AN INTRODUCTION TO DYNAMIC RANGE

1. Understanding Dynamic Range

The term 'Dynamic Range' can refer to the range of tones, brightness or luminance which:
- are in a scene to be photographed
- can be captured by the eye
- can be captured by a camera
- can be displayed on a monitor
- can be expressed in a photographic print

Luminance is a measure of the intensity of light passing through a defined area.

Dynamic range is defined as the ratio between the brightest and darkest parts of an image, while luminance is an absolute measure of light intensity.
The ratios can be expressed as:
- numbers (e.g. 100:1)
- f-stops (each stop represents a doubling or halving of brightness)
- exposure values (EV) (an increase of 1EV represents a doubling of brightness, and a ratio of 1024:1 = 10EV)

The dynamic range of a scene is defined as the ratio between the brightest and darkest parts. A bright daylight scene can have a dynamic range of 100,00: 1, or 17 stops (EVs). This exceeds the range of even the best cameras.

The human eye can capture exposure levels in a range of about 18-21 stops (estimates range up to 30). This is based on its ability to adjust to different light levels (as well as its 'software' - the brain). The eye's capability at a single glance is much less, at about 10-14 stops.

The best cameras have a range of 14-15 EV, using RAW capture and base ISO, and are able to cope with most scenes. Older cameras can have a much lower dynamic range, often around 6-8 EV. 8-bit JPEG files have 256 levels (8 EV)
Note that dynamic range is only one aspect of sensor quality. ISO, colour sensitivity, noise and other factors need to be considered.

Television sets and computer monitors have less dynamic range capabilities than cameras, though new 'HDR' models are available providing a greater contrast ratio.

Photographic film has a dynamic range of 10-11EV, while photographic prints are generally in the range of about 6-7 EV.

If the dynamic range of our PDIs and prints is limited, why do we need to consider the dynamic range of our cameras and final images? In many cases we don't have a problem that can't be fixed with editing. The issue is obtaining images that best fit what the brain perceives rather than what the camera captures. This is necessary because what is perceived depends on the fact that the eye can rapidly change its aperture and the brain combines images to give a result that compensates for the scene dynamic range.

(This difference between camera and brain perception also accounts for the inclusion in photo-editing programs of modules for geometric correction, allowing for changes such as the alteration of verticals to overcome apparent convergence.)

The capture of an image should avoid loss of detail in bright areas (blown highlights) or land in shadows. Cameras with better dynamic range can provided better images and reduce the need for complex editing. Even so, some scenes are beyond the capability of even the best cameras.

2: Overcoming Dynamic Range Problems

There are many ways to address problems caused by high scene dynamic range. With a single image, improvements may be obtained with in-camera techniques, editing, or both.

Where the dynamic range in a scene is very high, better results may be obtained by capturing multiple images and combining them in editing processes.

2.1: Controlling Dynamic Range in a Single Image
There are many ways to address problems caused by high scene dynamic range. With a single image, improvements may be obtained with in-camera techniques, editing, or both.

To get good results:
- shoot RAW files (with or without jpeg)
- use over- and under-exposure controls
- expose to the right (ETTR) *or the left, depending on the scene*!
- use flash to brighten dark areas
- use a graduated neutral density filter
- use built-in camera modules which analyse the image and apply a tone curve
- choose optimum lighting conditions

Expose to the right' (ETTR) involves changing the exposure value (EV) to a level higher than that determined by the exposure meter. The term comes from the fact that increasing the exposure value shifts the image histogram to the right. ETTR brightens the image and helps to ensure that detail is retained in darker areas. Care needs to be taken to avoid over-exposure of highlights.

A negative EV (exposing to the left - ETTL) darkens the image and helps to ensure that detail is retained in brighter areas. This can help prevent over-exposure of highlights. Exposing to the left tends to increase noise in shadow areas.

Use of flash is helpful where the flash will brighten darker areas, such as interiors or where near objects are in shadow or silhouetted

Graduated neutral density (GND) filters can be used to reduce the dynamic range of scenes. These are used to reduce the brightness of the sky relative to the foreground in landscapes. They can have a hard or soft transition and come in a range of stop/EV reductions, and are most useful where the horizon is flat.

Polarising filters can also be used to reduce the brightness of blue skies and to make other improvements to image quality.

2.2: Choosing Optimum Lighting Situations
Dynamic range in landscapes is highest when there is bright sunlight. Lower dynamic range occurs in overcast conditions and when the sun is lower, as in the so-called' golden hour' and 'blue hour'.

