Sam Noble Museum

Digital Imaging Basics: From Y2K to the Present

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>99.99% of animal species that have ever lived are extinct.

The Modern biota is the tip of an enormous iceberg.

- **Virtually all of the 3.5 billion year history of life has to be reconstructed without the benefit of genomic data.**


Morphology IS our data.

Most of the record of life on Earth can be studied only via morphology. Documenting morphologies via imaging is a critical task of Paleontology Collections.

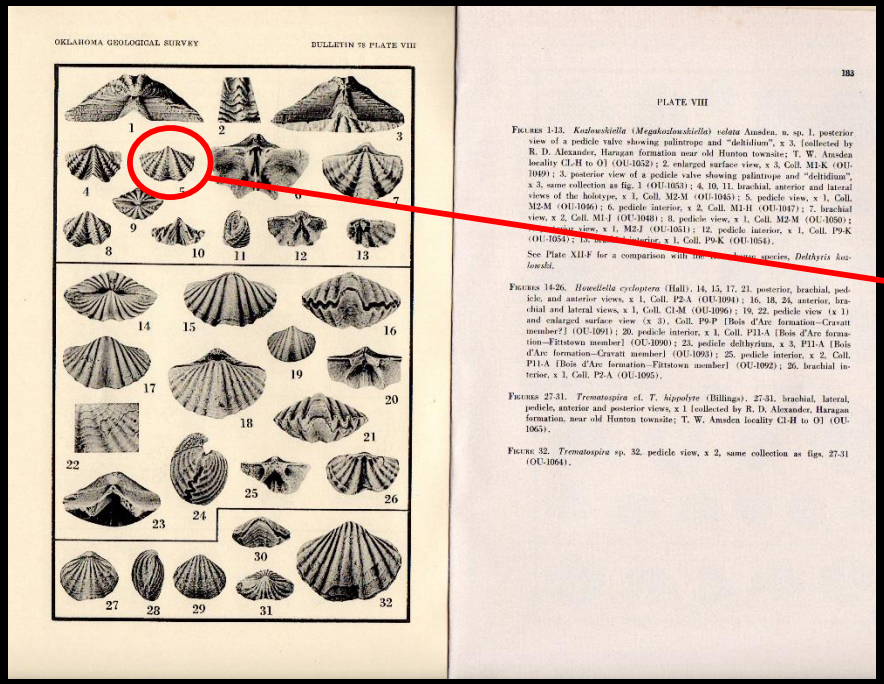
Goals in imaging specimens

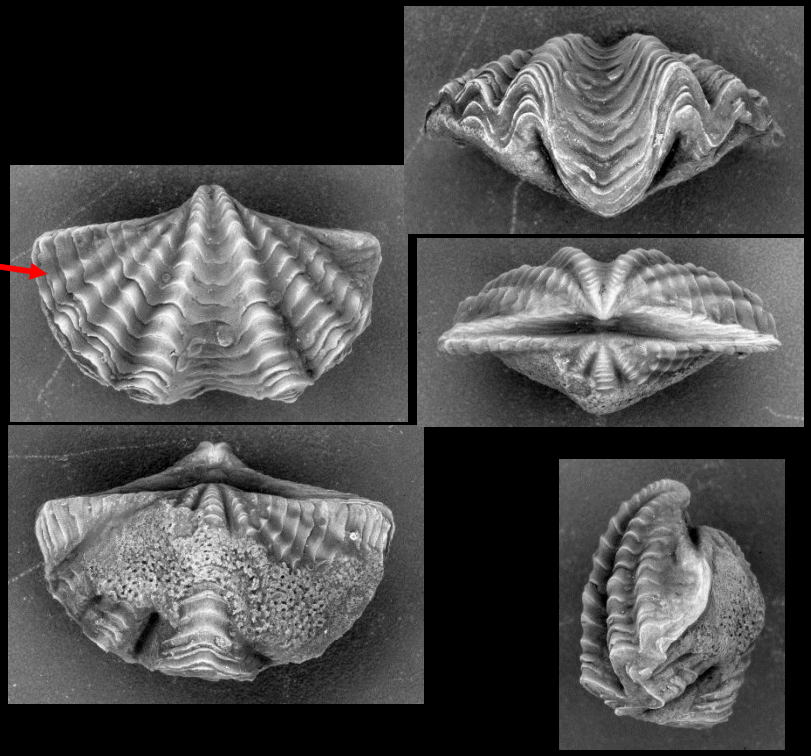
- **Cost effective**
- **Time effective**
- **Documenting specimen condition**
- **Multiple, standardized views of specimens**
- **High quality images, suitable for publication**
    1. **"Digital loans", including permission to publish images with appropriate acknowledgement.**
    2. **Images suitable for capturing landmark or other biometrical data.**

Why?

