FOCUS STACKING

AN INTRODUCTION BY TONY MORENO

IN PURSUIT OF FOCUS: DEPTH OF FIELD

Depth of Field is the range of objects in view that will be reasonably sharp and in focus.
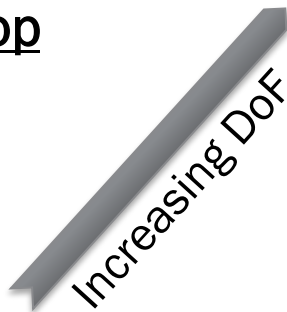
Photographers control their depth of field by adjusting:

- Lens aperture's f stop

- Lens focal length

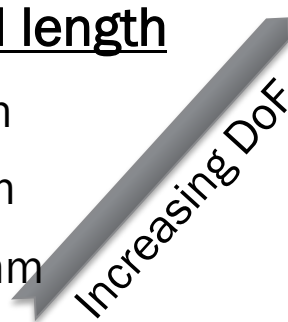- Focus distance (the distance from the camera to the desired plane of focus)

f stop
f11
f8
f2.8

Increasing DoF

Focal length
17mm
50mm
200mm

Increasing DoF

Focus Distance
100meters
10meters
1meter

Increasing DoF

IN PURSUIT OF FOCUS: DEPTH OF FIELD
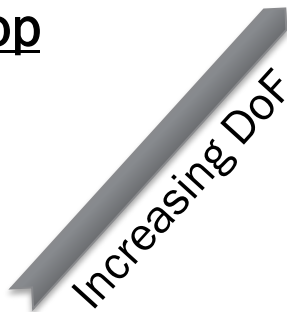
For Example:

      If a photographer did not want to change their f stop for exposure reasons, but wanted more depth of field, they could move backwards, thus increasing the focus distance… or they could change the lens to one with a smaller focal length (wider angle lens).
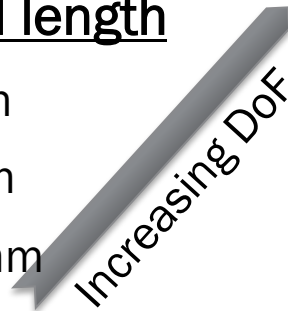
f stop
f11

f8

f2.8

Increasing DoF

Focal length
17mm

50mm

200mm

Increasing DoF

Focus Distance
100meters

10meters

1meter

Increasing DoF

LANDSCAPE PHOTOGRAPHY

Landscape photographers usually want everything in focus, from the mountains off in the distance, to the grass in the foreground. Sometimes a bush, tree, or other visual interest is close to the camera position. The only way to get the background AND this object to both be in focus is to use small apertures, perhaps beyond f16.

PRODUCT PHOTOGRAPHY

Product photographers work very much the opposite from landscape photographers. Here, magnification is important, and macro lenses come into play. The photographer will work up close to the product with very short focus distances. This will drive the depth of field to be more narrow and will cause the photographer to select higher apertures to get back some DoF.

…but my lens goes to f32!
No problem! Right?

YOUR LENS IS NOT PERFECT

- Every lens has a sweet spot, the f stop that will produce the sharpest result that the lens can produce.

- Zoom lenses may also exhibit a sweet spot somewhere in their focal length range, for example, the extreme ends of the zoom range often perform the poorest.

- Wide open f stops are soft, even with many of the expensive ones.

- High f stops beyond f11 begin to loose sharpness from diffraction.

  Example: https://www.dpreview.com/reviews/ canon-100-2p8-is-usm-c16/5

OVERCOMING PHYSICS WITH SOFTWARE

Focus stacking is a software driven photo construction technique where you:

- Set the lens to its sharpest f stop, usually in the f5.6 to f8 range

- Take multiple images, adjusting the focus point for each one, starting from one end of the focus range and moving to the other

- Import the "stack" of images into focus stacking processing software

- Let the software align the images and build layer masks for each image

- Review the result and look for defects

TOOLS YOU WILL NEED

- Tri-pod

- Computer with focus stacking software
  - Adobe Photoshop, Affinity Photo, Heliconsoft

- Optional: Camera control software to control the focus in discrete steps

- Optional: In product and macro photography the range of throw for the focal plane may be just an inch or two. Focus rails are commonly used to lock the lens to one focal distance and move the camera and lens together forward and back in controlled movements

TAKING YOUR IMAGES

- Compose your shot and lock everything down
  - Give yourself extra framing and cropping room
- Set focus to manual control
- Turn off image stabilization
- Set exposure controls to manual so they cannot change between frames taken
- Turn off Auto White Balance and set to an appropriate color temperature
- Set aperture to the lens's sweet spot
  - Probably around f5.6 to f8
  - The larger the aperture, the easier for the software to detect areas in focus vs. out of focus

THE PROCESS IN PHOTOSHOP

- Click "File > Scripts > Load Files Into Stack…"

- Select your files

- Checkmark the box to auto align the images. Even though your camera was on a trip-pod.