This does not mean that all photography should be done when the light is bright and there are sharp contrasts in the subject, although more complex editing may be required in this case.

2.3: In-Camera Dynamic Range Optimization
Several manufactures have an in-camera process which effectively applies an S-curve to the captured image and restores shadow and highlight details. Nikon's version is called "Active D-Lighting". ADL is said to be useful for astrophotography. Other manufacturers have similar modules.

These optimized images can also be used in conjunction with 'standard' images in image blending.

These techniques are applied to JPEG files, not to RAW files.   However, if the camera is set to take both RAW and JPEG files, they can alter the RAW image by slightly reducing the exposure level.

Unless dynamic range is extreme, standard photo-editing approaches can overcome the effects of over- and under-exposure of parts of an image. These include use of tone curves, exposure, brightness, contrast, saturation, tone mapping and other modules on the whole image. Many image problems can be addressed though careful manipulation of the tone curve, but this can be complex and alternative approaches can be simpler.

Unless masking is used, these controls tend to affect the whole image, even though they may be directed towards a particular effect or tonal range..

3: Editing Single Images

Unless dynamic range is extreme, standard photo-editing approaches can overcome the effects of over- and under-exposure of parts of an image.

There are many options within standard photo-editing software to adjust the tonal range of the final image. These include tone curves, exposure, brightness, contrast, saturation, tone mapping and other modules. Such modules can be used on the whole image or part of the image. Using a control generally has an effect on the whole image even where it is directed towards brightening dark areas or reducing highlights.

In some cases it is better to edit only part of the image. This the equivalent of 'dodge and burn' techniques in photographic film editing. Selection of part(s) of the image for editing can be done in several ways:
- using masks, which may be drawn or created using selections based on luminosity, hue or selected using artificial intelligence (AI)
- using 'point', localised or radial selections
- using 'single-image HDR"

Layers and masking can be used gives better control over the final image. For example, a dark area can be brightened without affecting areas which are already bright.

Luminosity masking allows the selection of particular tonal ranges for editing, such as for adjustment of exposure. This can give a better results than editing with curves, but it's not a simple technique and can result in artefacts if not used carefully.

4: Using Multiple Images

4.1 Situations where multiple images may be required

Even with a high-quality camera and good processing techniques, some high dynamic range situations can best be addressed with multiple images.

Examples include building interiors, night photography and high-contrast landscapes, such as sunset scenes where foreground retail is to be retained.

Using multiple images is not practical where there is continuous movement in the subject although some programs allow for removing the effects of movement.

4.2 Exposure bracketing

Exposure bracketing involves taking several images of the subject with varying exposures. Many modern cameras have built-in exposure bracketing capability (automatic exposure bracketing - AEB). Even where this is not provided, bracketing is a fairly simple process.

When bracketing images, use the Aperture Priority setting, to retain a constant aperture as changing the aperture can change the image in some cases. Select an aperture for good depth of field and use the exposure value control to obtain images with positive and negative EVs. Changing the EV will change the shutter speed when using automatic exposure bracketing and a fixed ISO.

With manual bracketing, the shutter speed can be changed manually.

The objective is to have two or (usually) more images with different exposure values.
A good starting point with automatic exposure bracketing is to set exposures at O, +2EV and -2EV. Where there is a very high contrast it can be useful to include a wider range of EVs.

With experience in the techniques, it is useful to experiment with manual control to ensure that all parts of the scene have at least one image recorded showing appropriate exposure and detail.

It is preferable to use RAW images if possible rather than JPEGs in order to capture a wider dynamic range and have more detail for final processing. Most High Dynamic Range programs will accept RAW files and JPEGs but some programs only accept JPEGs.

It is also preferable to use matrix (whole-frame) metering.

Use of a tripod is strongly preferred, although some programs include image alignment so that multiple images can be used in some situations where use of a tripod is impossible.

Bracketing options vary between cameras. Some cameras have a 'BKT' button while others may require going into the menu.

Some offer a fixed number of exposures (usually three) and limited variations in EV. Others allow for up to nine exposures in AEB and EV increments from 0.3 to 3.0

4.3 Processing Multiple Images

4.3.1 High Dynamic Range Programs

Images can be processed in specialised High Dynamic Range (HDR) software or other image blending software. There are specialised HDR programs such as Photomatix and LuminanceHDR, and most general-purpose editing programs now include an HDR module. Some programs have a free basic version and a more advanced paid version. Most programs offer a free trial. In some general purpose programs the HDR modules are not clearly evident, so it is worth checking the user manual if in doubt.