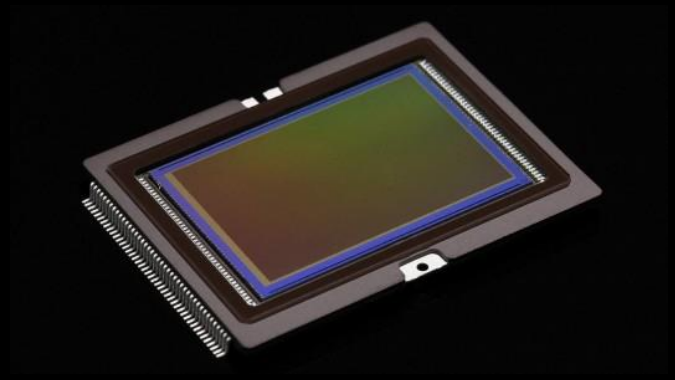
To promote the use of the collection

(among other uses).





In the simplest terms, cameras consist of a method of focusing and capture of images

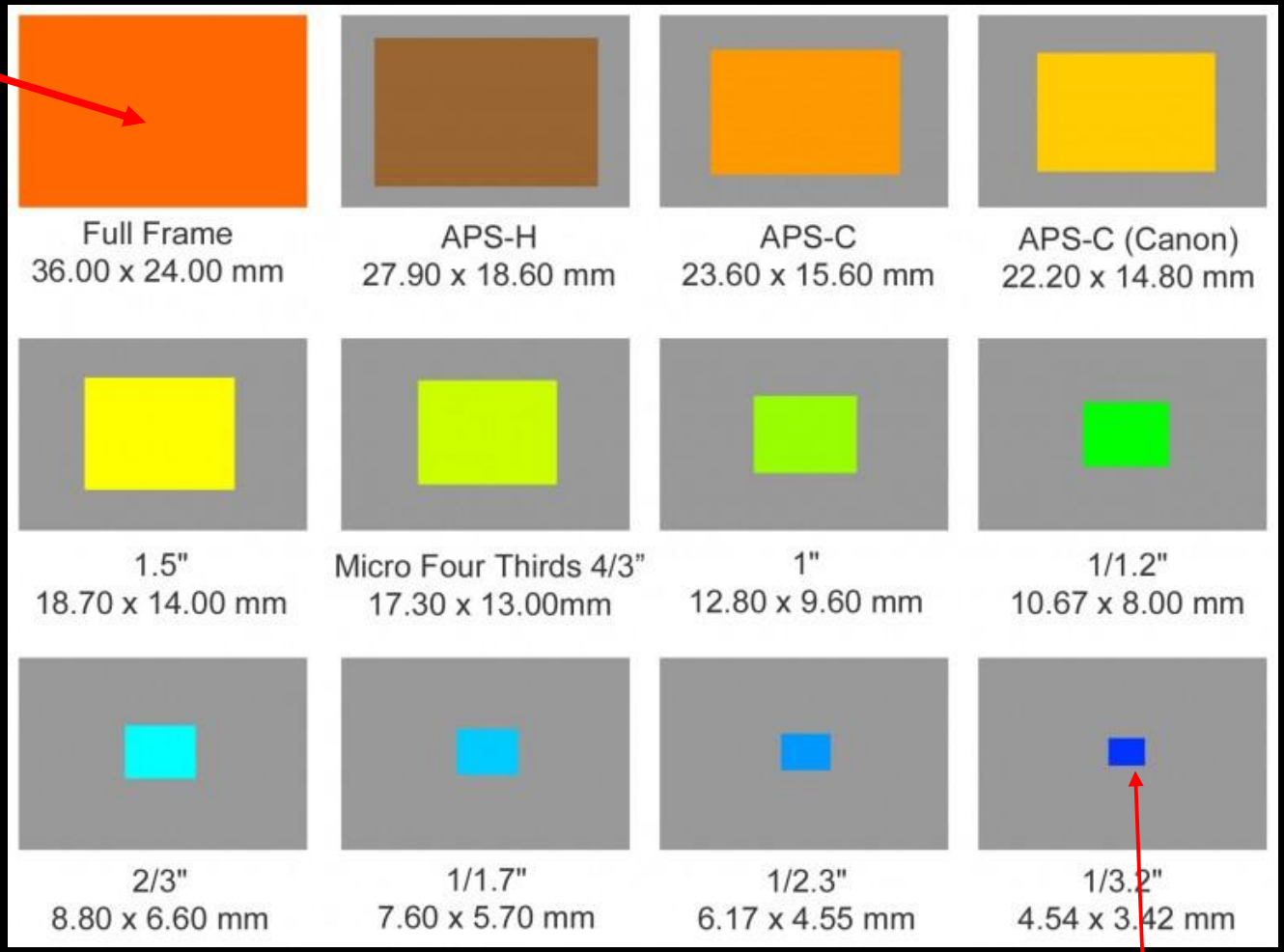


Images taken at 1:1 referred to the image on film compared to actual size

Sensor Sizes

Full Frame