- If exposure varied, checkmark the box for keeping tones, but be guarded later and make sure the algorithm doesn't produce changes in exposure or tone rather than correct it.

- Click ok and wait for Photoshop to align and stack the images.

- Click "Edit > Auto-Blend Layers…"

2019
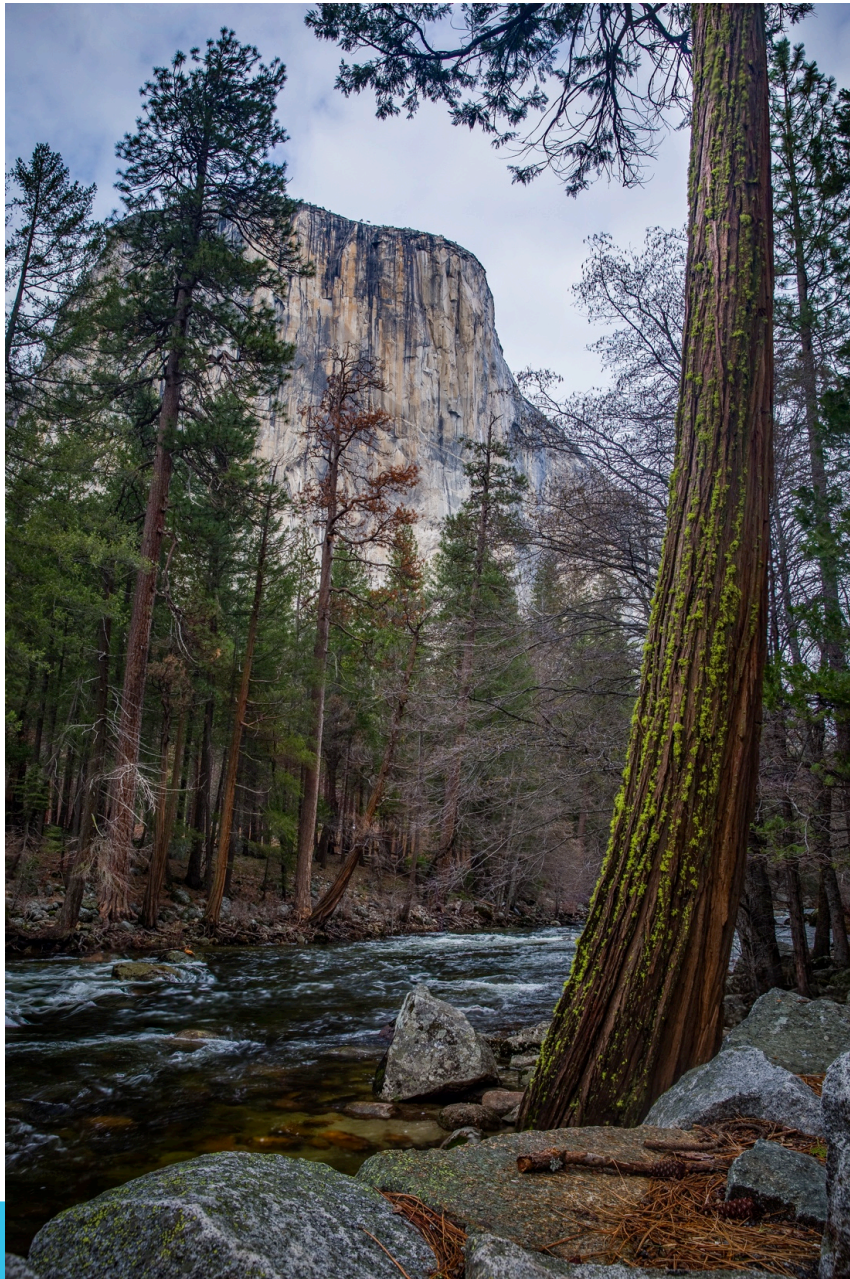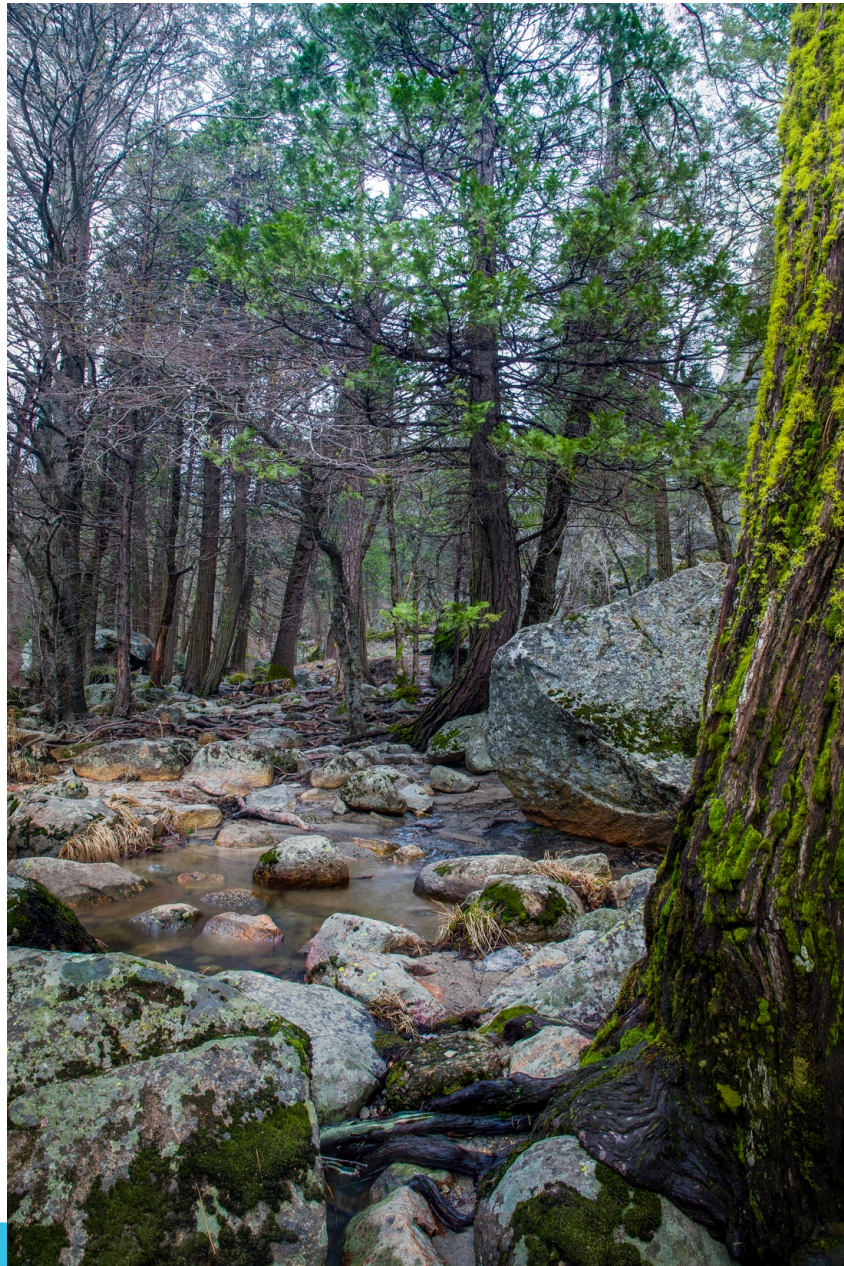
LOOKING AT THE RESULT: LAYERS

