you in hard copy in a secure location and on a BU password protected secure network where held electronically.

Personal information which has not been anonymised will be accessed and used only by appropriate, authorised individuals and when this is necessary for the purposes of the research or another purpose identified in the Privacy Notice. This may include giving access to BU staff or others responsible for monitoring and/or audit of the study, who need to ensure that the research is complying with applicable regulations.

Sharing your personal information with third parties
As well as BU staff and BU student working on the research project, we may also need to share personal information in non-anonymised for with external examiners for the research study.

Keeping your information if you withdraw from the study
If you withdraw from active participation in the study we will keep information which we have already collected from or about you, if this has on-going relevance or value to the study. This may include your personal identifiable information. As explained above, your legal rights to access, change, delete or move this information are limited as we need to manage your information in specific ways in order for the research to be reliable and accurate. However if you have concerns about how this will affect you personally, you can raise these with the research team when you withdraw from the study.

You can find out more about your rights in relation to your data and how to raise queries or complaints in our Privacy Notice.

You can find out more about your rights in relation to your data and how to raise queries or complaints in our Privacy Notice.

Retention of research data

Project governance documentation, including copies of the evaluation form: we keep this documentation for a long period after completion of the research, so that we have records of how we conducted the research and who took part. The only personal information in this documentation will be your name, and we will not be able to link this to any anonymised research results.

Research results:

Version: v1
Ethics ID: 27907
Date: 19 November 2019

We will keep your personal information in identifiable form for a period of 6 months after completion of the research study. Although published research outputs are anonymised, unless you have chosen to be identified, we need to retain underlying data collected for the study in a non-anonymised form to enable the research to be audited and/or to enable the research findings to be verified.

You can find more specific information about retention periods for personal information in our Privacy Notice.

Contact for further information

If you have any questions or would like further information, please contact Rehan Zia, Lecturer in Computer Animation, Bournemouth University Email: rzia@bournemouth.ac.uk or Ian Stephenson, Senior Lecturer in Computer Animation, Bournemouth University Email: istephen@bournemouth.ac.uk

In case of complaints
Any concerns about the study should be directed to Rehan Zia. If your concerns have not been answered by Rehan Zia, you should contact Deputy Dean of Research and Professional Practice, Dr Einar Thorsen, Faculty of Media and Communication, Bournemouth University by email to researchgovernance@bournemouth.ac.uk.

	Initial boxes to agree
I confirm that I have read and understood the information provided and I agree to take part in the study	NG

I understand that my name and words may be quoted in thesis, publications, reports and other research outputs.	NG
I agree that my real name can be used in the above	NG
I do not agree that my real name can be used in the above	NG

Version: v1
Ethics ID: 27907
Date: 19 November 2019

Participant Name:

Neil Goridge

Organisation/Affiliation:

Bournemouth University. National Centre for Computer Animation (NCCA)

Please state your photography experience:

I have been a professional photographer for nearly 20 years. I was accepted into the Royal Photographic Society in 2004 and I have been published online and in print on multiple occassions. I have worked with and have had work published by companies such as MacMillan Cancer, Royal Shakespeare Company, Bournemouth University, Poole Lighthouse, Oxjam, Hobbycraft, Brownsea Open Air Theatre and Steppin' Out Academy of Performance. I shoot around 30-50,000 photos a year, employing a wide variety of styles and skills.

I have taught camera acquisition (both stills and video) for around 10 years at Bournemouth University. I started with BA Journalism and BA Media Production, before moving onto camera acquisition for MA Digital Effects, BA VFX, BA CAAD and BA CATA.

Please state your observations about the images exhibited in "Landscapes on the Cusp of the Real & the Fantastic" exhibition by Rehan Zia in relation to:

1. the dynamic range fo the scene photographed
2. the local and global scene contrast rendered
3. ghosting and misalignment artifacts
4. tonemapping artifacts such as halos and inverse tonemapping
5. diffration artifacts
6. chromatic abberations
7. banding
8. noise
9. depth of field coverage of the scene
10. capturing of the decisive moment in the scene

1. Dynamic Range of the scene photographed

The dynamic range captured in the photographs is generally very comprehensive. By that, I mean that all shadow and all highlight information is retained, even in challenging lighting conditions. I would say that in 1 photograph there is possibly a loss of highlight detail (clipping) in a small region, but this could be down to processing choices or printing. This is the cavern shot where there is a bulb on the left hand side which doesn't resolve infinite detail.

2 Local and global scene contrast rendered

Each photograph renders a good range of contrast values and contrast consistency. The photographs have a good balance aesthetically and artistically and while there is some variance in contrast processing within the whole panel of images as a collection, this appears to be due to artistic choices rather than any errors in capture. I would say that each of the photographs has recorded the correct amount of information and the processing which has then been applied is appropriate to the individual scene.