With the variety of sensor sizes in today's digital cameras, magnification is a function of sensor size, pixel counts, and final dpi.



iPad & iPhone

We did not re-invent the wheel. Decades of film photography had solved many issues transferable to the digital age.

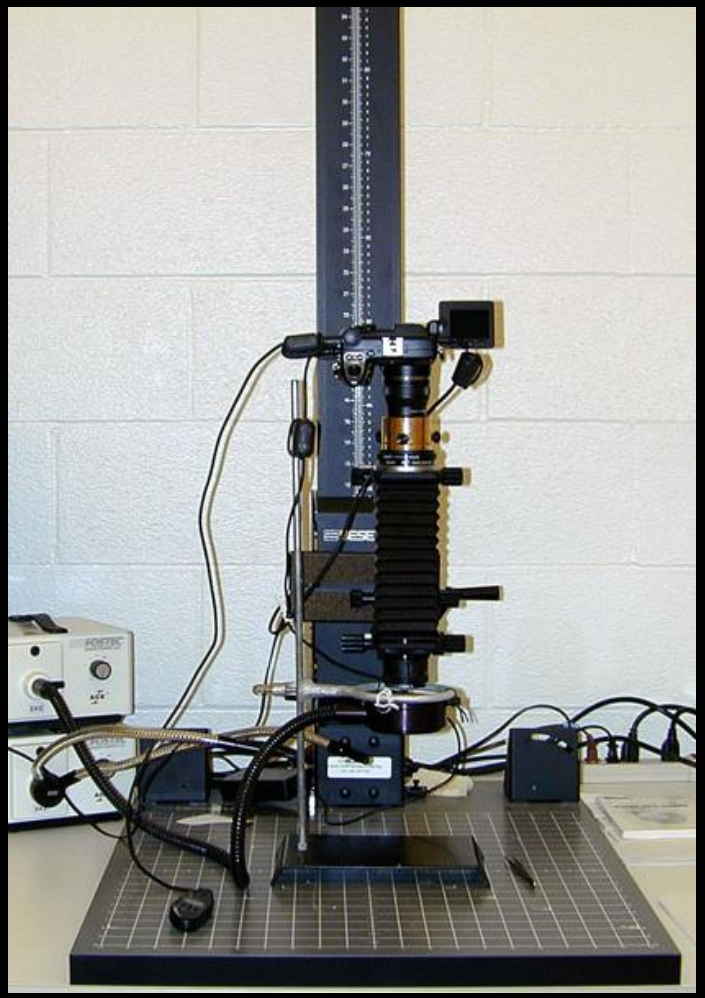
Starting with existing film equipment from a previous curator...

