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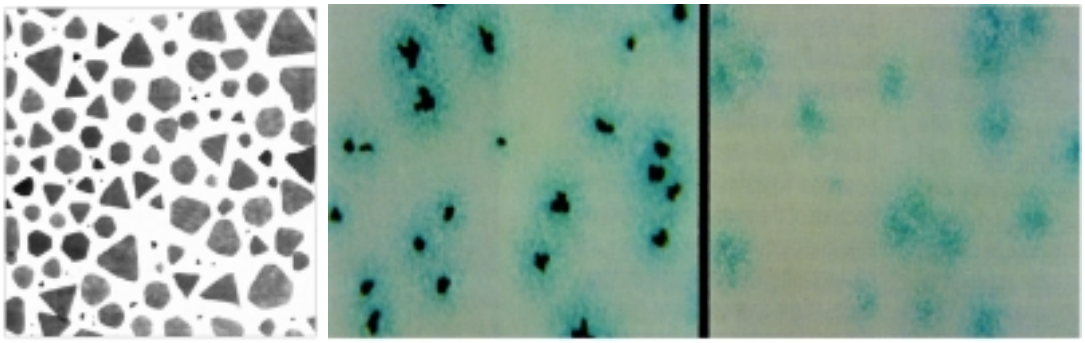
# GRACE: Film Grain and Grace

## Film Grain, an emotive issue

All film images are made of grain, but it is the visibility of the grain that is the issue. Some will say it is part of the film look, others prefer what can be described as a clean grain-less image, similar to a video camera image. This paper attempts to explain the origins of film grain, how grain can be minimised at source and describes Cintel's **Grace,** a film grain reducer with unique properties that is designed for Cintel's range of film scanners

## Film Grain, The Source

Processed Motion Picture Film comprises of three colored layers of dye[(1)] where the density of the dye represents the image. However the dye is not a continuous "wash" but comprises discrete clouds of dye. These dye clouds are what we see as film grain. Film images exist as very many adjacent varying sizes of dye, the image is perceived in a similar fashion to that of newspaper and magazine images where the image comprise millions of ink dots.



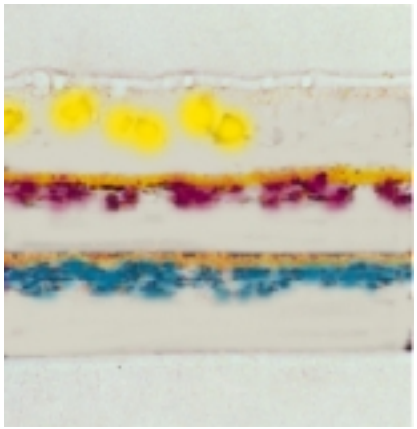
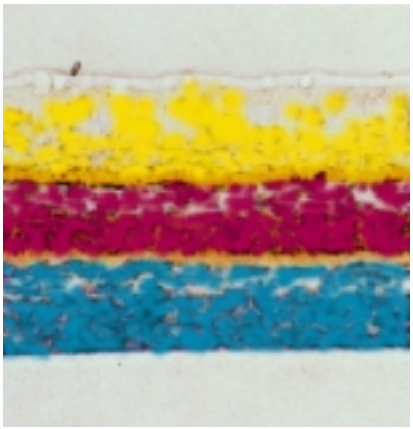
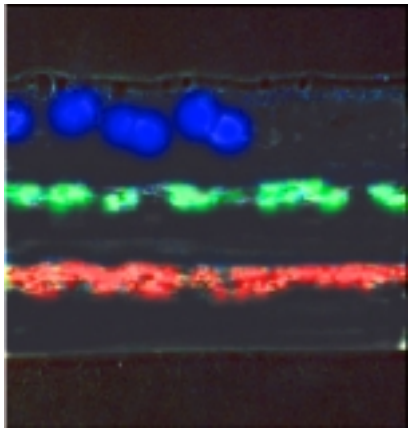
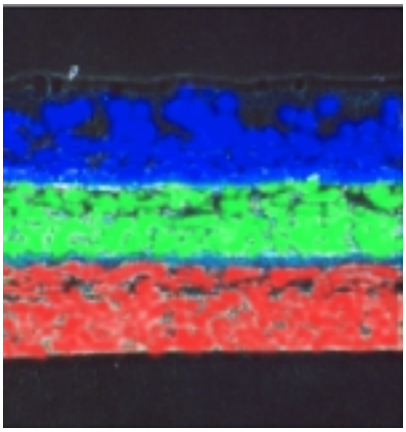
**Kodak T Grain process** **Silver Grain & Dye Cloud** **Dye cloud after full**

*(Electron Microscope image of film grain/dye (x600) - Courtesy of Kodak PMI)*

There are many properties to film grain, however the most critical as far as perception is concerned are the following :-

- The grain sizes for a particular film stock remain the same regardless of film gauge or image format. Therefore a smaller film gauge or format will show more grain for a similar size final picture
- The faster or more sensitive the film, the larger are the individual grains
- The largest grains are exposed with the least light, therefore the darkest parts of the image comprise just the largest grains which are much more visible than small grains.
- Film manufacturers use very large grains for blue sensitivity. This combined with minimum exposure can enhance blue granularity in images.