3. Ghosting and misalignment artifacts

I could see no ghosting or misalignment within the photographs. This is impressive when considering that the processes of multiple image recording (HDR) will often result in these particular issues.

4. Tonemapping artifacts such as halos and inverse tonemapping

There is very little in the way of halo effects, which again is impressive. I would say that it is only slightly noticeable in 2 photographs. The first is in the photograph where you have a rock in blue water and you can slightly see a halo along part of the edge of the rock. The other occasion is in the photo of the castle residence, where a halo effect is slightly visible along part of the wall. However, they are barely noticeable and you have to look extremely carefully to see them.

5. Diffraction artifacts

I could see no diffraction artifacts

6. Chromatic Abberation

No chromatic abberation found

7. Banding

No banding found

8. Noise

The photographs reveal no visible areas of unwanted noise through errors during capture. One image displays a considerable amount of noise but my belief is this is purely aesthetic to provide texture and enhances the overall look and feel of the photograph. It feels considered and appropriate and doesn't display typical 'noise' problems such as a lack of detail, colour errors etc.

9. Depth of field coverage of the scene

An extremely large depth of field has been achieved in each photograph. I believe focus stacking has been used on at least some of the photographs and this has been carried out with subtlety and nuance as it is not possible to see where the layers have been masked and revealed. Any reduction in sharpness appears to be due to environmental atmospheric conditions on the day when the photograph was taken, such as fog and mist. Using this technique has given the photographs a sense of depth that you wouldn't ordinarily see 'live'.

10. Capturing the decisive moment in the scene

In each of the photos there appears to have been a clear intent to capture mood and compositionally interesting elements, both of which will have required timing and precision. This is evident in the lighting, environmental atmospherics, the moving elements within the frame and the chosen time of day. There is also sense of scale in each of the photographs which has been given prominence by their content and method of the way the images have been captured.

Using HDR, focus stacking and panoramic techniques, Rehan seems to have been able to record high quality data which is then flexible enough to produce various types of processed imagery. For example, you have high contrast and highly detailed landscapes in which you can analyse the fabric and texture of particular areas, but equally the technique has allowed for more subtle representations of the world to allow the viewer to make their way through the photograph evenly, being able to view the world of light and detail in ways which the human eye is unable to naturally perceive.

Version: v1
Ethics ID: 27907
Date: 19 November 2019

Bournemouth University

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You have been chosen based on your photographic and industry expertise and experience.

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How long will the questionnaire/online survey take to complete?

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How will my information be managed?

Bournemouth University (BU) is the organisation with overall responsibility for this study and the Data Controller of your personal information, which means that we are responsible for looking after your information and using it appropriately. Research is a task that we perform in the public interest, as part of our core function as a university.

Undertaking this research study involves collecting and/or generating information about you. We manage research data strictly in accordance with:

- Ethical requirements; and
- Current data protection laws. These control use of information about identifiable individuals, but do not apply to anonymous research data: "anonymous" means that we have either removed or not collected any pieces of data or links to other data which identify a specific person as the subject or source of a research result.

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Research data will be used only for the purposes of the study or related uses identified in the Privacy Notice or this Information Sheet. To safeguard your rights in relation to your personal information, we will use the minimum personally-identifiable information possible and control access to that data as described below.

Publication
You will not be able to be identified in any external reports or publications about the research without your specific consent. Otherwise your information will only be included in these materials in an anonymous form, i.e. you will not be identifiable.

Research results will be published

Security and access controls
BU will hold the information we collect about you in hard copy in a secure location and on a BU password protected secure network where held electronically.

Personal information which has not been anonymised will be accessed and used only by appropriate, authorised individuals and when this is necessary for the purposes of the research or another purpose identified in the Privacy Notice. This may include giving access to BU staff or others responsible for monitoring and/or audit of the study, who need to ensure that the research is complying with applicable regulations.

Sharing your personal information with third parties
As well as BU staff and BU student working on the research project, we may also need to share personal information in non-anonymised for with external examiners for the research study.

Keeping your information if you withdraw from the study
If you withdraw from active participation in the study we will keep information which we have already collected from or about you, if this has on-going relevance or value to the study. This may include your personal identifiable information. As explained above, your legal rights to access, change, delete or move this information are limited as we need to manage your information in specific ways in order for the research to be reliable and accurate. However if you have concerns about how this will affect you personally, you can raise these with the research team when you withdraw from the study.

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Research results:

We will keep your personal information in identifiable form for a period of 6 months after completion of the research study. Although published research outputs are anonymised, unless you have chosen to be identified, we need to retain underlying data collected for the study in a non-anonymised form to enable the research to be audited and/or to enable the research findings to be verified.