Bellows

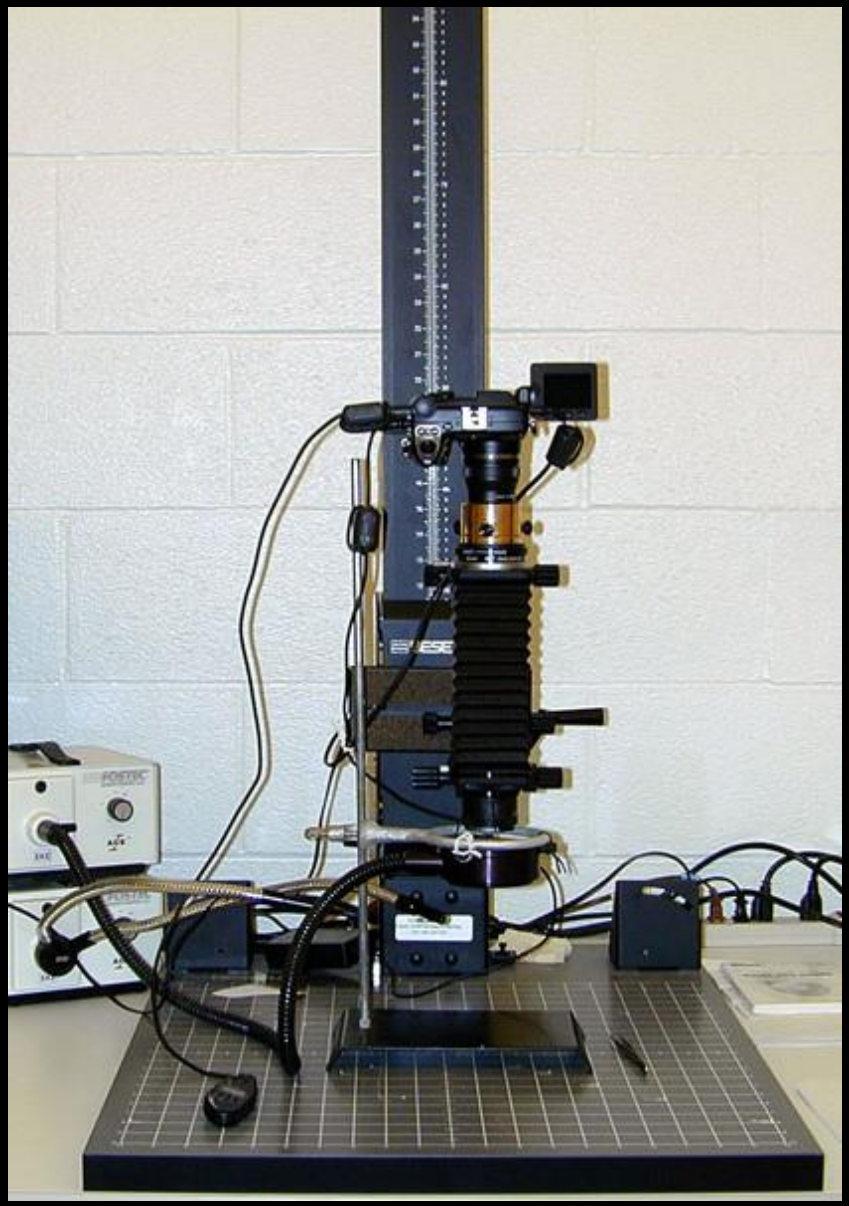
On-hand components

- Canon bellows
- Enlarger lenses
- Beseler copy stand
- Fiber optic lights (from dissection scopes)
- Nikon relay lens (from dissection scope)

We first pieced together various “point and shoot” cameras….



- Used alone with “built-in” macro settings
- Attaching with adaptors to a bellows with enlarger lenses



