Proposed Definitions and decoupling the term "PIXEL" from the terms "PHOTOSITE / SENSEL"
PIXEL ≠ PHOTOSITE

Now is the precise moment when we need to disambiguate and clarify the terms PIXEL, PHOTOSITE and SENSEL. In the name of linguistic precision, we cannot afford to continue to ambiguously conflate these terms, as that would render us incapable of distinguishing several different areas of discussion. Equating these terms renders us incapable of meaningfully discussing what happens in camera sensors as distinguished from rendered images.

Therefore, I am proposing the addition of four glossary terms;

PIXEL
The smallest element of an RGB image file, or the smallest addressable element on an addressable display device. A pixel is the smallest controllable RGB element of a picture represented on a screen.

The term PIXEL is very frequently incorrectly used to refer to a SENSOR ELEMENT or a PHOTOSITE in the camera sensor context, or in an un-deBayered RAW file creating ambiguity in the meaning of PIXEL. PIXEL is very frequently incorrectly used ambiguously to refer to a SENSOR ELEMENT. This is an error born of a lack of precision in our use of these terms in digital imaging. Interestingly and conspicuously, Dr Bryce Bayer never used the term "PIXEL" anywhere in the patent for the Bayer Pattern Sensor, but rather, in every case he referred to "SENSOR ELEMENTS";

US PATENT NO. : 3,97l,065 DATED July 20, 1976 INVENTOR(S) : Bryce E. Bayer

I urge participants to review that patent, it is easily searchable on line.

PHOTOSITE

An individual physical light sensing photodiode or device on a digital imaging sensor. This refers to the smallest single element of light sensing circuitry on a sensor, ie; the actual silicon on the sensor. PHOTOSITES are most often fitted with a Red only, Green only, or Blue only color filter mask, but they yield only monochrome SENSEL VALUES which are later assigned colors in the deBayering process.

SENSEL (SENSOR ELEMENT)
A single sensor element of an array of sensor elements, such as in a Bayer pattern CMOS sensor.

SENSEL VALUE

This term describes the data product of a PHOTOSITE in a RAW (undeBayered) file. It is important to distinguish monochrome RAW PHOTOSITE data from the RGB PIXELS that result from deBayering.

A camera sensor is made up of PHOTOSITES or interchangeably SENSELS that yield SENSEL VALUES, not PIXELS. PHOTOSITES do not become PIXELS until they are deBayered or otherwise averaged into displayable tri color RGB PIXEL values.

If we do not distinguish these terms, we have no name, no word to accurately describe, differentiate and distinguish what is one single PHOTOSITE value in a camera RAW frame.

Almost every camera employed in motion picture production today utilizes a monoplanar Bayer pattern mosaic sensor, whereon each PHOTOSITE is masked by one of three color filters, Red Green or Blue. The values derived from PHOTOSITES in RAW files are monochrome values that will only become color values when their assigned Red Green or Blue is applied as an early step in deBayering.

Because Bayer pattern SENSELS are not coincidently sited, an interpolation algorithm is required to mathematically derive displayable RGB PIXELS. This process is called demosaicking, or in the case of a Bayer sensor, deBayering. When SENSELS are presented to a deBayering algorithm, complex color averaging processes RAW SENSEL VALUES so that PIXELS result.

In all cases, PIXELS are derived from PHOTOSITES in a ratio of *many* to *fewer* by a deBayering algorithm. Averaging of color values in the deBayering process combined with the effect of Optical Low Pass filters which blur the image to reduce the frequency of the sensor output to the Nyquist frequency results in PIXELS of lower effective resolving power than an unfiltered undeBayered monochrome image from the same sensor might yield. This means that a deBayered RGB color image from a Bayer pattern sensor inherently yields less effective resolution than that of its parent RAW image. The resolution of that resulting RGB image cannot be accurately and honestly be characterized by counting PHOTOSITES on the sensor that created it, as output resolution depends largely on what deBayer algorithm was applied. Each type of deBayer algorithm yields a different effective output resolution, always a fraction of the original sensor PHOTOSITE count.

The only exception case wherein the number of PHOTOSITES on a monoplanar sensor results in the same number of PIXELS on a display is in the case of an unfiltered monochrome sensor, whereon individual PHOTOSITES map directly to individual monochome display PIXELS in a ratio of one to one. In this case, the display is still displaying RGB values, in tonal scales that result in a monochrome picture.

There is a mathematical limit to the effective resolution of that can be derived from RAW Bayer pattern data when deBayered into RGB pictures. For example, ARRI designed the original Alexa Alev-III sensor to employ an active SENSOR ELEMENT area of 2880 x 1620 PHOTOSITES from which it deBayered to a 1920 x 1080 HD picture, employing a deBayer algorithm generally acknowledged to be 2/3 of the SENSOR ELEMENT count of a sensor. The math is simple, 2/3 of 2880 gives 1920 PIXELS in the horizontal domain, and 2/3 of 1620 gives 1080 PIXELS in the vertical domain, a true HD picture. Some more advanced deBayer algorithms are capable of

higher efficiency fractions or percentages, but never yielding equal to or more resolution than the PHOTOSITE count of the RAW SENSEL data. We can re size an image into a larger container, but there is no gain in perceived resolution without sharpening and image processing.

SUBPIXEL
Any one of the single color elements units that make up a display PIXEL.

Digital cinema projectors have optical elements that combine light from red, green, and blue channel sources in optical alignment (optical superimposition). Direct-view displays such as LCDs and OLEDs do not combine light from their color components. Instead, each PIXEL on the display surface is composed of three (or sometimes four or more) SUBPIXELS.

SUBPIXEL ACCURACY
Refers to describing a physical location in a raster or raster image that is of finer resolution than that which that raster can record or portray.