- Photoshop will construct a PSD file comprised of multiple layers.

- Each layer is one of the images that was imported as part of the stack.

- If you started at one focus "end" and moved towards the other "end", the stack of layers will also have this natural progression which makes navigating the stack easier.

- Layers at the top will cover over layers below.
  - ALT-click the eye icon = Show/Hide all currently visible layers

Layer 1   Layer 2   Layer 3

LOOKING AT THE RESULT: LAYER MASKS

- Layer masks tell Photoshop what content from that layer will be viewable.
  - White masking will show that part of the image, provided nothing from layers above will cover it.
  - Black masking will not show that part of the image.
- Layer masks are gray scale. The "% of white" will act like a "% of transparency". You can paint shades of gray onto the mask.
- When focus stacking, Photoshop only makes black and white layer masks.

LAYER MASKS WITH LANDSCAPES

When you've taken a set of landscape images, the natural progression of objects in focus is from the bottom (close to camera) to the top (horizon).

Use this to your advantage when reviewing layer masks. Quickly remove any white in areas above or below the zone where focus *SHOULD* be.

The zone of focus will be a horizontal white line in the layer mask.

LOOKING AT THE RESULT: DEFECTS & ERRORS

- Zoom in and inspect the image that is presented.

- Do you see anything wrong?

- Do you see any elements that are blurry?

- Do you see any elements that look scaled wrong?