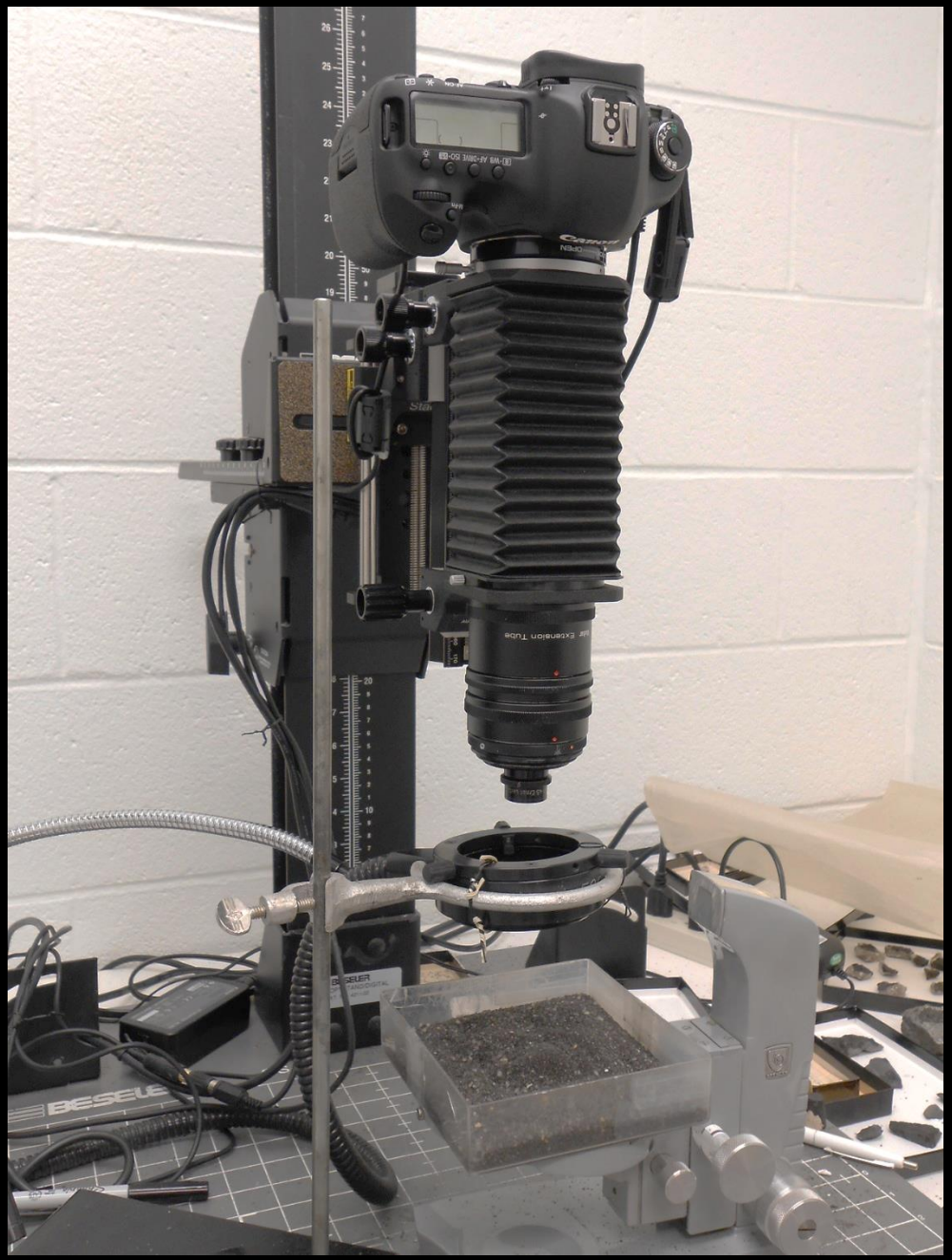
Problems:

- **Small sensor size**
  - **Digital “noise”**
  - **Poor Bokeh**
  - **Large “zone of distortion”**
- **Too much glass**
  - **Camera lens**
  - **Relay lens**
  - **Enlarger lens**
- **Poor optics/light control**
  - **Mismatched focal lengths**
  - **Camera aperture**
  - **Enlarger lens aperture**

As digital cameras evolved, we were able to add a couple of adaptors and bellows lenses…

We are able to combine the old with the new with impressive results…

- **Images of objects ranging from 30cm to <1mm (@600 dpi)**
- **35mm sensor size (full frame)**
- **Good depth of field, great with stacking.**
- **Good Bokeh**
- **NO "zone of distortion"**

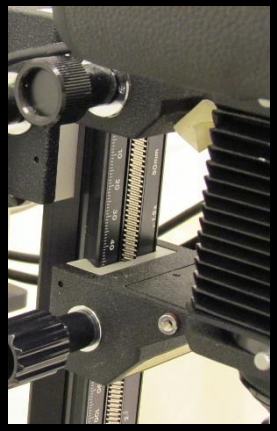


Making it Right

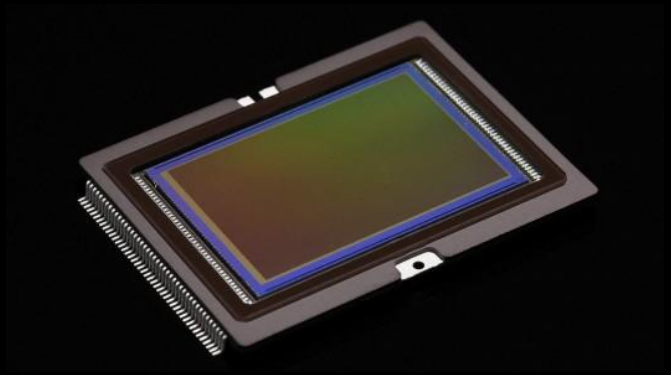
i.e. calibrating lens and sensor

Calibrating Magnification…

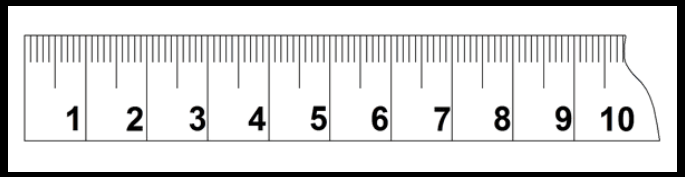
For a given lens



bellows extension



and sensor size/pixel count

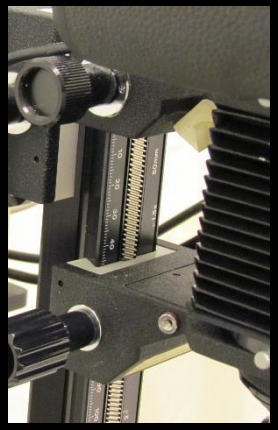


Take an image of a scale bar at various bellows settings (record the setting)

