Digital cameras for digital cinematography

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Digital cameras, from left to right: Sony F23, Panavision Genesis, ArriD20, Viper and Red One

Since there is great diversity in high-quality professional digital cameras and each manufacturer has its own features, it is necessary, to choose one based on our experience, to have the information provided by the manufacturer, help from colleagues, seeing films or tests done with the camera in question, and, in general, all the information we can find before deciding on a camera to use in a production. The camera aside, when testing you should keep in mind:

The set of lenses to be used
The recording system (video or data)
The post-production work system: capturing and filming.
The digital grading system
The Intermediate (or negative) chosen to film with
The positive stock used to view it analogically.

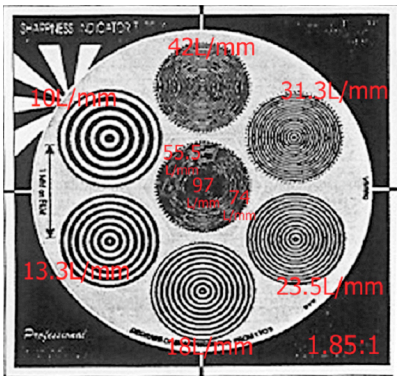
Once you have decided on the camera model and the format, you can carry out your evaluation with the following factors in mind from a photographic perspective:

-The resolution
-The camera's sensitivity
-The latitude: applicable gamma curves
-The color: sampling, depth and color space

As with emulsions, it is necessary to carry out tests not only on the digital camera chosen but also on the lenses to be used in filming. The company in charge of the post-production should work in both digital and analog environments.

Before filming the test, it is convenient to adjust the camera to the parameters we want, changing the values from the different menus according to the photographic concept you want to develop. You will have to acquaint yourself with the camera and use it days before testing. In my case, and when I shoot to be transferred onto 35mm, I usually configure the camera to obtain the greatest latitude and sensitivity possible, modifying the gamma curves and the matrix to establish the base for what will be the film's color.

The resolution:



It's obvious that we need to evaluate the camera's resolution, especially if you're working for the big screen.

The resolution is measured in lines per mm or in horizontal pixels by vertical ones; the more lines or pixels, the more detail captured by the system. The resolution depends on the sensor, the digital process applied (compression, recording system, etc.) and the lenses used, and, if it's going to be transferred onto 35mm, on the film recorder, the emulsion and the projector's lens.

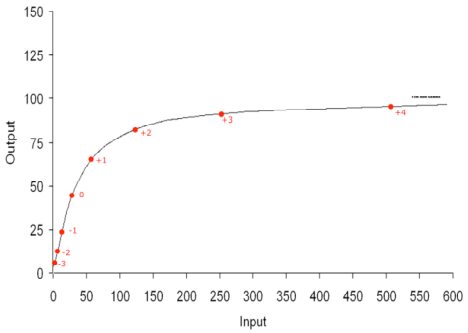
To evaluate the resolution, I use a Putora chart photographed at a certain distance. Since the resolution depends on all the factors mentioned before, you have to see the chart on the final format to be used; in other words, see it projected in a printed copy or in digital projection. If the camera is configured for greater latitude, you will have to grade the chart in post-production before viewing it in projection.

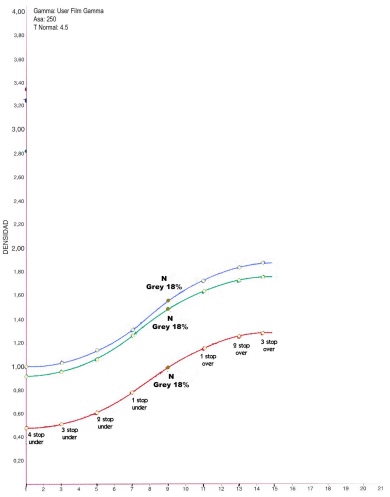
It must be noted that modifying the detail does not at all modify the camera's resolution.

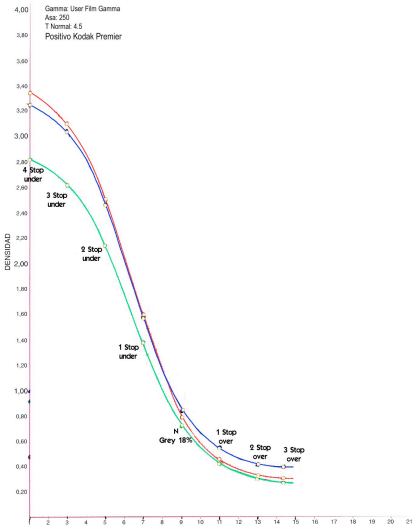
The sensitivity:

To determine the camera's sensitivity you first have to configure it, deciding what gamma curve to use and then seeing whether to modify parameters like the Knee, the Black gamma, the shutter, etc.

