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presents

the film look

The BKSTS **Bernard Happé** Memorial Lecture

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What is it that makes films look like films? It is widely recognised that images shot on celluloid and projected on a cinema screen have a distinctive look, a warmth, depth and sheen which leave video images looking inert in comparison. Just think of all those 1970s and '80s television dramas where the narrative flipped between rather flat interior scenes shot on tape to luscious exterior sequences shot on celluloid. That difference is "The Film Look".

The Film Look is one of the things that makes cinemagoing special — perhaps as important as the rows of soft chairs, rhythmic whirr of the projector, motes of dust captured in a beam of light and the salty sweet smell of popcorn. Indeed, filmmakers shooting on digital and high-definition cameras often go to great pains in post-production to reproduce the mechanical singularities and accidents of scenes shot on celluloid — lens flare, weave, contrast, depth and strobing.
This special supplement to *Cinema Business* magazine explains that The Film Look is a product both of how we perceive still and moving images, and essential differences between how film and video images are shot and projected.

The author, Peter Swinson, is an acknowledged expert in the technology of film, and this supplement is based on his well-received BKSTS: The Moving Image Society Bernard Happé memorial lecture. We think it makes an important contribution to the ongoing and often controversial discussions surrounding the introduction of digital cinema.

Cinema Business would like to thank Peter Swinson for editing his lecture and to Jim Slater of the BKSTS and *Image Technology* magazine.

Mark Moran
Managing Editor, *Cinema Business*




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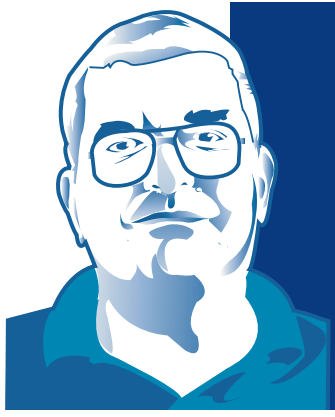
Peter Swinson



For over 20 years Peter was responsible for the introduction of Rank Cintel's range of film scanners.

With an electronic design background Peter moved to the film industry, Bell & Howell Professional Division, in the early 1970's where he added all technical aspects of the Motion Picture Industry to his skills. Peter joined Rank Cintel, now Cintel International, in mid-1980s. Peter now runs an independent consultancy company, offering his experience and expertise to companies throughout the world.

Peter Swinson Associates Ltd
Tel: 01727 830468
email:peter_swinson@compuserve.com

Bernard Happé

Bernard Happé, FBKS, Vice-President of the BKSTS from 1970 to 1972. He was, for many years Technical Director of Technicolor where he was responsible for many ground breaking developments in motion picture processing technology.

The Bernard Happé Memorial Lecture has been held annually, in his memory since 1991 and is arranged by the BKSTS.

Introduction

Without doubt motion picture film has a distinguishing look that is difficult, if not impossible, to emulate with other moving image acquisition systems. This is often referred to as “The Film Look”. Many of The Film Look parameters may actually be regarded as imperfections in the film. They do not occur with electronic origination. I believe some of these imperfections are beneficial rather than “harmful” and many are retained even when the film display devices are video or digital cinema based.

Man in his present form has been on this planet for more than 100,000 years. His senses have spent 99.9% of this time without film or television. Our visual senses are today much the same as prehistorically when we were about to be eaten or about to catch something to eat. In the past 100 years, since movies have been around, it would be unreasonable to suggest that our visual senses have changed in any significant way. The eye is but the means of detecting images. It is extremely clever in function but, much like a video camera, requires complex decoding to provide meaning to the received image. This decoder is extremely complex and is the least understood part of our anatomy; it is of course the brain.

The brain has separate areas for processing: static images; pattern recognition; textures; resolution; brightness levels; vertical or horizontal motion; and fast and slow stimulus. Many of these states come into play when watching a movie.

Peter Swinson

Image acquisition and the brain

When capturing images the camera is not dissimilar to the eye and brain. Both need a finite time to acquire the image. The brain needs between a 10th and a 100th of a second to process any input. Also the brain is not shuttered, and builds up the image over a similar period of time. How does this equate to our film and video capture world?

Rotating image

Film Camera
Shutter 1/48th sec

Fast CCD Shutter
1/500th sec

Fig. 1

Fig. 1 shows a single frame of a rotating wooden doll, captured by a film and Charge Coupled Device (CCD) camera.

