"FROM DIGITAL TO DARKROOM"

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ANTHONY ARTHUR MEINTJES

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1. INTRODUCTION

Since the late eighties the much vaunted 'digital revolution' has had a dramatic impact on the field of visual media in general, and on photography in particular. The technological advances have been of such enormous significance and breadth that many photographers have felt overwhelmed, or even threatened. The popular media have contributed to the perception that photography's demise is imminent. As Mitchell observed:

> 'From the moment of its sesquicentennial in 1989 photography was dead - or, more precisely, radically and permanently displaced - as was painting 150 years ago'[1]

The response to the new technology from the popular media in particular, has been prone to hyperbole and even hysteria.

> 'The debate on 'post-photography has become obsessed with the "digital revolution" ... there is even the danger that the 'revolution' will make us forget about what we want to do with images - why we want to look at them, how we react and respond to them.'[2]

The new technology differs substantially from traditional photographic image making, particularly in the post-capture phase, and requires a new language and understanding. It is the intention of this essay to outline the principal technical parameters of digital imaging, and provide a context in which to view the broader implications it has imposed on traditional photography.

> 'A technology is nothing until it is given a use and a form within a culture'[3]

By exploring the implications of a new technology and its software, techniques are discussed that bridge electronic imaging with photo-chemical practice, with special reference to monotone printing. All the black and white photographic prints exhibited as part of this submission, although captured on film, went through a digital phase prior to printing.

It is important to highlight the fact that the fundamental photographic principles and procedures have remained unchanged, and the silver-based process has remained one of the most efficient light-capturing methods. Needless to say, the proliferation of the photographic image has had a profound influence on the visual media.

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1 Mitchell (1992) p.20

2 Kevin Robins in Lister (CD)1992

3 Lister, op cit.

As Sontag has written,

> 'Photographs give people an imaginary possession of a past that is unreal, they also help people to take possession of the space in which they are insecure.'[4]

With recent technological advances, however, digital imaging is providing an increasingly attractive alternative to film. As technology increases the quantity of information that can be seized instantly (i.e. comparable to film), this technology will have a broader range of applications. This is particularly true of images destined for offset lithographic printing rather than electronic publishing, as larger quantities of image data are required.

2. A DIGITAL REVOLUTION

It would be fair to say that the development of digital imaging is the most significant technological step in the evolution of photography thus far, to the extent that it rivals the invention of photography itself. Just as the Kodak box camera allowed photography to access a mass market, so has digital imaging become increasingly pervasive as a medium. Digital cameras are increasingly replacing film in many spheres of the global image communications industries.

> "The history of every art form shows critical epochs in which a certain art form aspires to effects which could be fully obtained only with a changed technical standard, that is to say, in a new art form."[5]

The simultaneous development of camera capture devices, desktop scanners, and computers with faster processing speed and larger storage capacity, have fuelled the rapid growth of digital image processing. These hardware advances have enabled software developers to provide powerful tools for graphic artists and the pre-press industry. Since 1989, electronic resources have become more affordable, allowing "desktop publishing" and electronic imaging to flourish.

Over and above any aesthetic considerations, imagemakers are constantly driven to take advantage of technology to satisfy an increasingly demanding picture industry, altering the status of the photograph permanently. The enormous adjustments that are taking place in the way our world is being represented are much more than just technological change, and according to Valery,

> 'In an image based economy, [these] images have an imperious scope: they are enlisted to produce desire, encourage commodity consumption, entertain, educate, dramatise experience, document events in time, celebrate identity, inform and misinform, they offer evidence.

4 Sontag (1977) p.9

5 Benjamin (1930) p.2

Change, then, in how such artefacts are produced, consumed and understood, is a matter of some historical moment.'[6]

3. A RELUCTANCE TO EMBRACE A NEW MEDIUM

Given that digital technology has a wide range of benefits for the photographer, there is an apparent reluctance to engage in the use of a digital mode for the production of images. It could be seen in part to stem from the introduction of a new language into an established style: intimidation by a sophisticated technology and a new idiom.