If the material is going to be transferred onto 35mm, I usually film a gray chart 18% overexposed and underexposed in 1/3 steps. To determine the normal T, I light a gray chart flatly and with the adequate color temperature (3200ºK or 5600ºK). I check the gray value with any given diaphragm on the waveform monitor. I usually place the gray value at around 45%, although in some productions I have placed it at 35%. With this diaphragm I adjust my photometer in ASA value until they coincide. I capture the photographed charts in the lab and I grade the "normal" to obtain a more balanced gray. I apply this same grading to the rest of the overexposed and underexposed charts. Once they are corrected I film them, obtaining an intermediate that I later print. In the lab, I measure the density of the grays both in the intermediate and the print and then I compare it to the LAD. That way I can evaluate whether the normal gray coincides with the standard and therefore to the sensitivity marked on my photometer or if, on the contrary, I have to overexpose or underexpose. In sum, in analog projections, the correct density of the mid-gray determines the camera's sensitivity when it is configured in a certain way. Now, digital cameras are not linear in their sensitivity, so the amount of light and color vary the sensitivity. That's why it's good to at least underexpose or overexpose the gray up to five diaphragm points and then evaluate the values in low and high lights both in the waveform monitor and the density measured in the lab. For this test, you mustn't gradually close the diaphragm but vary the amount of light that falls on the chart by placing neutral density filters on the lights. It would also be good to carry out a test with the two standard color temperatures, 3200 and 5600. In some cases, it's also good to evaluate the chart with fluorescent light. As a result of these tests, you can adjust your photometer to different ASAs, whether you're working indoors or outdoors, with more or less light and different color temperatures. In any case, the photometer lets you pre-light and see contrast ratios, but the definitive evaluation of the exposure must be done with a waveform monitor.







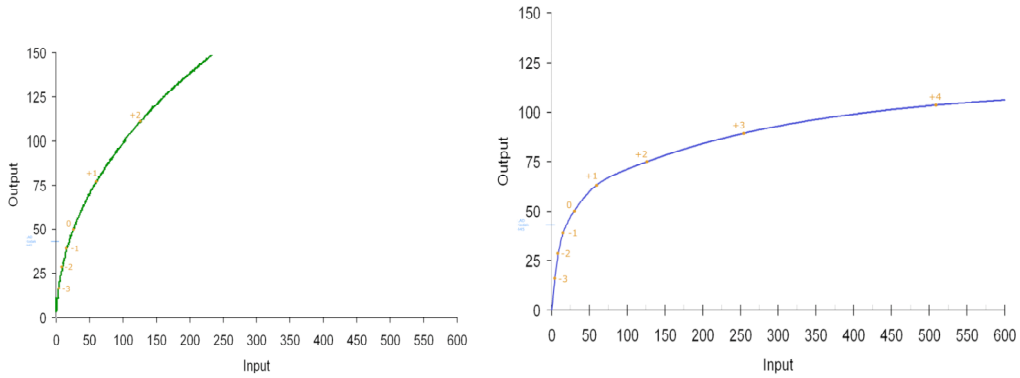
Notice the relation between the gamma curve, the intermediate and its corresponding print to evaluate sensitivity.

If the projection is going to be digital or exclusively for a TV monitor, follow the same steps but also use a gray chart (the classic X) to determine the correct value for the mid-gray with respect to the diaphragm used.

The latitude

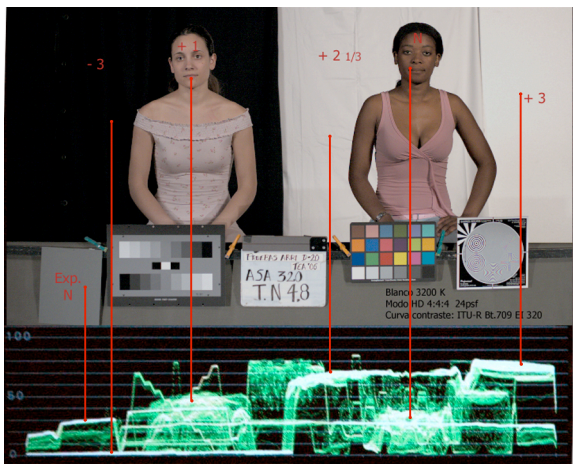
Latitude is the amount of gray values that a camera lets you reproduce from black to high lights.