MORE LENS SHENANIGANS: FOCUS BREATHING

- As you adjust focus from one extreme to the other, most non-cinema lenses will slightly change their field of view. This is effectively a change to the focal length.

- When focal length changes, perspective and image compression change.

- Photoshop's automated focus stacking does not account or scale for these changes.

$91,000

$26,100

COMBATING: FOCUS BREATHING

- Shoot scene from a farther distance. Use a longer focal length if needed to compensate changes in your desired composition.
    - The less you adjust your focus ring, the less breathing occurs.
- With macro photography use a focus rail to avoid moving focus.
- Avoid complex close-up scenes (lots of variation in depth)
- Flower arrangements will require a lot of layer mask work
- As you adjust focus through your shots, make very slight adjustments to the focal length (requires zoom lens).
    - It is easier to do this in a controlled manor by using a tethered connection to a computer with a grid overlay on the video feed.
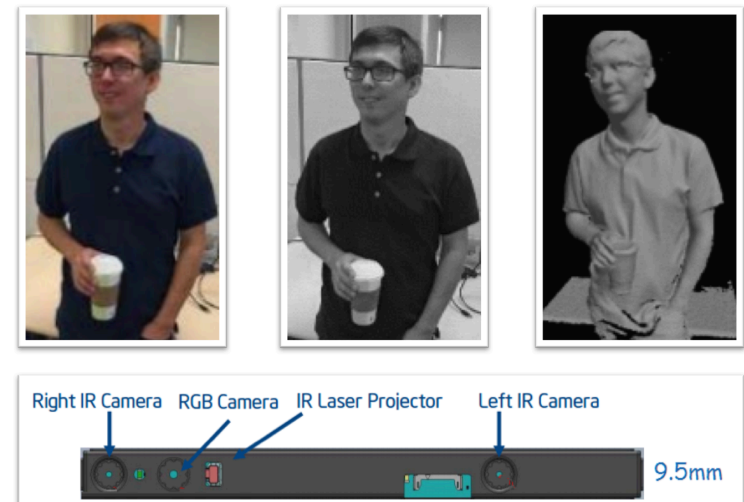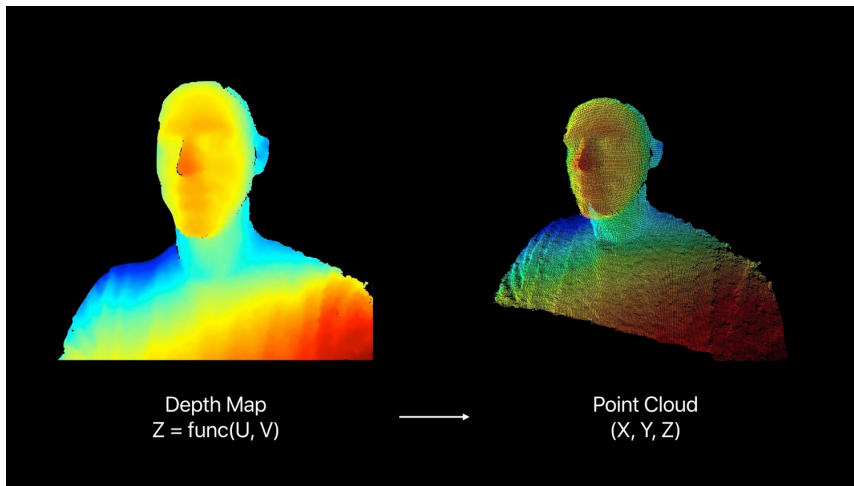
ALTERNATE EDITING METHOD

- After performing the auto-blend layers step, merge all the layers by clicking "Layers > Flatten Image"

- Look for errors

- Identify the in-focus image in your set of images that will correct the software error

- Bring that image into the project onto a new layer

- Add a layer mask and make that layer mask black if it is not already black

- Select the layer mask and the brush tool

- Select white as a color and paint white onto the layer mask over the area with the error is located

WHAT THE FUTURE HOLDS

When cameras begin storing 3D depth-map data like the iPhone, photo processing software will be able to use that data to aid in making better layer masks.

Intel RealSense cameras work out to 10meters but are currently designed and marketed for product development and office use.

Depth Map
Z = func(U, V)

Point Cloud
(X, Y, Z)

Right IR Camera   RGB Camera   IR Laser Projector   Left IR Camera

9.5mm

RESOURCES:

https://www.dpreview.com/techniques/4314481850/looking-sharp-a-focus-stacking-tutorial

https://digital-photography-school.com/a-beginners-guide-to-focus-stacking/

https://www.reallyrightstuff.com/macro