In the face of the rapid advances in digital technologies, the traditional sense of photography has been seen to be undermined by these complex, rapidly evolving technologies. The fate of the photographic image has been debated widely in the media, and the "death of photography" wildly quoted. Digital technology is often framed in terms of "replacing" traditional methods of image-making. It is critical in the face of such argument, to discover which aspects of photography could be threatened by digital innovations. Any reluctance to involve digital technology in the image-making process is more likely to stem from a social/documentary perspective than from a scientific application. Photographers, who feel that photography is being "threatened", project a narrow vision that can only dilute the usefulness of such an important innovation.

The recording or capturing of selective image data is a process that relies on a range of subjective choices, in addition to the mechanical, chemical or electronic procedures required to achieve it. The practical aspects of the process vary according to the method of capture being utilised and usually rotate around convenience or necessity. However, it is in the post-capture stage of imaging that the full potential of a digital mode can be exercised.

Historically, innovations in photography have been embraced or rejected depending on their usefulness. Since the late eighties, an explosion in software and desktop computer development has produced a phenomenal growth market in the graphics and reprographics industries. The digital developments in this sphere are equivalent in importance to the invention of the photographic process itself, and partly constitutes a re-invention of photography.

The intimidation might also originate from the hyperbole that has been generated by the 'techno-euphorics', and the tendency to exaggerate the break from traditional photography, both with regard to technological changes and the cultural antecedents of the medium as a whole. Some traditionalists and exponents of 'pure' photography argue that digital imaging permits alteration and manipulation on such a vast scale, there is a danger of photography 'losing credibility'.

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6 Lister, op cit

It is possible that the camera has become such a familiar and recognisable part of our everyday existence - and so crucial to it - that we are no longer (if we ever were) aware of just how many assumptions are built into the process of taking a photograph. Despite - maybe because of - the lingering assumption that the camera reflects reality, and is largely a causal process, we are perhaps not as aware as we should be of how inherently interpretative a photograph is. It is likely that even professional photographers are relatively oblivious of the number of fundamental interpretative decisions being made as they take each photograph:

> "It has long been understood that a photograph is a complex, constructed image of reality rather than a simple window on the world. To differing degrees all photographs are the outcomes of decisions, choices and organisations within the frame"[7]

4. INFLUENCES AND INTERVENTIONS INPHOTOGRAPHIC PRACTICE

It is worth remembering the number of levels of influence inherent in taking even the most innocuous of photographs. Indeed, with regard to traditional photography, it is easy to overlook the extent and degree of interference and the unconscious assumptions involved in the capturing of an image. As Linda Nochlin has observed:

> "... photography was often thought to be particularly 'artless' and, by the same token, particularly associated with reality, because of its tendency simply to record the raw data of visual experience, whatever happened to be caught by the lens at a particular time, whether or not a unified composition resulted, and whether or not human figures were oddly dissected by the photographic frame."[8]

4.1 IMAGE CAPTURING

4.1.1 The Crop

As the printed image is confined to the paper format it is printed on, the optical window is limited by its frame. This is influenced by the optical choices the photographer may make, and the spatial relationship he/she chooses to have with the subject matter.

The window through which the world may be 'captured' is therefore entirely selective. A photographer may exercise control over this area by using the mobility of the capturing device to include or exclude graphic elements that provide the most desirable combination. In order to include selected information in a given area, it is necessary that visual territory also be excluded. This selection is highly subjective, and marks the beginning of a process by which a

7 Ibid

8 Nochlin, (1994) P.37

given situation is manipulated by the photographer to suit his/her interpretation. Whether subtle or dramatic, the framing process reinforces the notion that no photographic image is ever a causal reflection of the world: it is an interpretation particular to an individual.

