THE BERNARD HAPPÉ MEMORIAL LECTURE

THE FILM LOOK Can it really be defined?

The second part of Peter Swinson's 2004 Bernard Happé Memorial Lecture explaining why material shot on film has a unique natural 'look'.

Grain and Aliasing

The randomness of grain and therefore the random sampling has an intrinsic benefit in terms of preventing aliasing with patterned materials. The images in Fig 21 and Fig 22 show the effect grain has on the captured image. Figs 23 and Fig 24 show how this effect is used to advantage in scanning film, especially at HD resolutions and beyond. Until electronic cameras have the ability to use random changing pixel sizes and positions, I believe aliasing will remain an issue at the upper limits of non film based acquisition.

Grain and Dynamic Range

The dynamic range of film negative has always been admired, and this range is due almost entirely to the variance of grain size and distribution within the film material. Without going into too much detail, if we assume the size of grain determines the amount of light captured by the grain, then it becomes clear that a small grain needs a lot of light and a large grain very little light.

This can be seen in Fig 20. Where there is little illumination, only the large grains have been exposed, and where the amount of light is greater, so a greater range of grain sizes is exposed. In digital terms one could refer to the grain size as the bit size. The smallest grain needs most light, so it becomes The Most Significant Bit. The largest grain requires the least light, so it becomes The Least Significant Bit.

How does this relate to the dynamic range of film? In simple terms if there are 10,000 different grain sizes in the film emulsion, they act somewhat like digital bits, and have the ability to differentiate between an awful lot of light levels. But this still does not determine the total contrast range. Total range is determined by how large the largest grain is

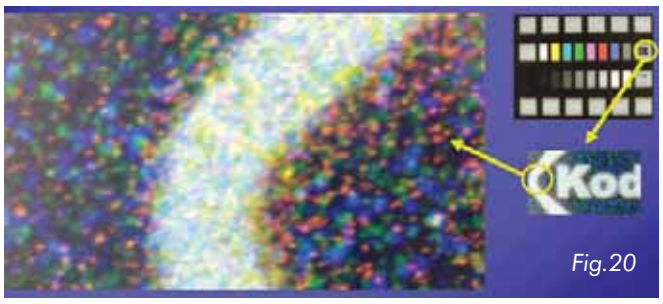
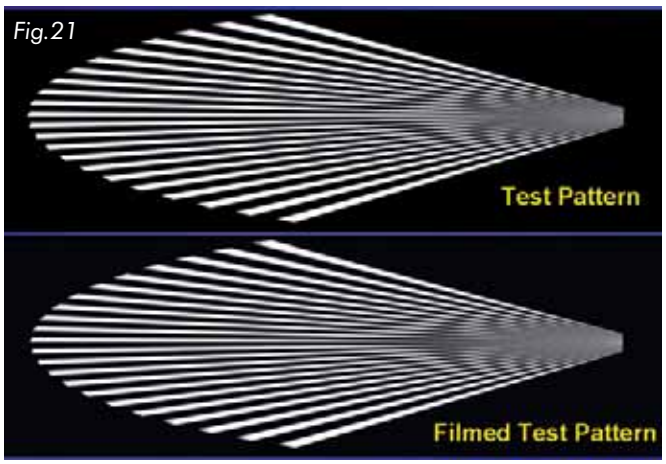
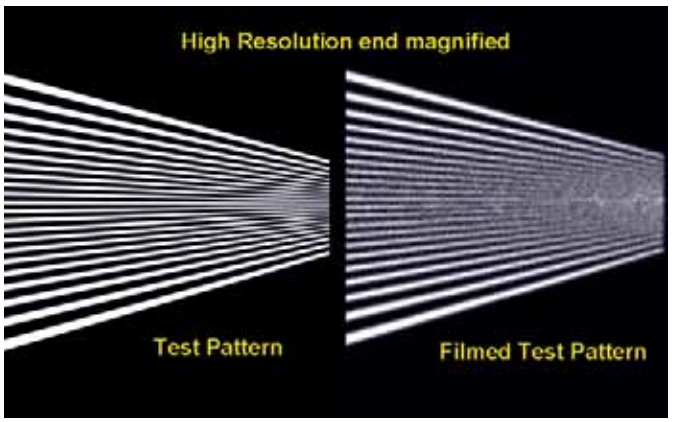
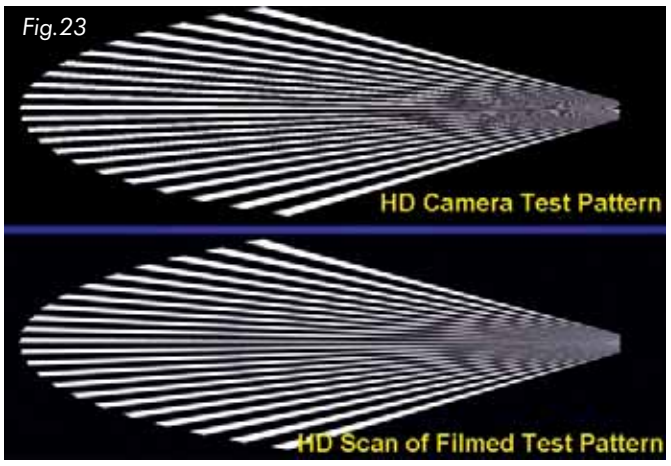