Latitude is commonly translated as diaphragm points; thus, a negative can work with 12 diaphragm points and an HD camera, like the F-900, with around 8 points. The more latitude, the better the representation of the real image. The latitude determines the dynamic range that the camera can handle; the dynamic range is the ratio between the brightest part of the image and the darkest; for example, images with a 600:1 range can be handled with a negative emulsion without any problems but it is too high to work with in video, which accepts ranges of 200:1 better. In the last few years, HD video systems have gained latitude with the use of pseudo-logarithmic curves, like the Digital Praxis for Sony, the Panavision curve in Genesis, or the Log curves in the Arri d-20, etc. The gamma curve chosen is decisive for the latitude and the image's contrast.



Notice the difference between the ITU 709 curve and the logarithmic curve designed by Digital Praxis. The first one has little latitude- some five stops- and the second one can reach up to eight. It's important to determine what curve to use and then choose the reference value in the curve for the 18% neutral gray. This value can be referenced to the Lad digital- CV445 in 10bit- or to the 103 value in 8bit. This means that the value in our waveform monitor can be placed between 40% and 50%, depending on whether you want more detail in shadows or high lights. It's clear that depending on where you place your reference gray, you will adjust your photometer accordingly. Keep in mind that for correct viewing, if the images are filmed with log curves, you will have to apply a certain LUT.

For this test, like in 35 mm, I photograph models with white and black backgrounds and the corresponding charts, overexposing and underexposing in values of 1 diaphragm. The lighting is done as I've already explained in the article about emulsion tests with a representation on the waveform monitor. This test is digitally graded to a light and then each exposure is corrected to try to leave the image as normal as possible. Once the grading is done, the images are filmed and graded again in the colorMaster to be projected. If the projection is digital, then keep in mind the projector's standards, especially the RGB color space and the gamma, making sure the LUTs are correct during color correction. When viewing the tests observe:



Typical arrangement of models and charts for evaluating digital cameras.

Elements to evaluate in one light printing:

- Verify the exposure index used in your photometer and compare it to the waveform monitor and density values: observe the general luminosity (the image's brightness) and the skin tone. Since the print is graded for mid-grays, you can observe the skin tones.

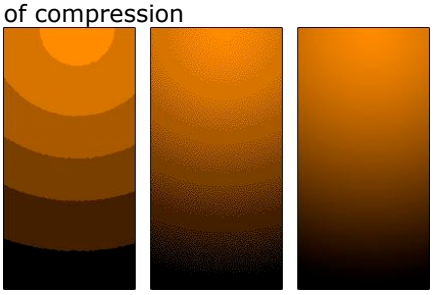
-How much you can underexpose the image to obtain good penumbras, observing the noise in the underexposures and the color information for those penumbras. You should

also observe to see as of which exposure the blacks have no information due to the black clipping. Grayish shadows normally indicate a lack of color information.
-You can see possible color deviations in shadows or high lights.
-In high lights, observe to see as of what exposure the whites have no detail and the White clipping is on. You can also see how the color is in the underexposures and then evaluate the lack or not of said information before the clipping.

Elements to evaluate with the graded print
Each overexposure and underexposure

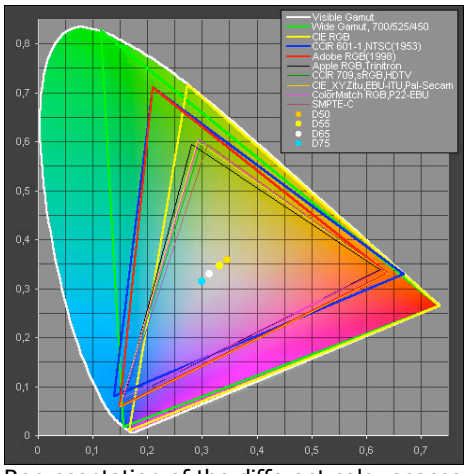
-The latitude: at how many stops over and under do you still have detail in shadows, high lights and mid tones, to recover.
-Digital cameras handle underexposure better than overexposure. In my experience, in general, HD video cameras with log curves can capture up to 3 stops over the average value and, depending on the manufacturer and the configurations, between 4 and 5 points under that average value.
-See the noise generated by the recovery of detail in shadows. There is an obvious difference between filming in 8 bit and 10 bit (especially in the color), for example.
-Watch the high lights for the possibility of having posterization, banding or other effects.
-Watch for the appearance of "artifacts" due to compression, scarce quantification, etc.