The area of inclusion has at times been deliberately surrounded by an exposed frame, to reinforce the fact that the entire image area has been used, and final framing has taken place at the moment of exposure. This convention has been practised consistently by photographers since the invention of the Leica 35mm camera, and has almost become a language spoken between photographers: this is how the image was seen at a particular moment.

4.1.2 Depth of Field

Another "moment of exposure" influence is the use of selective focus. Depth of field being that portion of the live area at which distance the light rays remain sharply focused on the film plane: the larger the lens aperture, the shallower this portion is; the smaller the aperture, the deeper. A shallow depth of field can be used with enormous effect, to optically define an area in order to highlight an object or portion of an image, thereby rendering unfocussed areas of detail as seamless gradation.

The extent of its effectiveness is determined by the distance of the point of focus from the lens, and the size of the aperture: the closer the shallower, the further the deeper. Lens designers have constantly endeavoured to produce 'faster' (larger aperture) lenses, primarily to extend the range of light intensity required for image capture; large apertures lower the light requirement, allow for thinner slices of focus, and provide a brighter viewfinder.

This principle can be extended by using a camera, which has a lens plane that can be independently shifted and tilted relative to the film plane, allowing the photographer to choose the angle at which the plane of focus will reside. The plane of sharp focus can slice through the live area at angles other than ninety degrees to the lens (the Schlemflug principle). Since this technique is at odds with the conventional understanding that focusing takes place on a plane at right angles to the lens, the effect can be disquieting and eerie.

4.1.3 Optics

As perspective is determined by optics, the vast array of available lenses will alter the relationship between the film and the object photographed. This choice can dramatically influence the graphic interpretation of a given viewpoint, and hence be pivotal in establishing a recognisable, optical 'style'. For example a photographer wanting to remain unobtrusive to a subject would geographically require an optical arrangement that would isolate a smaller 'window', but still render an image of sufficient image information. This would necessitate a high enlargement factor, which would determine the choice of optics. The familiarity of long lens images, with their distinctive 'stacking', or depth compression, has established that look as a recognisable image type.

4.1.4 Film Type

Colour and monochrome film types present the photographer with an important choice, both technically and aesthetically. For example, an image captured in full colour can be output in black and white. The black and white medium can be extremely flexible in its rendering of tone. In addition, and more importantly, a monochrome image can portray the world as one step removed from the full colour view we perceive by eye. By thinking of images from the Second World War and trying to imagine them in full colour, one realises how powerful the associations can be. The events and their documentation become one. Most Holocaust films reflecting this period of history have chosen a monochromatic rendition for that reason.

Photo-chemical colour positive prints can be produced from either negative or positive film types, and as with black and white film types, a variety of emulsion sensitivities are available, with most innovations in emulsion design focusing on film speed and grain size.

Instant film types are popular for previewing a situation prior to capture on the final choice of film. Some of the most interesting and imaginative permutations in image alteration have centred around the Polaroid product range. These picture treatment styles can approach illustration, and are extremely distinctive. Polaroid emulsion transfers and lifts onto selective paper types are good examples of how photographers have experimented with film types to establish new styles.

Unusual and distinctive results can be produced by processing positive film types in negative film chemistry (and vice versa), which will inaccurately map colour and tonal range. There are film types that makes use of wavelengths beyond the visible spectrum, such as infra red, which will render tones that do not approximate those produced by a panchromatically sensitive emulsion. As these tones (black and white) and colours are mapped differently to the values we are familiar with, they produce extremely unusual images.

So a huge variation of choice exists in the permutations of available emulsion types, and the chemical processing they require; enough to radically alter the mood or context of an image.

4.1.5 Filtration

By placing filters directly in front or behind the optics of a capturing device, it is possible to influence image-making dramatically. To control colour, filters can be divided into three categories:

1) Colour balance filters, which shift the entire colour spectrum toward the red or blue end.
2) Colour correction filters, which neutralise a colour bias due to inaccuracies in the manufacture of film.

3) Narrow-cut gels, which radically alter the colour captured, usually for effect or scientific use.