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Contact for further information

If you have any questions or would like further information, please contact Rehan Zia, Lecturer in Computer Animation, Bournemouth University Email: rzia@bournemouth.ac.uk or Ian Stephenson, Senior Lecturer in Computer Animation, Bournemouth University Email: istephen@bournemouth.ac.uk

In case of complaints

Any concerns about the study should be directed to Rehan Zia. If your concerns have not been answered by Rehan Zia, you should contact Deputy Dean of Research and Professional Practice, Dr Einar Thorsen, Faculty of Media and Communication, Bournemouth University by email to researchgovernance@bournemouth.ac.uk.

	Initial boxes to agree
I confirm that I have read and understood the information provided and I agree to take part in the study	ac

I understand that my name and words may be quoted in thesis, publications, reports and other research outputs.	ac
I agree that my real name can be used in the above	ac
I do not agree that my real name can be used in the above	—

Version: v1
Ethics ID: 27907
Date: 19 November 2019

Participant Name:

ANDREW JONATHAN COPE

Organisation/Affiliation:

ARTS UNIVERSITY BOURNEMOUTH

Please state your photography experience:

TWENTY NINE YEARS FREELANCE SOCIAL / COMMERCIAL PHOTOGRAPHER

FOUNDATION DEGREE IN ART – PHOTOGRAPHY
BA (HONS) IN PROFESSIONAL PHOTOGRAPHY
MA IN COMMERCIAL PHOTOGRAPHY
VT BLACK & WHITE PRINTING AUB
FULL TIME TECHNICIAN DEMONSTRATOR AUB

Version: v1
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Please state your observations about the images exhibited in "Landscapes on the Cusp of the Real & the Fantastic" exhibition by Rehan Zia in relation to:

1. the dynamic range fo the scene photographed
2. the local and global scene contrast rendered
3. ghosting and misalignment artifacts
4. tonemapping artifacts such as halos and inverse tonemapping
5. diffration artifacts
6. chromatic abberations
7. banding
8. noise
9. depth of field coverage of the scene
10. capturing of the decisive moment in the scene

A BODY OF WORK PRODUCED BY A VERY COMPETENT PHOTOGRAPHER. REHAN HAS, TO VARYING DEGREES EXTRACTED INFORMATION IN BOTH HIGHLIGHTS AND SHADOWS, GIVING THE FINISHED IMAGES AN "OTHER WORLDLY" LOOK. ALL IMAGES HAVE HAD THIS TREATMENT AND THEREFORE MOVE AWAY FROM A REALISTIC AESTHETIC.

BY MAKING ADJUSTMENTS BOTH OF THE DYNAMIC RANGE & THE GLOBAL SCENE CONTRAST TO THE OUTPUT PRINTED IMAGES, MAKE FOR A DIFFERENT EXPERIENCE FOR THE VIEWER, RELATING TO THE AMOUNT OF WORK THE VIEWER'S EYES HAVE TO DO, ALMOST MAKING IT EASIER ON THE EYE.

THE MID-TONES, SHADOWS & HIGHLIGHTS HAVE DETAILS THAT THE EYE WOULD PICK-UP ON, WHEN SCANNING FROM LIGHTER TO DARKER IN THEIR NATURAL SETTINGS, BUT ARE PRESENTED TO THE VIEWER IMMEDIATELY AND ALL IN ONE INSTANT, DENOTING THE IMAGES SIMULATION TO "THE REAL", AS OPOSED TO AN AUTHENTIC REPRESENTATION.

UNLIKE HYPERREALITY, THERE IS A DEGREE OF UNBELEIVEABILITY WHICH THE AUTHOR SUGESTS IN THE TITLE "LANDSCAPES ON THE CUSP OF THE REAL & THE FANTASTIC" & THEREFORE ACHIEVING HIS OBJECTIVE OF PRESENTING THE REAL WORLD WITH A SLIGHT LEANING TOWARDS THE IMAGINED OR CONSTRUCTED.

THERE ARE NO OBVIOUS MANIFESTATIONS OF GHOSTING, TONE MAPPING ARTIFACTS, SHOWING THAT THE PHOTOGRAPHER DEMONSTRATED HIS COMPETENCE & PROFICIENCY WITH THE POST-PRODUCTION PROCESS.

AS FAR AS I'M AWARE, CHROMATIC ABBERATIONS ARE CAUSED WITH OLDER STYLE LENSES, BEING USED WITH MORE MODERN TECHNOLOGY.

I DID NOT SEE ANY CHROMATIC ABBERATIONS WITHIN THE IMAGES BEING EXHIBITED.