Convert those images to a set dpi in an image editing program (we use 600 dpi). Use the measuring tool to determine the scale bar distance of 1cm (or 1mm)

Quantifying Sharpness…

For a given lens



and bellows extension

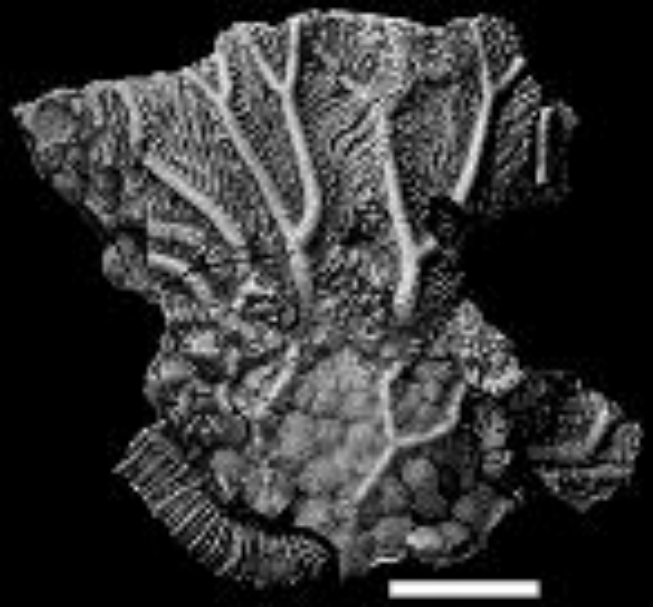
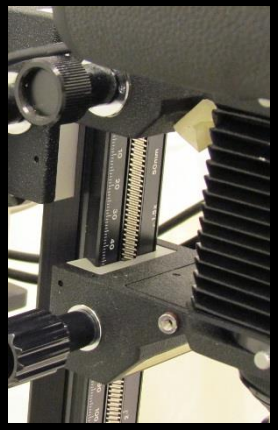


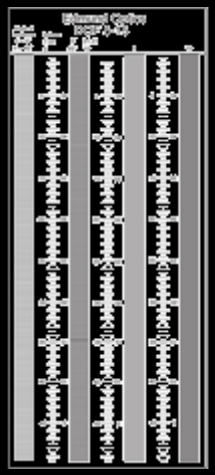
Image an object with some depth and detail at all available aperture settings (record the settings)