Non image-forming filters that can influence contrast control and highlight diffusion are among a selection of filters providing specific effects largely outside of colour space. A continuous-tone filter presence over the optic will be non-selective in its effect on the image and is therefore limited to the entire picture area. Gradated filters can be used to cover only a portion of the lens and thereby affect only a certain section of the image. However, accurate control depends on the careful positioning of the filter, the aperture used (depth of field), and the distance of the filter from the lens. The shape of the affected area is usually restricted to the linear or circular.

Other than the obvious results of colour filtration with colour emulsions, there are far more unusual and sometimes unexpected tonal shifts with panchromatic black and white emulsions. Since a narrow-cut colour filter will allow wavelengths of the same colour to pass through and inhibit or cancel wavelengths of opposing colours, certain colour values can be lightened or darkened by a certain colour. That is, provided the area concerned has a colour, and that it is distinguished from other areas. Other than this distinction, this process is not a selective one, and the filter effects will apply to the entire image area. A way in which colour filtration can be more selective, both for colour and black and white images, requires artificial light sources used with or without natural light, thus extending the photographers control in two directions: selective colour and selective exposure. As this kind of control over an image usually comes at a price, the logistics and costs can become excessive in relation to the benefits.

4.1.6 Lighting

The use of extra light, natural or artificial, can be utilised either to enhance a subject or as a requirement to reduce excessive contrast. The variations in lighting techniques are numerous and diverse. As light is the substance of photographic images, controlling light assists in its application. No matter what kind of imagery is being created, control of the illumination is one of the most influential and dramatic factors of all, from the subtle diversion or reflection of existing natural light, to the use of entirely artificial sources.

There is lighting equipment available that allows a photographer to "paint" light onto objects highly selectively. As this light can be applied to extremely small, local areas of an image, it permits the selective use of filters, both colour and effects. It stands to reason that the more numerous the separate applications of light, the greater the opportunity to apply additional treatments or filter effects with each application.

4.2 POST CAPTURE FACTORS OF INFLUENCE

4.2.1 The Darkroom

Once a latent image has been rendered visible on film, either as a positive or negative, there are a number of output options available that will influence the final image. Before the discovery of the colour reversal process, black and white images, which rendered negatively after processing, were printed either in contact with a photosensitive paper, or via an enlarging device, to reverse the tonal values back to positive.

With regard to black and white photographic printing, there are commercial printing papers available which offer a range of paper types with varying surface textures. In addition there are alternative printing processes that require a high level of involvement in the preparation of the receptor paper, such as platinum, palladium, cyanotype, kallitype, carbon, gum dichromate printing, oil and bromoil. Photographers continue to use these processes today for the image quality unique to each method and the value that can be attached to the object itself.

Due to the reluctance by gallery owners and art dealers to trade in artwork containing colour dyes and pigments that are untested for permanence, or of limited longevity, fine art photographers have tended to use monochromatic containing silver gelatine, or any of the photo-sensitive emulsion types already mentioned. All of these materials display excellent archival properties if produced and treated correctly.

Colour photo-chemical printing is a more complex process, requiring commercially produced paper that is exposed through a combination of filters, and processed in specific chemistry. Variations are limited to time related interventions in the standard processing requirement, altering the colour and contrast values of a print, within the confines of the materials' limitations. A skilled printer can selectively reduce or increase local light quantities to an image during the printing process. This applies to colour and black and white images. In addition, the use of colour filters over certain areas of a colour print allows a printer to exaggerate and influence the colour qualities of an image. The same applies to colour sensitive silver printing, resulting in the adjustment of the tone and/or contrast values.

Another treatment uses of a diffusion filter on an enlarging device to spread the light that contributes to the dark values of a print, adding a distinctive quality to both black and white and colour prints. This most closely resembles prints produced at a time when the inferior quality of lenses resulted in the unwanted spread of light, 'inscribing' those images within a time frame of technological development.

The above lillustrates the choices available to image-makers using physical, chemical and mechanical (traditional) means to exert control over the creation of photographic imagery.