Both images were captured at a rate of 24 frames per second. Note how the fast CCD shutter "freezes" the image. Video cameras do not always use fast shutter speeds, however there is a tendency to do so!

The brain accrues an image at cinema and TV brightness levels over a period of about 1/30th second. Therefore, as with film, fast motion is smeared in the brain. This to us looks natural and our brains calculate a perception of a sharp image.

When the brain is presented with a video image taken with a fast shutter speed it is confused. Frame to frame it calculates rate of motion, but it is seeing a sharp image with no smear. This is not natural, and we subconsciously find it irritating.

Film projection and brain

Film shot at 24fps must be displayed at this rate. At the same time the projector must move the film between frames. Cinema projectors typically spend half the time showing the image and half the time showing nothing.

For a two-hour movie your cinema charges you to watch one hour of movie and one hour of black!

Showing the frame once every 48th of a second would introduce too much flicker to the brain. A 48th of a second of black followed by a 48th of a second of the frame is processed as two distinct images by the brain.

To fool the brain is simple. Open and close the shutter at least twice or even three times for each film frame. While the total amount of black and image are the same they are chopped into shorter intervals. The brain does not have time to recognize these intervals separately and is not disturbed by the flicker.

Is this a "pleasantry" to the human visual system. Is the brain more relaxed with an image that is only there half the time? Has the brain less processing to do?

Stereoscopic vision

Lack of 3D vision rarely confuses us

2D depth cues are acquired very early in life

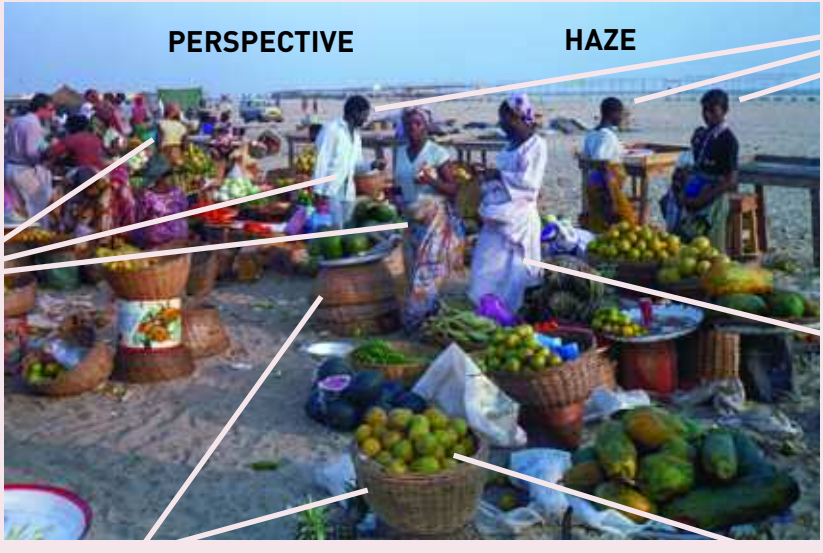


Fig.2

Our limit of 3D vision is quite shallow, well under 100 metres. Beyond this we assess depth from other clues.

It is said that although born with 3D vision we quickly learn depth recognition without the benefit of 3D. **Fig.2** shows visual clues to image depth. The telling of a visual story, which is what the movies are about, has little need for 3D.

Eye focus can confuse

We also receive depth clues in another manner. The distance the eye focuses when looking at an object. **Fig.3**

A near object seen on TV seems natural to us. It also seems we are content to see near objects displayed at a distance. Distant scenes are naturally fine on big distant screens. However we can become uneasy when a distant scene requires us to focus closely, as when displayed in our living room on TV.

Is this a pre-historical hang over? A close predator focused at a greater distance than expected is not dangerous while a distant vista closer than it should be could mean more potential danger.

Does the cinema relax our pre-historical fight or flight senses while TV in our living rooms tenses them?

Fig.3

Fooling the visual system

Our eye/brain combination does not always do what we expect, and some of these unusual responses may assist our perception of film images.

Fig.4 shows how well we invent recognizable patterns, there are no squares or triangles! **Fig.5** Indicates the brains separate horizontal and vertical interpretation, parallel diagonal lines become distort when overlain by vertical and horizontal lines.

Fig.4

Fig.5

Fig.6

Fig.6 further shows how pattern recognition can be fooled, by our different interpretation of vertical and horizontal views. Turn the page sideways to see this work.