The HDR module in Luminar Neo is based on the well-known Aurora HDR program, which is no longer available as a separate purchase.

Some general-purpose free photo-editing programs such as RawTherapee also include HDR modules.

4.3.2 HDR Image Merging
HDR (and other similar image blending or merging techniques) are essentially about maintaining detail and realistic luminance values in both highlights and shadow areas where there is a substantial range of luminance values within the scene

HDR programs usually combines a standard image taken at 0EV with one or more images which are brighter (positive EV) and darker (negative EV). Different programs can use different algorithms for this purpose and produce different results.
Programs vary in their layout but usually involve:
-        opening multiple images
-        aligning images
-        merging images
-        removing 'ghosts' (blurred sections which can result from movement within the scene)
-        tone mapping (this is separate from the merge process and is sometimes in a different module)

After the automated merge process is completed there is usually a need for further processing. For example, HDR merging can produce over-saturated colours. While some people deliberately aim for this effect, it is often useful to to use the vibrance or saturation sliders to reduce saturation.

As well as correcting over-saturation, other common controls such as exposure levels, noise reduction, contrast, sharpening, and white balance may be used to improve the final image.

4.3.3 HDR Problems
In addition to possible over-saturation, some common problems with HDR (though less so as programs improve are:
-        halos (bright or dark areas at margins)
-        unnatural lack of contrast- 'grunge'
These can be prevented by careful processing, although some HDR enthusiasts like the effects and seek to enhance them.

4.3.4 Tone Mapping
Tone mapping is often used in conjunction with HDR merging but is a different process. HDR produces images with a wide tonal range, preserving detail in both the highlights and shadow areas. Tone mapping reduces the tonal values within an image to make them suitable to be viewed on a digital screen. For example, an HDR photo that has a 100,000:1

dynamic range needs to undergo tone mapping so that the tonal values fall between 1 and 255.

Tone mapping modules usually include a number of controls, of which the most important are Tone Compression and Local Contrast.   Other controls such as exposure, sharpness, saturation and white balance may be included.

4.3.5 Getting Natural Effects in HDR
The quality of the software is important in getting natural effects in HDR processing. Some programs are better than others preventing halos, for example. It is also important to avoid over-sharpening and excessive use of tone compression and contrast.

4.3.6 Non-HDR Exposure Blending
Some professional photographers prefer to use manual blending of images rather than automated HDR and consider that they obtain better results from this approach.
Many photo-editing programs include modules for blending or stacking images. Exposure blending, using layers, masks and other techniques is more complex but there are many resources which explain how to use exposure blending. This is a complex subject and is with fmation will be included in resources document.

5. Summary

Understanding dynamic range is important in getting good quality images. Most modern cameras can cope with a fairly wide dynamic range. Photo-editing allows substantial improvement in presentation of a suitable tonal range in images.

There are many techniques for whole-image and selective editing .

Where scene dynamic range is extreme, use of exposure bracketing can be used, with images combined using 'classic' HDR techniques or exposure blending.

6. Alternative Approaches

High dynamic range scenes often result in accurately exposed fore- and mid-ground but over-exposed skies. A simple solution to this is the use of sky replacement. This function is becoming more common and simpler in photo-editing programs.

Another solution where only small sections of the sky are blown out is to use cloning or generative fill.

■

Resources for Dynamic Range

Following is a short list of resources, including books, websites and videos, covering various topics in the field of dynamic range in photography. These should be used in conjunction with the information provided in camera manuals and photo-editing user guides. There are many other resources in addition to those listed.

1. Understanding Dynamic Range

Understanding Dynamic Range in Digital Photography (Cambridge in Colour)
https://www.cambridgeincolour.com/tutorials/dynamic-range.htm

What is Dynamic Range?
https://www.adobe.com/au/creativecloud/video/discover/dynamic-range.html

Dynamic Range Photography Explained
https://www.adorama.com/alc/dynamic-range-photography-explained/

https://digital-photography-school.com/understanding-dynamic-range-photography/

Understanding ISO, Shutter speed and Aperture; A Beginners Guide (Photography Life)
https://photographylife.com/iso-shutter-speed-and-aperture-for-beginners

2.1: Controlling Dynamic Range in a Single Image

10 Reasons Why You Should Be Shooting RAW
https://photographyconcentrate.com/10-reasons-why-you-should-be-shooting-raw/#:~:text=Because%20no%20information%20is%20compressed,shot%20in%20the%20JPEG%20format.