***Film Dye. magnified cross section (Courtesy of Kodak PMI)***

| ***Negative*** | ***Minimum exposure*** | ***Normal exposure*** |
|---|---|---|
| *Blue Sensitive*<br>*Green Sensitive*<br>*Red Sensitive* |  |  |
| ***Resultant image*** | ***Minimum exposure*** | ***Normal exposure*** |
| |  |  |

## Film Grain, how to minimise when shooting

From the above description of the sources of film grain, it can be seen that certain steps can be taken to minimise the effects of grain.

In order of degree of minimisation these steps are :-

- Use the largest suitable film gauge and image format on the film
- Use the slowest suitable film stock speed, consistent with the look required
- Where possible over expose by about 1 stop to avoid large granular lowlights
- Be careful not to underexpose blue to the extent that a lot of correction will be required when color correcting

Always remember that the film grain IS the image, however the resolution of the grain usually exceeds the resolution of the taking lens. In other words several grains will occupy the sharpest edge of visible image detail. It is this factor that Cintel have based their Grace film grain reducer upon.

## Film Grain, how it effects film transfer

One of the advantages of scanning film, both for TV, HD and Film mastering, is the degree of control in terms of color correction and image re-positioning. Such control should not be an excuse to ignore any of the steps described above when shooting the film. If the film is underexposed then grain will be doubly noticeable as the correction not only amplifies the grain, but also shows the large underexposed grains more prominently. Likewise a loose shot that is zoomed and cropped at scan time will magnify all the grain sizes.

With particular reference to blue grain the complaint often heard in a transfer suite is that the blue is noisy and this is usually blamed on scanner noise. More often than not this is untrue and very easy to identify. Simply defocus the gate lens, this will defocus the blue film grain and the blue will look quiet, this shows that the blue “noise” is actually blue grain on the film.

## Traditional Film Transfer Grain Reducers

For several years downstream grain removers have been available to our industry. Until very recently such grain reducers were format dependent. There existed SDTV versions and HDTV versions. Recently combined SD & HD units have become available *yet such “real-time” grain reducers for data are very rare devices*.

Most existing grain reducers comprise of video in/ video out devices. They are designed to primarily remove video noise but recent units have been developed to produce better results with film grain.

While all these devices have filters to minimise noise/grain on an individual frame basis, their acclaimed results rely on inter-frame comparisons, known as recursive filtering. This is based upon the assumption that no two or more adjacent frames will contain the same noise, however the image frame to frame will be similar, therefore it is a relatively simple matter to identify the noise or grain and subtract it from the real image.

This is fine for scenes with slow movement, however fast action tends to confuse the grain reduction processing, which then either switches off around the fast action, smears the action or generates multiple ghost images. Additionally at scene changes there is no correlation between images and the devices must either switch off for a few frames or cause severe artefacts at the scene change.

Apart from grain reducers some scanners minimise grain by operating at reduced resolution in their color channels. This will help minimise some grain, especially in blue, but at the expense of resolution. This may be fine for SDTV, but does limit quality in HD and 2K/4K film scanning. *Diffuse illumination will also help keep grain at a lower level, but again diffuse illumination also somewhat reduces the final image resolution.*

***Samples of Motion errors on traditional Noise Reducers*** [(2)]

*S16mm Scanned Frame*

*Recursive Smear on fast motion*

*Recursive filter on fast motion*

*Correction turned off on fast motion*

## Grace, a new approach to Film Grain Reduction

Traditional noise/grain reducers are situated at the output or at least downstream ends of film scanners or video suites. Grace is unique in that it resides right up at the scanner head. This provides significant benefits when it comes to grain reduction. These are :-

- Resolution independent. SDTV, HDTV, 2K data, 4K data, etc
- Film gauge and image format independent
- 14 Bit RGB processing, offers much more subtle grain correction than 8 or 10 bit video systems
- No TV field interpolation or de-interlacing required
- Not affected by color channel manipulation or aperture correction

Grace is designed specifically to reduce film grain, located at the scanner front end the 14 bit RGB processing enables Grace to provide high degrees of grain removal without any need to rely on recursive filtering. This has major benefits, such as :-

- No smearing of scenes regardless of their motion content.
- Continuous grain reduction over scene boundaries
- Instant programmability (Frame by frame selection)
- No additional frame stores
- No processing delay
- Still frame adjustment

***Grace Grain Reduction S16mm (Sample)***

***Grace Grain Reduction 35mm***

***Grace Grain Reduction 35mm***

## Grace control

Grace's operational simplicity means very few controls are required. While Grace is still in prototype form we have already seen that a single level control with some switched master settings appear to cover most eventualities**.** The prototype also includes a front end split screen facility, offering the user a comparative view of the original scene and a Grace'd version.

## Conclusion

Grace offers our industry the best of both worlds. For those who prefer the filmic grain inclusive look, then Grace will probably be used in a very subtle fashion. For those desiring a look that is more a match with video cleanliness then Grace will provide any degree of grain removal desired.

Grace is fully complimentary with Cintel's Oscar Dirt and Scratch Restoration system Such a combination offer full image clean up for pristine transfers to all TV HDTV and Film Data formats.

(1) The film dyes are the processed result of silver film grain. The dyes are Cyan, Magenta and Yellow, on scanning they are converted to their compliments Red, Green and Blue
(2) These images were simulated