5. THE DIGITAL MEDIUM

5.1 ANALOGUE MEDIA COMPARED TO DIGITAL MEDIA

The essential differences between these media are well described by Binkley's distinction between analogue and digital:

> "Analogue media store information through some kind of transcription which transfers the configuration of one physical material into an analogous arrangement in another. A digital medium, on the other hand, is not a transcription but a conversion of information. Digital media store information 'as formal relationships in abstract structures'. In short, as numbers lodged in electronic circuits or in transits as electronic impulses."[9]

If the chemical form of a photograph is an analogue representation of space in a scene, it is illustrated by this excerpt of Edgar Allan Poe from his 1840 article "The Daguerreotype":

> "If we examine a work of ordinary art, by means of a powerful microscope, all traces of resemblance to nature will disappear - but the closest scrutiny of the photogenic drawing discloses only a more absolute truth, a more perfect identity of aspect with the thing represented. The variations of shade, and the gradations of both linear and aerial perspective, are those of truth itself in the supremeness of its perfection."

In opposition to the subtlety of the continuous tone, if one were to subdivide a picture plane into a grid of picture elements (pixels), with each having a specific value, the grid would be capable of constituting an image which can be stored in computer memory and be interpreted by hardware, in order to display or print it. Unlike an analogue, continuous-tone image, the gradients in digital images are broken up into steps of tone, and are seen as continuous only when presented in concentrations that exceed the resolving power of the eye. There is also a significant difference when enlargement is considered. Digital images contain a fixed amount of data. Although the number of cells in the grid can be increased to enlarge an image, no additional information would be supplied, as it would (up to a point) in a continuous tone photograph.

The electronic image has a number of economic advantages over photographic film; the absence of chemical process, the low cost of storage and the rapid transmission of image data to any destinations that are telephonically linked. The essential characteristic of digital information is that it can be

9 Timothy Binkley in Lister, op cit

manipulated easily and quickly by computer, and can be copied without degeneration.

Looking historically at the use of the computer in art, it can be traced back to the 1950's and the creation of oscillograms,[10] arguably the first electronic images produced. In the mid 1960's the first computer generated graphics were created almost simultaneously in Germany and the U.S. After pictures were first translated into arrays of integers, a sophisticated mathematical theory of digital image transformation and combination was constructed, and became the foundation for computer image processing systems.

A steady increase in the production of digital graphics followed, boosted in the early nineties by the phenomenal growth in 'desktop publishing' and digital imaging. Among the first to really exploit this new potential were print and packaging designers. They were closely followed by advertising industry, forever seeking new visual communication options, obligingly attainable by the increasingly affordable hardware and software. The possibility of easily manipulating photographic images and graphics suited the pre-press industry very well, and it eagerly embraced the opportunity to elevate the production values and aesthetic considerations permitted by the digital medium.

The computers' influence on photography is enormous, and raises many questions about the nature of the role it does and can play. If the range of photo-chemical enhancement and manipulation techniques that have been discussed seems extensive, they are rudimentary and sometimes clumsy compared to the variation and subtlety possible in a digital medium. With the computer hardware industry continually providing high speed processing capability, software developers are producing increasingly sophisticated tools to process image data for a myriad of purposes.

> "In the early years of any genuinely new technology it is especially important to clear the mind of the habitual technological determinism that almost always comes with it"[11]

5.2 THE DIGITAL MEDIUM AS A PHOTOGRAPHER'S TOOL

The computer is undoubtedly the most powerful and influential post-capture tool available to a photographer. Here is a brief look at where the digital factors of influence can fit into the broad spectrum of photographic image production.

Of the choices already discussed, all except one has its counterpoint in a digital medium. The optical choice made when capturing an image can not be accurately altered later. Focal length determines perspective and the capture area of the image. The perspective qualities can be simulated, but the spatial distinctions cannot always be adjusted after capture. Short of reconstructing the

10 Device to measure and display varying amplitude of electrical signals over a period of time, using a cathode ray tube as display.