Fig.20

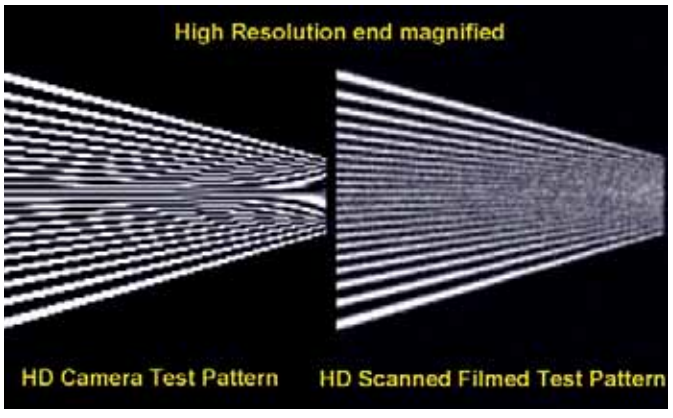


Below: Fig 22 - Magnified section of Fig 21





Below: Fig 24 - Magnified section of Fig 23



compared to how small the smallest grain is. If the difference in size is 10,000 to 1 then the film can handle a brightness range of about 10,000 to 1.

Grain's great variety can reduce digital bit depth requirements. Ever since the introduction of Digital Film scans, we have heard the view that we need more bits to faithfully represent the film image. The figure often quoted is at least 14 bits per colour linear or 10 bits per colour Log. Well I would contest this, so long as the granularity is retained and the 35mm scanned resolution is around 4K. In such conditions many fewer bits will suffice.
And here are some images to prove it. (At the extreme)

