**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)