11 Robins in Lister, op cit

image with the individual objects and planes, the optical choices are best exercised before image capture. All the other influences available when taking or printing images can be duplicated or simulated.

The overriding advantage of post photographic manipulation is the choice of subjective alternatives that can be exercised (and reversed if necessary). Moreover, the post photographic process usually takes place in a location conducive to consultation and free from the constraints and pressures that are present at image capture. The vast range of opportunities offered by software vendors are not to be under-estimated; if the limitations imposed on the medium are largely determined by the skill of the operator and his/her imagination, these highly sophisticated applications have opened up possibilities unconstrained by the physics and chemistry associated with traditional photography.

Note should be taken of the distinction between images captured to film or electronically imaged, and bitmap[12] images created digitally without the use of optics and light (autographic images originating within software). Although 'pinhole' cameras require no optical interference, light remains the key requirement for all photographic imagery.

12 The technique of mapping pixel-based images into individual bits of computer memory.

5.3 THE DEFINING CHARACTERISTICS OF THE MEDIUM

5.3.1 Digitising the Image

In order to exercise control over an image captured on conventional material, it is necessary to convert the image into digital data, or picture elements. This digitising process is dominated by two different technologies.

A scanning device is the equivalent of a desktop camera; it makes use of a lens to focus an image from a 'bed' or a drum, onto a CCD[13] array or a photomultiplier tube[14]. In essence, it provides for the electronic capture of data through a lens from an illuminated source, and differs from a camera device insofar as it is stationary and the subject is limited in size by the dimensions of the bed or drum.

The cheapest and most common scanner technology uses light sensitive CCD hardware to convert lightwaves into electronic data. They are desktop machines designed to scan reflected or transmissive originals. The other, more costly scanner technology makes use of photo multiplication hardware, which is capable of higher resolution factors and can read higher maximum density values from the artwork. These high-density values are generally found in transmissive materials, which usually display a greater density range than reflective artwork.

Camera-backs, which are designed for a variety of formats, scan the image from directly behind the camera lens, avoiding the use of film. These electronic data capturing devices fall into two groups: those that capture data instantly, and those that scan an image area over a period of time. Instant capture hardware places limitations on the file size, which could be inadequate for large printed output. Camera-back image scanners can capture much larger file sizes (currently over 360mb) over a period of time, from directly behind the camera lens, thus avoiding the use of film. The length of period depends on the light intensity and aperture used. The latter type has the obvious disadvantage of imaging only stationary subjects, with the use of a continuous light source (no strobe lighting).

It is worth noting that an RGB colour image that is destined for monochromatic output, whether captured digitally or scanned from film, provides the image-maker with three black and white versions. Each is the equivalent of a monochrome capture through a red, green and blue filter. This is extremely useful if one considers that the three images can be mixed in any configuration and intensity: three pictures in one capture.
The choice of tonal values extending over the different areas of the image is therefore greatly extended.

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13 Charge Coupled Device: analogue device used to convert the incident image into an electrical form.

14 A vacuum light sensor in which electrons are multiplied, to convert a small quantity of light into a usable electrical signal.

5.3.2 Resolution

Every digital or bitmapped image has four basic characteristics: resolution, dimension, bit depth and colour. When an image is scanned, or digitised, the number of samples to be recorded in a given area needs to be specified as in pixels per inch, or pixels per centimetre. The physical size of pixels in an image will vary depending on the chosen resolution. Digital image resolution is controlled by the number of bits[15] available for the digital code. As photographic images are bitmaps, the resolution of that image will influence the quality of the final output.

Monitor resolution can be defined as the measure of a system's ability to display the fine detail accurately. Therefore, if an image is to be viewed on a monitor only, the optimum quality required will equal the screen resolution of that monitor. If however some form of printed output is desired, an optimum image resolution appropriate to that form of output would be required, and this can vary substantially, depending on the device hardware. Clearly any device that is capable of producing fine/smooth tonal qualities will require a higher resolution, which in turn will result in a larger file size.