Fig.25

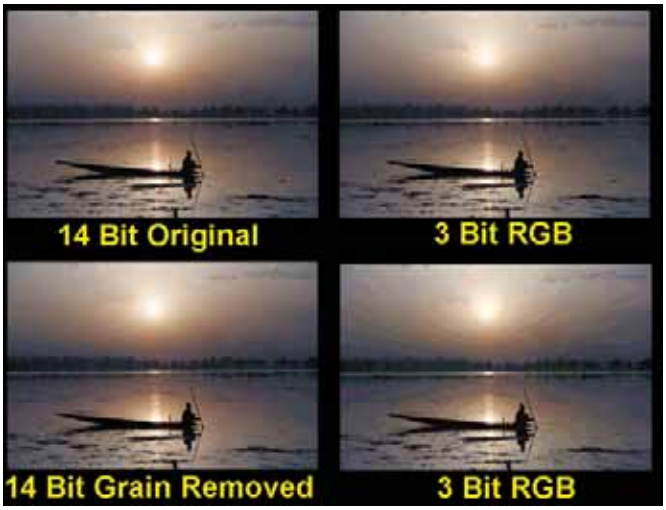


Fig 25 (above) shows the original 4K scanned 35mm frame with grain. Resampled at 3 bits per colour. It also shows the same frame grain reduced and then resampled. It is clear that the grain reduced image is not satisfactory with 3 bits per colour; we need more bits to represent less image information!!
Is it the very subtle lack of banding in images that retain grain, that adds to the film look when displayed on digital systems of 8 or 10 bits per colour?
"The Film Look" prime source, grain, can help in the Digital World

Grain's Prime contribution to The Film Look

Stochastic Noise and Stochastic Resonance. Terms not often used in our industry, but paramount to understanding why film looks so different. Our prehistorical visual system has acquired an interesting characteristic - when it comes to fine random granularity or noise, it tries to ignore it. The brain equates such 'noise' to grass waving in the breeze or leaves rustling on trees. It has no importance, what is important is the image hiding behind or in the grass or trees. That image could be a leopard, tiger or any patterned image that does not change over very short periods. Put simply. our brain tries to tune noise out of our consciousness. It would have to be a very big brain that could process so much random information!

The brain's attempt to tune out noise was demonstrated as follows. Fig 26 (above) shows a set of vertical columns covered in noise. The columns were offset horizontally and shown alternately. Everyone agreed that the noise was fixed to the columns, as they moved the noise moved horizontally as though it was part of the actual columns. Only when the columns were removed was it observed that the noise was two sets of random noise, one for each image. Furthermore at the point that the columns were removed, most observers noted that the two noise patterns still moved from side to side for a few seconds before it became obvious that they really did not. An example of the brain trying to filter out noise; it attributed the noise to being part of the pattern so that it did not have to process it separately. Just as it would have on the grass plains of our ancestors.

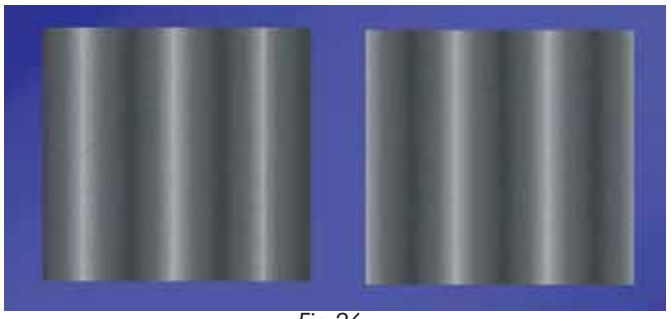


Fig.26

Stochastic Noise

As it is impossible to demonstrate the effect in this journal, I shall attempt to describe it.

As already noted, film's active capture medium is randomly sized and randomly positioned grain, all held in the film emulsion. When an image is filmed the grain represents the shades of the image at each location. Analyse any individual frame and we will see only the shades that each frame collected. The edges of shades, that represent resolution, may or may not, at high resolutions, be present depending on the position of the grain. But film grain is random, therefore an edge that is not represented on one frame may well be in the next, and if not in the next then probably in the third frame.

Looking at it this way the film image can acquire very high resolutions if sampled over several frames.

Very early on I mentioned the brain's image integrating capabilities that cause smear on moving images. This same integration gives us the perception of great detail in static or slowly moving film images. A series of stills from

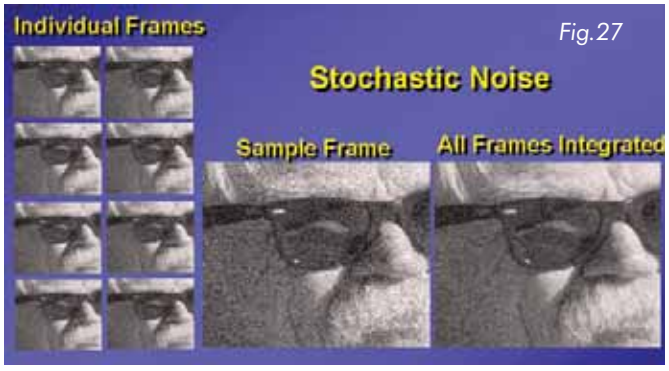


Fig.27


Fig.28

a film all look to have a similar resolution, run them at 24 fps and it is amazing how much more detail appears. Fig 27 attempts to show the effect, which significantly contributes to "The Film Look"