Determining Depth of Field…

For a given lens



and bellows extension



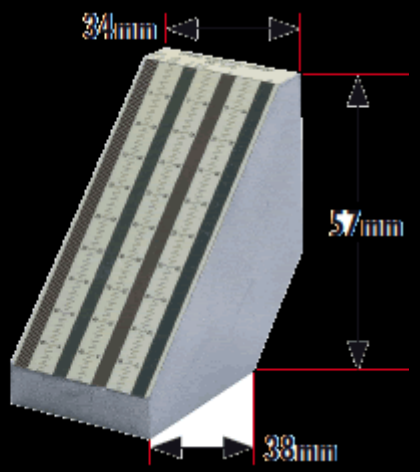
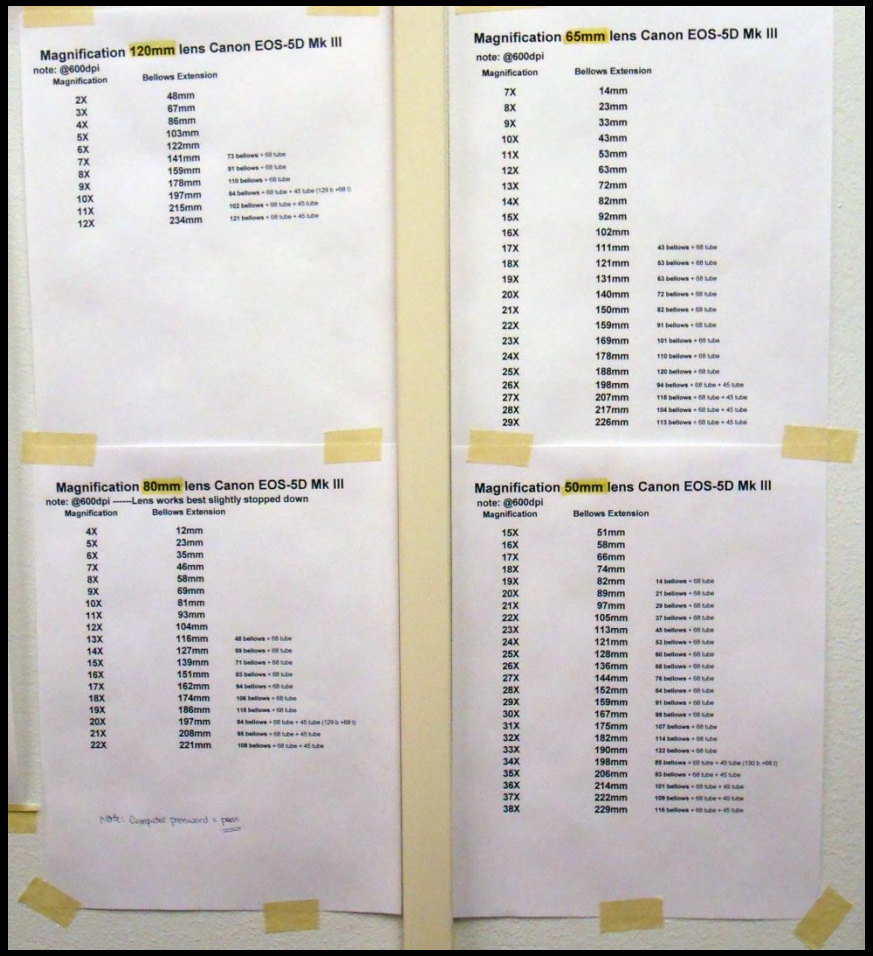


Image a Depth of Field target at all available aperture settings (record the settings)

Documenting Results, tieing it together…



Magnification 120mm lens Canon EOS-5D Mk III

note: @600dpi

Magnification	Bellows Extension
2X	48mm
3X	67mm
4X	86mm
5X	103mm
6X	122mm
7X	141mm
8X	159mm
9X	178mm
10X	197mm
11X	215mm
12X	234mm

Magnification 65mm lens Canon EOS-5D Mk III

note: @600dpi

Magnification	Bellows Extension
7X	14mm
8X	23mm
9X	33mm
10X	43mm
11X	53mm
12X	63mm
13X	72mm
14X	82mm
15X	92mm
16X	102mm
17X	111mm
18X	121mm
19X	131mm
20X	140mm
21X	150mm
22X	159mm
23X	169mm
24X	178mm
25X	188mm
26X	198mm
27X	207mm
28X	217mm
29X	226mm

Magnification 80mm lens Canon EOS-5D Mk III

note: @600dpi ------Lens works best slightly stopped down

Magnification	Bellows Extension
4X	12mm
5X	23mm
6X	35mm
7X	46mm
8X	58mm
9X	69mm
10X	81mm
11X	93mm
12X	104mm
13X	116mm
14X	127mm
15X	139mm
16X	151mm
17X	162mm
18X	174mm
19X	186mm
20X	197mm
21X	208mm
22X	221mm

Note: Computer password = peer

Magnification 50mm lens Canon EOS-5D Mk III

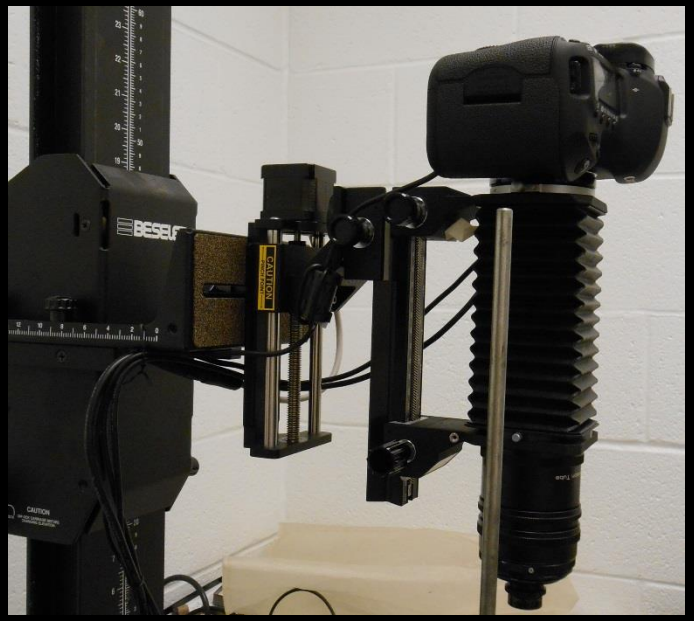
note: @600dpi

Magnification	Bellows Extension
15X	51mm
16X	58mm
17X	66mm
18X	74mm
19X	82mm
20X	89mm
21X	97mm
22X	105mm
23X	113mm
24X	121mm
25X	128mm
26X	136mm
27X	144mm
28X	152mm
29X	159mm
30X	167mm
31X	175mm
32X	182mm
33X	190mm
34X	198mm
35X	206mm
36X	214mm
37X	222mm
38X	229mm