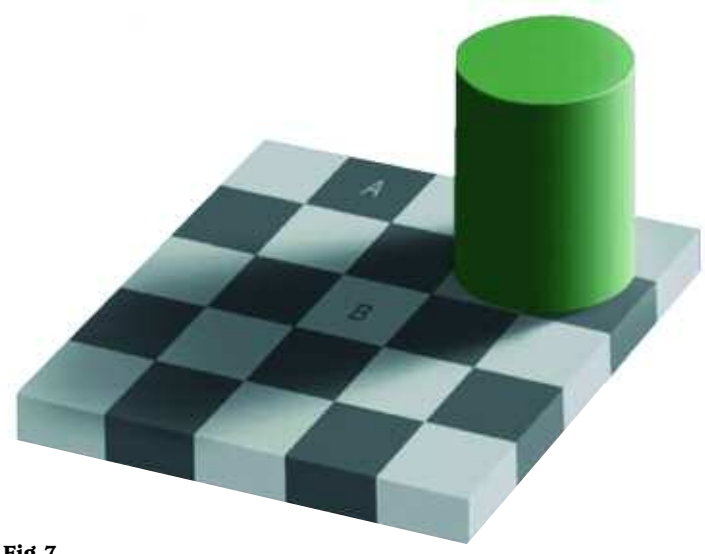


Fig.7

Is film's slight unsteadiness a GOOD thing?

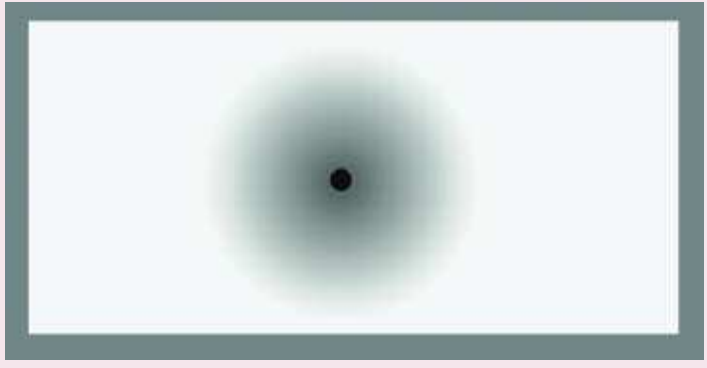


Fig.8

Fig.7, from the internet, demonstrates very clearly the brains attempt to compensate for brightness differences that it expects to see between lit and shadowed areas. It is unbelievable that areas (A) and (B) are the same brightness. To prove it, cover everything except the (A) and (B) squares.

In the shades of the jungle the brain processes images for maximum differentiation. It is another case of our prehistoric ability to detect the predator the shade and direct sunlight at the same time. In film it translates to seeing a greater shadow detail.

Stare at the black central dot and the outer gray will quickly disappear. Our visual senses need motion to see anything. While staring at the spot move the page about very slightly and notice how the grey area re-appears. We have two choices to see objects, either they must move or we must move our eyes.

How does all this relate to movies?

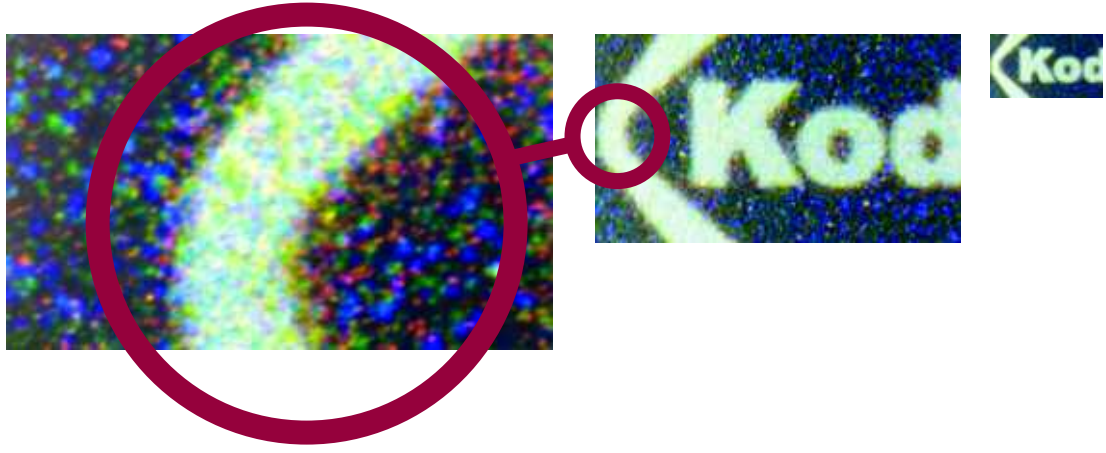
Find any image or text on a page in this journal, pick a point to stare at and try to stop your eyes moving. Very quickly the visual system starts to become uncomfortable. Now, without moving your eyes, gently move the journal around. The image becomes clear for as long as you move the page.