With electronic image acquisition, this frame by frame randomness is missing, since electronic cameras repeatedly sample at the same point in every frame.

Stochastic Resonance

There is always the desire, at least in the Digital world, to remove random grain or noise. We have seen how that may compromise bit depth when digitizing the image; its significance, however is much more subtle in reference to The Film Look.

Film Grain amplifies the brain's ability to see fine shading and this is known as Stochastic Resonance. Fig 28 (above) shows two images of a face. The image that looks slightly "noisy", also looks sharper and with more subtle detail. But it is not. Both images are the same, but in the image without "noise" we cannot see all that is there. Why not? We need to go back to look at how the visual system works to understand what's going on here. While we assume a continuous link from the eye all the way to the nerve cells in the brain, the links are not actually solid as shown in Fig

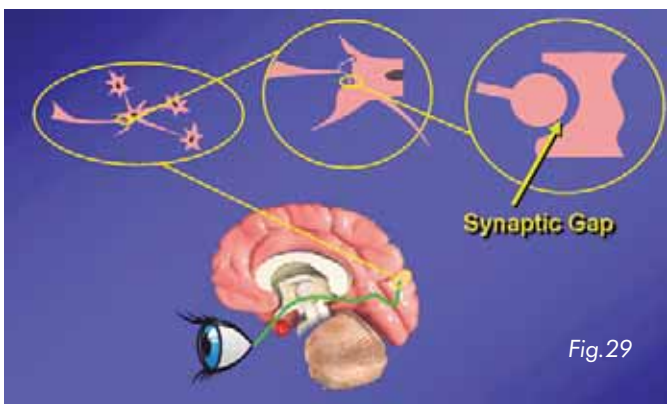


Fig.29

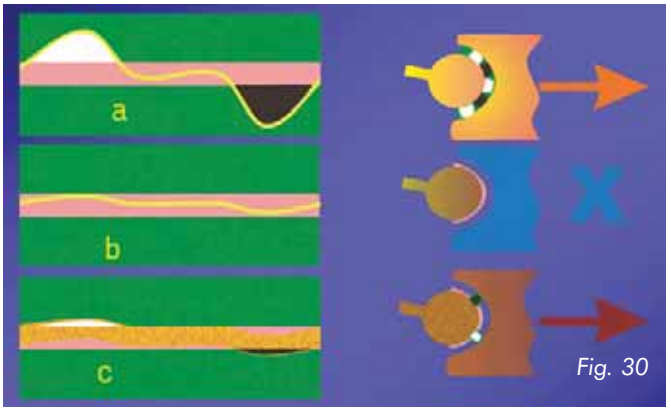


Fig. 30


Fig. 31

29, and there is a certain threshold at the synaptic junction between nerve cells below which a signal cannot cross.

Referring to Fig 30, let's assume that the threshold is the pink area and the green area is above the threshold. The yellow wiggle represents a particular signal from the eye. What happens?
For image (a) the white and black levels are big enough to jump across the synapse. However if the signal from the eye is very small because of only tiny changes in brightness (b) the signal cannot cross the synapse.

But if we add to the image some noise or grain as in (c) the original very small brightness change is modulated and is now big enough to jump across the synapse and because there is a real brightness change the noise will be biased by the brightness difference. Keep in mind that the brain filters out the noise. Remember the swaying grass and tiger syndrome, in this same instance the brain will filter out a lot of the noise but retain the sense of the subtle brightness change. Furthermore, adding noise or grain to example (a) lets us see more detail in the original example - and in Fig 31 we can now see finer subtlety.