Blown-up picture to see the effects of compression


Effects of banding in 8Bits and its disappearance in 24 bits.

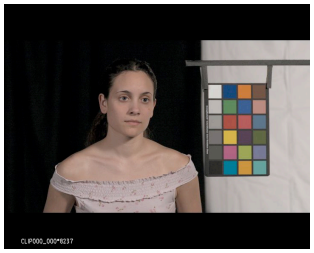
Color.

To evaluate a camera's color you need to have the monitor calibrated during the shooting, if possible a 20" CRT. Many HD video cameras use different color standards, for example, the SMPTE or ITU, and you will also have to intervene in the way the camera sees colors using a matrix. With a little patience and some experience, you can intervene in the matrix to obtain a colormetric base different to the standard one to get certain effects. To evaluate the color, apart from the monitor, you will need to use a vectorscope to see the effects on the tones and the saturation caused by the modifications. In any case, it is convenient to first do some tests with the standard values.



Representation of the different color spaces.

The above tests also serve to evaluate the color, but I like to do a test only with the color chart and the model's face. I proceed in the same way as with 35mm and, in grading the face, I observe the different deviations in the chart's color patches and then I evaluate the skin tone based on its more or less natural appearance. This test allows you to make certain decisions, for example, something I usually do when I film with Sony cameras is to modify the R-G and R-B in the matrix to desaturate the red and make it slightly more magenta, so that when it is corrected in the grading the skin tone looks more natural, eliminating that copperish tone so very typical of these cameras. I usually check this test with the makeup department so it can be used as a base for later tests with the actors.

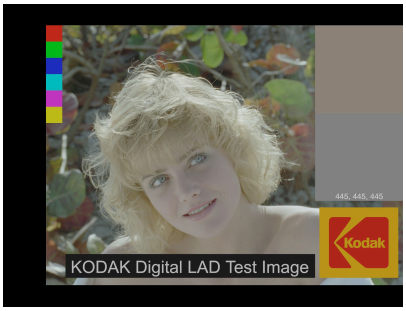


Makeup tests in digital systems are crucial. The image's digital condition brings with it great sharpness and its lower latitude needs makeup with different components from those normally used in 35mm to get natural skin tones.

The same thing happens with costumes since their color and texture looks different on 35mm.

To understand color behavior in cameras you need to know what color space it uses, the sampling it carries out, whether it is 4:2:0, 4:2:2 or 4:4:4, the analog signal's quantification, the compression, etc. These tests let you develop LUTs to pass from one color space to another, as when, for example, when we tape in HD video and then film, or if we want to achieve a certain color that can be used as a reference in both shooting and post-production. You need specific tests for all this starting from all the general ones I propose here closely related to the post-production.
Finally, with the information obtained from the tests above, it would be good to film some outdoor shots with different degrees of relation between shadows and high lights.

Tools for the tests:



Gray chart with 18% reflectance
White chart with 90% reflectance
Gray scale
Macbeth color chart, DSCLab or similar ones
Kodak color scale
Putora resolution chart or other
Black cloth, white cloth and white reflective board
Incident light meter
Spotmeter
Colormeter
20" calibrated monitor
Waveform monitor and vectorscope
Clapperboard and a notebook
Fair-skinned models and, in some cases, dark-skinned models

Lighting material:
-Tungsten: Fresnel 5Kw, 2 Kw, 1Kw and 650w
Chimeras, stretchers with white diffusion 216, flags.
-HMI 5600K: Fresnel 1200w and 575w.
- White cloth and black cloth
All the devices should be adjusted to the necessary color temperature and corrected for color deviations.
Some reference values:
LAD Digital Kodak 10 bits CV445 value

Cineon Grayscale Conversion

	Log E	Neg D	Print D	10b P.D.	8bVideo	12b Lin	16b Lin
2%Black	0.85	0.36	2.70	180	26	85	85
18% Grey	1.80	0.94	0.74	470	103	786	786
90% White	2.50	1.37	0.16	685	235	4095	4095

Bibliography:

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