BANDING ONLY OCCURS WHEN THERE IS NOT ENOUGH DATA TO TRANSITION FROM AREAS SIMILAR IN TONAL RANGE/VALUE, AGAIN, NO EVIDENCE OF THIS PHENOMENA WITHIN THE IMAGES, I KNOW THAT WHEN USING THE HDR PROCESS, AN ABUNDANCE OF DATA IS CAPTURED, GIVING FULL POTENTIAL, AT EACH PIXEL SITE, TO EXTRACT INFORMATION WHEN POST-PRODUCTION OCCURS, WITH THE USE OF TONEMAPPING SOFTWARE.

BECAUSE THE PHOTOGRAPHER HAS USED HDR & FOCUS STACKING. WHILST THE CAMERA WAS MOUNTED ON A TRIPOD, THE NEED FOR THE USE OF HIGH ISO OR POST PRODUCTION SHARPENING, I PRESUME, WAS KEPT TO A MINIMUM AND THEREFORE, THERE ARE NO NOTICABLE ISSUES WITH NOISE.

THE PHOTOGRAPHER HAS ACHIEVED CRITICAL FOCUS ON ALL OF HIS IMAGES AS WELL AS A BROAD DEPTH OF FIELD, THROUGH THE USE OF FOCUS STACKING AND HDR. THERE WAS NO SIGN OF ARTEFACTS OR SOFTENING CAUSED THROUGH DIFFRACTION, I BELIEVE THE PHOTOGRAPHER HAS A WORKING KNOWLEDGE ABOUT THE RELATIONSHIP PIXEL SITES & LENS APERTURES TO ACHIEVE FOCUS & SHARPNESS THROUGHOUT HIS IMAGES, ALL THE WAY THROUGH FRONT TO BACK, FOREGROUND TO HORIZON.

AS SOME OF THE ELEMENTS WERE NON-STATIC, LIKE CLOUDS, GRASS WATER ETC, BRINGS INTO QUESTION 'THE DECISIVE MOMENT'. A SERIES OF MOMENTS (EVENTS) HAVE BEEN CAPTURED SEPERATELY, THEN RE-CONSTRUCTED, TO REPRESENT THE AUTHORS INTERPRETATION OF THE SCENE, THAT BEST SUITED HIS ARTISTIC NEEDS.

AS WITH ALL PHOTOGRAPHY FROM ITS INCEPTION TO PRESENT TIME, THE PHOTOGRAPHER DECIDES ALL OF THE LOGISTICS, TECHNICAL ISSUES, ARTISTIC & AESTHETIC ASPECTS OF HOW AN IMAGE FINDS ITS WAY ONTO A GALLERY WALL, HOW THE IMAGE CAME INTO EXISTENCE, A WHOLE LIFE TIME OF INFLUENCES, WILL GO INTO 'THE DECISIVE MOMENT'.

WHAT REHAN HAS SUCCESSFULLY DONE, IS ASKED US TO CONSIDER OTHER POSSIBITIES OF REALITY.

Version: v1
Ethics ID: 27907
Date: 19 November 2019

Bournemouth University

Participant Information Sheet

The title of the research project

Fixing it in the Present – The Decisive Moment in High Dynamic Range Photography

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I agree that my real name can be used in the above	✓
I do not agree that my real name can be used in the above	

Participant Name:

Rutherford

Organisation/Affiliation:

BU

Please state your photography experience:

12 years commercial photography (1982-93) 40 years fine art photographic practice (1980-present), exhibited internationally (Canada, USA, New Zealand, France, Japan)

Please state your observations about the images exhibited in “Landscapes on the Cusp of the Real & the Fantastic” exhibition by Rehan Zia in relation to:

1. the dynamic range fo the scene photographed
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3. ghosting and misalignment artifacts
4. tonemapping artifacts such as halos and inverse tonemapping
5. diffration artifacts
6. chromatic abberations
7. banding
8. noise
9. depth of field coverage of the scene
10. capturing of the decisive moment in the scene

Work includes an impressive dynamic range in the scenes photographed

As for some the other issues on which you have requested comments:

- the local and global scene contrast rendered
- ghosting and misalignment artifacts
- tonemapping artifacts such as halos and inverse tonemapping
- diffraction artifacts
- banding

…it would have been helpful to have been provided an explanation/definition of some of the terms (not all photographers will be conversant with the particular technical issues and challenges central to your practice) and a little guidance as to the nature of the feedback you seek.

While there appears to be some instances of chromatic aberration, in most cases, these add to the ‘otherworldly’ appearance of the images

Good depth of field coverage of the scene

As most images are landscapes, it is not clear how ‘the decisive moment’ (at least as Cartier-Bresson used it) is relevant or applicable to the appreciation of the rendering/depiction of the scenes in these photographs. In so far as it is relevant to your practice, I expect that the influence of ‘the decisive moment’ lies in shaping (and restricting) the ‘kind’ of scenes, events and ‘moments’ your practice can be used to render. (For example, while this approach enables you to draw out colours and tonal ranges not available in other practices, it would not be feasible for social documentary or photojournalism.)