This may explain why the image on the right in Fig 28 appears to have not only more sharpness but shows more subtle detail. This is an effect that relies entirely on film's subtle shading capture and grain

So, are Stochastic Resonance and Stochastic noise the major contributors to "The Film Look"? I believe they are.

Conclusions: Contributions to "The Film Look"

- We have seen that film frame rates and motion smear match the human visual system. In cinemas, are our eyes and brains more relaxed than when close TV viewing?

- The Slight unsteadiness of film may take over the need for our eyes to move around, relaxing the visual senses

- Film Grain is the Asset of Film, not a detractor.
- Grain reduces any coherent aliasing both at

source and when scanned to TV.

• Grain's size range determines the dynamic capture range.

• Grain helps reduce digital bit depth requirements.

• Stochastic noise and resonance provide integrated detail frame by frame and enhance our ability to see very subtle texture changes in the image.

Finally I offer two converse arguments, both based on throw back to our pre-history.

First argument: Film Is more Real than Video

As we have seen the human visual system is a very discerning device, honed many years back: to spot other animals, either as potential attackers or as a food source. Is it possible that our brains are still programmed for this now long unneeded visual acutance? If this is the case, is the film's image unsteadiness and the random grain treated by the brain as a more realistic view of the world, rather than a rigid vista which is more common to us now.

Take a still photo of a man-made structure, avoiding people, traffic, smoke etc and show it on a movie screen. Tell people it is a live movie, shot using the latest ultra steady camera and noiseless capture, who could tell whether it was real or not? Only if we add in natural details, such as people or clouds moving or trees and grass swaying does it immediately become obvious that it's a still image

Now take a similar still shot on the calmest day, of a field of long grass or trees, even with still mountains in the distance. Show this to the same people, I bet they will subliminally note the lack of the tiny motion in the scene and recognise it as a still image. AND if shown the real scene in a movie very few would question the background mountain moving slightly; it would most likely in real life prehistorically have been due to heat haze.

Is it therefore the granularity and the slight wobble that makes the whole scene come alive, and reminds us of our prehistoric real vistas, with waving grass and heat haze that our brains are still used to.

In other words : The Film Look is a much more real look, it includes minute moving stimuli that may be imperfect but are more realistic, or at least take some load off having to move our eyes. And where such movement is combined, in the cinema at least, with only seeing the image 50% of the time, this provides our visual senses not only with a realistic view but with a 50% reduction in brain processing!

Second argument: Film is not real, video is

Film is grainy and banging about all over the place, therefore it cannot possibly be real. We are being told a story and there is absolutely no chance of a tiger suddenly jumping out and eating us. Therefore we become much more relaxed. If this is the case, how is it that our pre-historical visual

Fig.32

senses do this? There were no Cinema Caves thousands of years ago, or indeed story tellers.

There is however one other scenario where we normally feel safe that has probably not changed over the thousands of years - Images in our Dreams.

Is the unreality of film acting like a dream and causing us to relax? If so, is the ultra clean and stable video image reminding us of a real world, where we must always be on guard, for who knows what's really out there?

So there you have it. Peter Swinson's take on The Film Look. It's mostly in the mind whichever way you look at it!

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Peter Swinson now runs an independent consultancy company, offering his experience and expertise to companies throughout the world.
Tel: 01727 830468
email:peter_swinson@compuserve.com

Demonstrations

The lecture was followed by an interesting four-way demonstration of 35mm Film and simultaneous HD video acquisition of a "featurette" provided by Arri and shown using both 35mm projector and a DP 2K Cinema projector. Fig 32 shows the various combinations that were displayed.

Bernard Happé, FBKS, Vice-President of the BKSTS from 1970-72, who was responsible during his time as Technical Manager at Technicolor for many ground-breaking developments in motion picture processing technology. The annual lecture in his honour was inaugurated in 1991.

Peter Swinson was the 14th Happé Memorial Lecturer.