Lens/bellows extension Tables

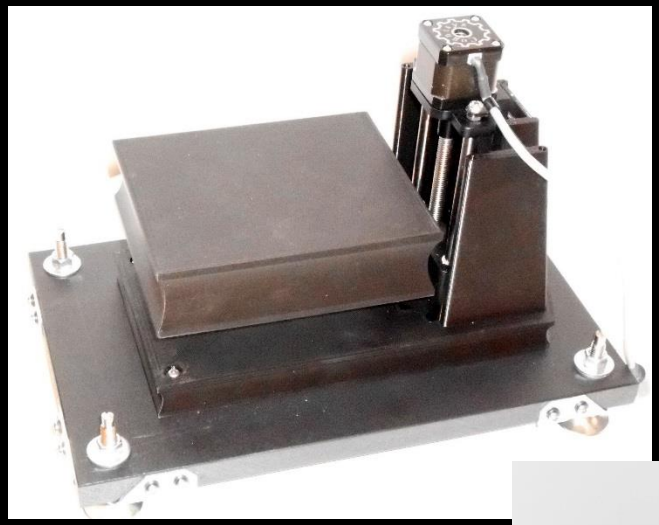
Breeze Systems DSLR Remote Pro software, top image = Live View, Bottom image…camera control

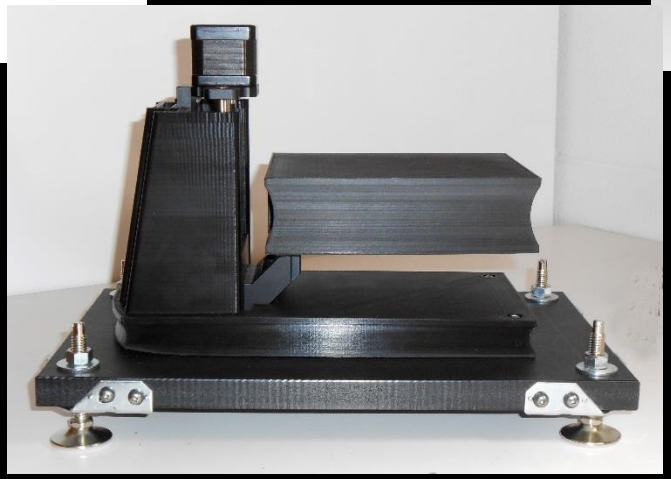
Upgrades…



Stackshot

Stackshot upgrades…





2	115V, MI-150 Fiber Optic Illuminator	$375.00	$750.00
1	2.37" ID, Fiber Optic Ring Light Guide	$395.00	$395.00
1	18" Dual Branch Semi-Rigid Light Guide	$265.00	$265.00
	Subtotal		$1,410.00

Lighting

1	Besler CS copy stand	$534.95	$534.95
1	Canon Autobellows (FD mount)	$159.95	$159.95
1	Bower Lens adapter FD to EOS	$37.95	$37.95
1	Vivitar Macro Extension Tubes	$91.00	$91.00
1	General Brand Reverse adapter 55mm Canon FD	$14.95	$14.95
	Subtotal		$838.80

Stand & bellows

	Leitz 12cm f4.5 Summar micro lens AND Leitz 65mm Milar micro lens ~$400 ea. Used		$800.00
	Canon EOS 5D Mark III camera body	$3,499.00	$3,499.00
	Canon EOS 6D Camera body	$1,999.00	$1,999.00

Camera & Lenses

	Additional Hardware		
1	StackShot Macro Rail Package	$525.00	$525.00
	Computer/Software		
1	Helicon Focus Pro X64 (Mac or PC)	$250.00	$250.00
1	DSLR Remote Pro (Mac or PC)	$175.00	$175.00

StackShot & Software

Grand Total Canon EOS 5D Mk III **$7,497.80**

Garnd Total Canon EOS 6D **$5,997.80**