**Photogrammetry Notes**

The DSLR Camera

* The camera body
  + Shutter – controls the amount of time the sensor is exposed to light
    - Essentially two plates that separate for a certain amount of time depending upon the setting used (can change this manually)
    - Fast shutter controls for motion
  + Sensor plate – at the back of the camera, captures the image
    - Different sizes based on the quality of the camera
    - Full film is 35mm
    - The smaller you go, the less detail you are able to capture
  + Aperture – what allows light in to the sensor plate
    - Called the F-stop – can be changed manually
    - Ring that allows different amounts of light in to the sensor plate
    - Controls depth of field – the smallest aperture (higher F-stop) gets the least depth of field
      * *Depth of field* – what is in focus on the picture – want to focus 1/3 of the way in on a subject
    - F-22 🡪 smallest, least amount of light let in, least depth of field
    - F-2 🡪 largest, most amount of light let in, most depth of field
  + Lens
    - Wide angle lens used to shoot in tight corners
      * Wide angle gives distortion – captures more than you would see with the eye
      * 50mm lens is essentially what humans can see
    - Lens sizes
      * 12-35mm – wide angle
      * 36-60mm – normal
      * Up to 180mm – telephoto
* Exposure
  + The exposure on any given shot is a result of the aperture (F-stop)/shutter speed/ISO
    - Usually set the ISO first, then aperture and shutter speed follow
  + *ISO* – sensor sensitivity, it is a measurement that determines how sensitive the camera sensor is
    - 50 gives a lot of detail, as you go higher you get more noise in the shot
    - 100 is generally what we set the cameras at for photogrammetry
    - The lower the ISO the more light needed
      * More detail at 50, 100, 200, 400, 800, 1600, 3200, 6400 less detail
        + Generally do not want to go above 400 ISO
* Histogram
  + The histogram is a tool that is used to determine how well you have exposed your subject
  + Graphical representation of pixels in an image
  + It shows up in the camera after you take a shot
  + What you want in order to determine your subject is properly exposed is a normal distribution
    - Low end are dark colors; high end are light colors; middle is color
      * Overexposed – clipped on the light end
      * Underexposed – clipped on the dark end
* Image file format
  + It is possible to change this in the settings of the camera
    - Jpeg: better for home projects – loses quality each time it is worked on
    - Tiff: no loss of detail during editing
    - *\*\*Raw: lossless file type, is essentially a digital negative – can be used over and over\*\**
      * This is the type of file we want to be shooting in for photogrammetry
* Accessories
  + Tripod/monopod – used to stabilize camera
  + Grey card/color card – good way to control for meter/exposure
    - Essential for photogrammetry
  + Scale bars
  + Lights/flashes
  + Memory card

Photogrammetry Background

* What is photogrammetry?
  + Sequence of images that are put into a computer program that then creates a 3D model
    - Photos are much easier to archive
    - Based on access to digital cameras (see above)
* 3D concepts important for Photogrammetry
  + Dense cloud: cloud of points in 3D space, renders a 3D image
    - X,y,z point in space with associated color
  + Mesh: connected points create triangular surfaces, this makes up the mesh
  + Solid model: each face of the triangle becomes a surface which a color is projected on
  + Texture map: takes pieces from the photos and maps them on to the solid model, makes it look “better”
    - *This can hide poor 3D model 🡪 hide bad data, should always look at the solid model*
* Nature of measurement
  + Measurand: the subject being measured – has a quantity associated with it
    - Colors
    - Position in space
    - Can be georeferenced to the earth if need be
  + Quantity: outcome depends on the measuring system being used, the procedure being used, the experience of the operator, and the environment
    - These can all be recorded in a digital lab book – *always important to keep track of this information as a project progresses*
  + Measurement: act of taking a quantity
  + Precision: agreement between different measurements of the same quantity
    - Usually expressed by imprecision (standard deviation/natural distribution fits)
  + It is important to remember that there is no such thing as the “perfect measurement”
    - Accuracy is only as secure as our instruments are
    - Accuracy is never expressed as a quantity
    - *We are going for high precision as a support for accurate modeling*
* Archiving of 3D data – what do you do with the 3D reconstruction in the long term
  + Non-proprietary and open file formats – insures data is democratized, accessible to wide audience
  + Keep a digital lab notebook that records every step of the operation
    - Contains metadata – if you use the software they provide
  + Photogrammetry is among the easiest modeling technologies to archive
    - Allows it to be repeatable/replicable, which is crucial for scientific method
      * If you take the photos responsibly and following this procedure, anyone should be able to come along in the future and recreate the model as long as the photos are archived
* Rule based procedures
  + If you follow the rules as explained here, you will have good 2D and 3D models
  + ALSO should be software independent, have good models with any software
    - We will use *photoscan pro*
  + Much photogrammetry done in the field follows the rule “just take a lot of pictures and it will work” 🡪 this is not the case
    - Entertainment does not equal science, and this way is not scientific
    - By just taking a lot of pictures it is possible to get a good looking result, especially when the model is covered by the texture map, however it will have *significant* and *unknowable* error
      * FOLLOW THE RULES HERE (see workflow document)