Adding a little "wobble" to the image is saving the eye having to moving around. Is it the case that the slight unsteadiness of film images is actually an advantage? Does it subconsciously allow us to relax more while viewing!

Film grain is definitely a GOOD thing?

Is grain the curse of film? No it is not.

Grain in many respects IS the film look, it is what makes the image, there is nothing else. While film images comprise granular clouds of dye randomly scattered and randomly sized, electronic images are acquired onto regular fixed size and fixed position sensor



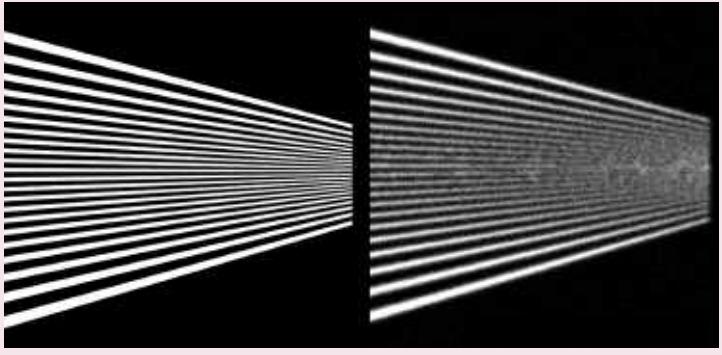
In general the largest piece of film grain is always smaller than the smallest electronic camera pixel. Film's image resolutions are captured with grains far smaller than other resolution limiting factors. It is grains structure that contribute greatly to The Film Look. But not necessarily in the way you would imagine.

Fig.9

Grain and aliasing

The randomness of grain and therefore the random sampling has an intrinsic benefit in terms of preventing 'aliasing' with patterned materials.

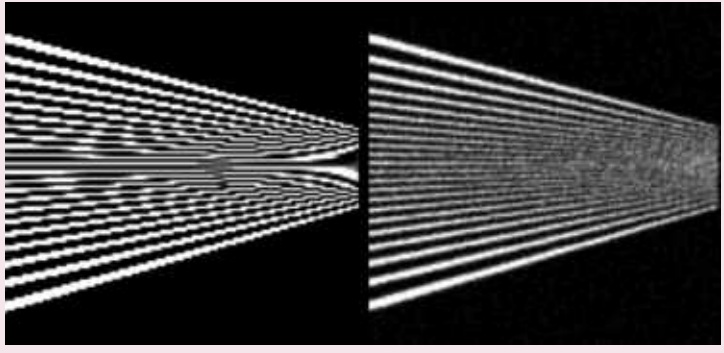
High resolution end magnified



Test Pattern

Filmed Test Pattern

Fig.10



HD Camera Test Pattern

HD Scanned Filmed Test Pattern

Fig.11

Fig.10 Shows the very fine resolution end of a test pattern and how film's grain samples it.

Fig.11 shows how an high-defintion (HD) video camera would sample. More importantly **Fig.11** also shows how an HD scan of film benefits over HD camera acquisition, in terms of patterned image aliasing.

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 dynmaic 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.

The dynamic range is proportional to the ratio of the largest to smallest grain size. And the shading subtlety is proportional to the variance i.e. With film's typical 10,000 different grain sizes 10,000 shades can be represented.

Grain's prime contribution to The Film Look

Stochastic noise and resonance. These are 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; what is important is the image hiding in the grass. 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.

Stochastic noise

As already noted film is just randomly sized and randomly position grain. When an image is filmed the grain represents the shades of the image at each location. Analysing 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 subsequent frame.

Looking at it this way, the film image can acquire very high resolutions sampled over several frames. The brain's image integrating capabilities that cause smear on moving images also gives us this grain untegration providing the perception of great detail in static or slowly moving film images. This significantly contributes to The Film Look.

Stochastic resonance

Film grain amplifies the brains ability to see fine shading and this is known as stochastic resonance.

Fig.12

Fig.12 shows two images of a face. The image that looks slightly "noisy", also looks sharper 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 links from the eye to the brain, these links are not solid, as shown in **Fig.13**.