Exposing to the Right Explained
https://photographylife.com/exposing-to-the-right-explained

How to ETTR (Expose to the Right) for Better Exposure
https://expertphotography.com/ettr-photography/

What is 'Exposing to the Left'
https://www.slrlounge.com/expose-to-the-left/

Light it Up! This is How to Use Fill Flash Photography
https://www.shootproof.com/blog/fill-flash-outdoors/

How to Use a Graduated ND Filter in Landscape Photography
https://petapixel.com/graduated-nd-filter/

How to Use a Polarizing Filter
https://photographylife.com/definition/polarizing-filter

2.2: Choosing Optimum Lighting Situations

5 Tips for Creating Spectacular Photos at Blue Hour
https://www.digitalphotomentor.com/5-tips-blue-hour-photography/

Blue Hour Photography: The Essential Guide (+ Tips)
https://digital-photography-school.com/5-quick-tips-for-better-blue-hour-photography/

Taking advantage of the golden hour
https://www.adobe.com/au/creativecloud/photography/discover/golden-hour.html

13 Techniques for Shooting Golden Hour Photography
https://expertphotography.com/what-is-golden-hour-photography/

2.3: In-Camera Dynamic Range Optimization

In-camera Dynamic Range Optimisation
https://amateurphotographer.com/technique/expert_advice/in-camera-dynamic-range-optimisation/

How to Use Nikon's Active D-Lighting for Best Results
https://expertphotography.com/nikons-active-d-lighting/

How to Use Canon's Auto Lighting Optimizer
https://expertphotography.com/canon-auto-lighting-optimizer/

3: Editing Single Images

Using the Curves Adjustment in Photoshop
https://helpx.adobe.com/au/photoshop/using/curves-adjustment.html

Understanding the Curves Adjustment
https://photofocus.com/software/understanding-the-curves-adjustment/

Set The Right Contrast and Color Balance With A Single Adjustment
https://www.photocascadia.com/set-the-right-contrast-and-color-balance-with-a-single-adjustment-by-sean-bagshaw/#:~:text=Proper%20contrast%20in%20most%20images,appear%20muddy%2C%20hazy%20and%20flat.

Brightness and contrast adjustments
https://www.photoreview.com.au/tips/editing/brightness-and-contrast-adjustments/

Apply the Brightness/Contrast adjustment in Photoshop
https://helpx.adobe.com/au/photoshop/using/apply-brightness-contrast-adjustment.html

What is image masking and how is it used in photo editing?
https://skylum.com/blog/what-is-image-masking-and-how-is-it-used-in-photo-editing

What Is Image Masking? Why Do You Need It?
https://www.colorexpertsbd.com/blog/what-is-image-masking/

Make selective edits with masking tools in Adobe Photoshop Lightroom.
https://www.adobe.com/products/photoshop-lightroom/masking.html

Adobe Photoshop: How To Create And Use Luminosity Masks
https://www.youtube.com/watch?v=pz7qdSMJm48

Lightroom for Landscape Photography: Luminosity Masks
https://www.youtube.com/watch?v=dyXWABU9jnI

https://www.slrlounge.com/easily-create-great-hdr-images-single-raw-file/

https://www.hdrsoft.com/resources/hdr-from-single-photo.html

https://blog.upskillist.com/6-easy-steps-to-create-single-image-hdr-in-lightroom/

4.2 Exposure Bracketing

https://www.ikelite.com/blogs/cheat-sheets/hdr-photography-camera-settings-and-technique

https://fotographee.com/how-to-setup-camera-shoot-hdr-photography/

https://digital-photography-school.com/setting-up-your-digital-camera-for-hdr-shooting/

https://expertphotography.com/hdr-photography-tips-improve-photography/

What is bracketing?
https://www.creativelive.com/photography-guides/what-is-bracketing

Book: Complete Guide to High Dynamic Range Digital Photography (Ferrell McCollough)

Book: The Complete Guide to Night & Low Light Photography (Michael Freeman)

Book: Creating HDR Photos The Complete Guide to High Dynamic Range Photography (Harold Davis) (Also on Kindle)

Book: Mastering High Dynamic Range Photography (Michael Freeman)
(Available cheaply as a paperback)

4: Blending multiple images in HDR software

4.3.1 HDR Programs

Specialist HDR programs include:

Photomatix (pro and 'lite' versions, with differing levels of features)
https://www.hdrsoft.com/resources/photomatix-pro-7-new-features.html

FDRtools (Basic and Advanced versions; Basic version is freeware
https://www.fdrtools.com/

easyHDR (free and paid version
https://www.easyhdr.com/

SNS-HDR (Pro, Home and Lite versions; Lite is freeware)
https://www.sns-hdr.com/

Oloneo HDRengine
http://www.oloneo.com/

Luminance HDR (free)
https://sourceforge.net/projects/qtpfsgui/

Machinery HDR
http://www.machineryhdr.com/

Dynamic Photo HDR
https://www.mediachance.com/hdri/index.html

HDR Darkroom
https://www.everimaging.com/

Picturenaut
http://www.hdrlabs.com/

HDR Projects 9 (Professional and Standard versions)
https://www.projects-software.com/projects-family/hdr

Nik HDR Efex Pro(part of DxO's Nik Collection

Most general-purpose photo-editing programs include HDR modules

Photoshop Merge to HDR
https://www.adobe.com/au/

DxO HDR Efex Pro (part of the Nik Collection)

4.3.2 HDR Image Merging

(Some of these references cover the whole HDR process, as well as editing.)

Trey Ratcliff's Complete HDR Tutorial
https://stuckincustoms.com/complete-hdr-tutorial/

Complete HDR Tutorial
https://www.scribd.com/document/322998690/Complete-HDR-tutorial-by-Wojciech-Toman-pdf

Book: Creating HDR Photos: The Complete Guide to High Dynamic Range Photography (Harold Davis) Available as a paperback and as a Kindle.

4.3.4: Tone Mapping

Tone mapping is a separate process from HDR merging, but most if not all HDR programs include a tone mapping module.

Understanding HDR and Tone mapping
https://skylum.com/blog/what-is-tone-mapping

Tone Mapping Tutorial for Lightroom
https://www.youtube.com/watch?v=Ig5fwuFZH3Y

How to Use HDR Tone Mapping for Photography
https://expertphotography.com/tone-mapping-hdr/

4.3.5 Getting Natural Effects in HDR

STOP EDITING LIKE THIS! - How to make YOUR HDR photos look NATURAL
https://www.youtube.com/watch?v=H74u766T7z4

My Workflow For Natural-Looking HDR Photos
https://ugoceiphotography.com/b/my-workflow-for-natural-looking-hdr-photos/

Creating natural-looking HDR photographs
https://nicolesy.com/2021/07/16/hdr/

7 Methods to Create Realistic HDR Images (Photographylife.com)
https://photographylife.com/7-methods-to-create-realistic-hdr-images

Natural HDR4 Pre4sets
https://seimeffects.com/dynamic/

4.3.6: Other image blending techniques (Non-HDR Exposure Blending)

Exposure blending: The Ultimate Guide for Beginners (Guide to HDR and non-HDR blending
https://fotographee.com/digital-photo-blending-beginners-guide/

5 Easy Steps to Exposure Blending for High Contrast Landscapes
https://digital-photography-school.com/5-easy-steps-exposure-blending-high-contast-landscapes/

Master Manual Exposure Blending With This Foolproof Photoshop Workflow
https://fstoppers.com/photoshop/master-manual-exposure-blending-foolproof-photoshop-workflow-583542

Forget HDR Software - 5 Ways To Blend Any Exposures in Photoshop
https://www.youtube.com/watch?v=dioqQ-NA8vE

How to Exposure Blend in Photoshop, Easy, Best and the Future   ai (Photos on the Bay)
https://www.youtube.com/watch?v=4_9Rs1bw898&t=200s

How to do exposure blending in Photoshop (Christian Mörhle)
https://www.youtube.com/watch?v=_cFqnthfm_8

6. Alternative Approaches

Add wow factor to your images with Sky Replacement.
https://www.adobe.com/creativecloud/photography/discover/sky-replacement.html

How to Use Sky Replacement in Photoshop 2024 (Step by Step)
https://expertphotography.com/sky-replacement-photoshop/

How to Use the Clone Stamp in Photoshop: Removing Objects
https://www.naturettl.com/remove-objects-photos-photoshops-clone-tool/

Content-aware fill
https://helpx.adobe.com/au/photoshop-elements/using/content-aware-fill.html

Make content in powerful new ways with Generative Fill.
https://www.adobe.com/au/products/photoshop/generative-fill.html

■