There is a certain threshold at the synaptic junction between nerve cells below which a change in brightness signal cannot cross. However if we add to the signal noise or grain this modulates the small real brightness changes allowing them to jump across the synaptic gap

Remember, the brain filters out the noise, the swaying grass and tiger syndrome. Therefore we retain the sense of the subtle brightness change but ignore the noise/grain. This may explain why the image on the right in **Fig.12** appears to have not only more sharpness but shows more subtle detail. This effect relies entirely on film's subtle shading capture and grain

I believe stochastic resonance and stochastic noise are major contributors to The Film Look.

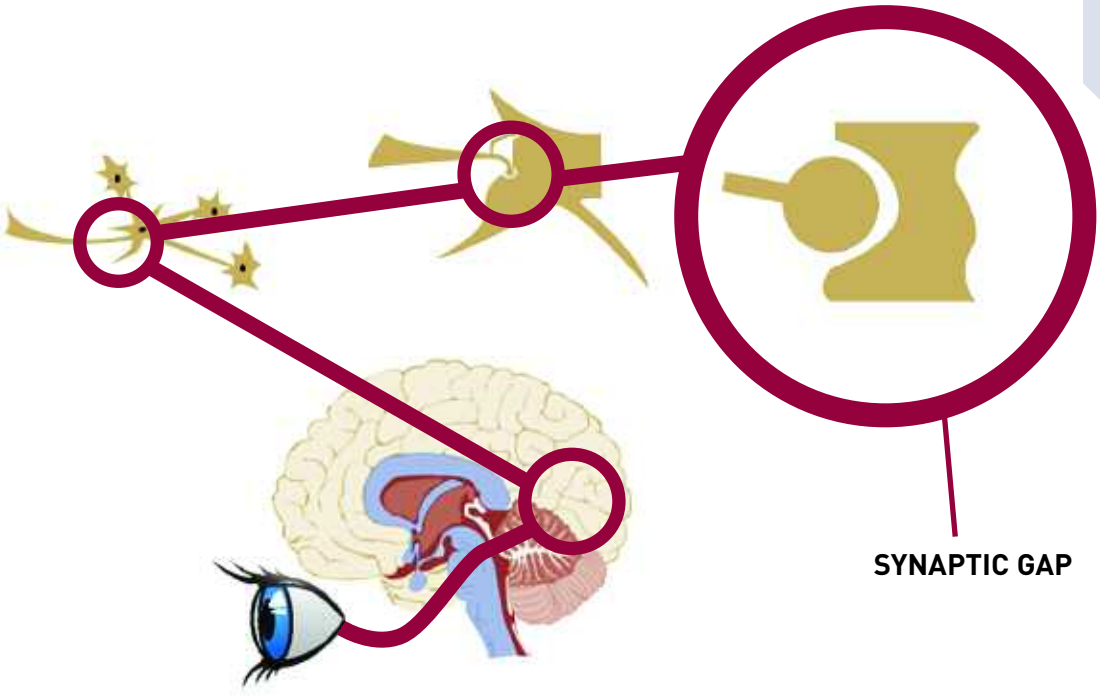


Fig.13

Conclusions

Film frame rates and motion smear match the human visual system.

In cinemas our eyes and brains are more relaxed than close TV viewing

The slight unsteadiness of film may obviate the need for our eyes to move around, relaxing the visual senses

Film grain is the asset of film, not the detractor.

Grain reduces coherent aliasing both at source and when scanned to TV.

Stochastic noise and resonance provide integrated detail frame by frame and enhance our ability to see very subtle texture.

Two converse arguments regarding The Film Look

Film is more real than video!

The human visual system is a very discerning device, honed many years back to spot predators or food sources. Our brains are still programmed for this now long unneeded visual acutance. 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 only common in modern times?

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, clouds or trees and grass that would be moving does it immediately become obvious it's a still.

Now on the calmest day, take a still photo of a field of grass or trees, even with still mountains in the distance. Show this to the same people, they will subliminally note the lack of the tiny motion in the scene and recognise it immediately 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.

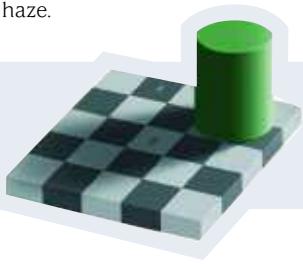
It is the granularity and the slight wobble that makes the whole scene come alive, and reminds us of our prehistoric real vistas, with waving grass and heat haze that our brains are still used too.

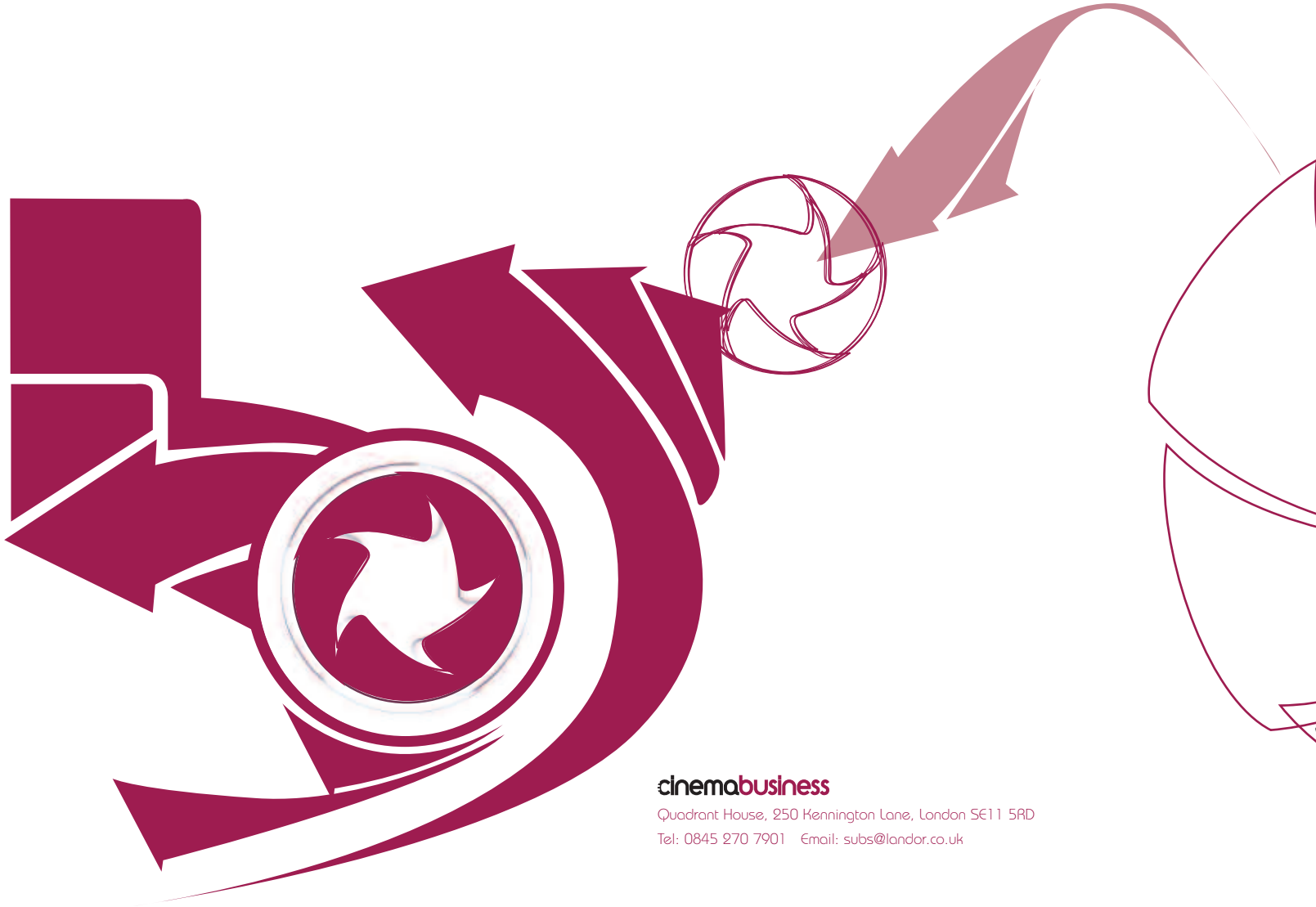
In other words, The Film Look is a much more real look. It includes minute moving stimuli that may be imperfect but are more realistic. And such movement combined, in the cinema at least, with only seeing the image 50% of the time, may offer a large reduction in brain processing requirements!

Film is not real, video is

Film is grainy and wobbling about all over the place, therefore it cannot possibly be real. Therefore we are being told a story and there is absolutely no chance of a predator suddenly jumping out and eating us. 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?

Peter Swinson
Extracted from the BKSTS 2004 Bernard Happé Lecture



cinemabusiness
Quadrant House, 250 Kennington Lane, London SE11 5RD
Tel: 0845 270 7901 Email: subs@landor.co.uk