5.3.3 Bit Depth

A brief description of bit depth is necessary in order to understand how colours and tonal values are represented. A bit is an individual element of a binary coded item; i.e. 0 or 1, and a bitmap is a digital image of touching pixels, which are small squares of solid black, white, varying tones of grey or colour.

Bit depth refers to the number of tones or colours every pixel in a bitmap is capable of displaying. When an image is scanned to a depth of one bit, each pixel can have only two states: black or white, and is described as a bi-level bitmap. If more than one bit is used to describe each pixel, a range of tones can be placed between black and white. A two bit depth adds two grey tones to the black and white making four levels in total, and eight bit data comprises 256 different levels of tone from black to white, which is sufficient to render tonal transitions smoothly, without the appearance of contours. These brightness levels are also referred to as VOT per channel (varieties of tone).

Greyscale and colour modes normally use eight bit data for each channel, totalling 24-bit depth for RGB colour space, and 32-bits for CMYK. Most software offers only limited support at depths greater than eight bits per channel. The combination of 256 brightness levels per channel allows 16 777 216 colours to be described.
Some scanners have the ability to record 12 or 16 bits per channel, which allows a much wider range of tones or colours to be captured. However, although scanner manufacturers will promote the virtues of a high bit-depth, if a scanner cannot read detail in the shadows, no amount of bit-depth will help. It is also of limited value when output to paper is required, since output devices do

15 A "bit" is an individual element of a binary coded item.

not support more than 256 VOT per channel, and are limited by the colour gamut of available inks and pigments.

For output to a film recorder however, which images onto photographic film, a bit depth of 12 per RGB channel is advantageous, if supported by the device. A higher bit depth can also be of value if tonal and/or colour ranges are to be dramatically adjusted (stretched or compressed), which results in the loss of data. If one adjusts the midpoint of a 256 level black and white image, there will no longer be 128 tonal levels above and below that point. The tones on one side will be compressed, and on the other side they will be stretched. This means that the surplus tones will be discarded, resulting in fewer real tonal values. Hence adjustments can be made at a higher bit depth and then sampled down to 8-bit.

5.3.4 Colour Models

Photographic colour, i.e. that portion of the electromagnetic spectrum that can be captured and represented on film, is limited by the physical and chemical characteristics of the materials used in the production of the light sensitive emulsion. The objective of the manufacturer is to reproduce colours as similarly as the human eye perceives them. In order to accurately map colours to film and print them, is to be reliant on the specifications (and limitations) inherent to the materials used. Any intervention or digression from the prescribed process will effect colour accuracy negatively. A point for point colour match is not presently possible, either photochemically or mechanically.

In order to work with images digitally, it is first necessary to view them, so a device with its own colour gamut is introduced to the chain of production: This is most commonly a cathode ray tube monitor. Using this method of image generation requires transmitted light as red, green and blue wavelengths: i.e. additive primary colour. This means that by displaying the maximum quantity of each primary colour a white will be produced, with a zero emission producing a black. All other colours can be displayed by adding these primaries in different proportions and intensities.

Subtractive colour functions in the opposite manner. All materials either transmit, reflect or absorb certain wavelengths, leaving the remaining mixture to be detected by our eyes. All light passing through, or reflecting off a material, is termed transmitted light since it will be less intense than the source. Therefore the cyan, magenta and yellow dyes or pigments used in photographic materials and offset litho printing inks, subtract varying quantities of red, green and blue from white light to produce a limited gamut of spectral colours.

Although the "RGB" colour model is central to computer graphics for the manipulation of colour, it offers little at the interactive interface, where the Hue, Saturation and Value model is more useful in visualising relationships of colour. (HSV) Whereas the RGB colour space can be described as a unit cube, where colour can be specified in terms of its primary components consisting of a 3-D set of Cartesian axes, the HSV attributes (see figure 1) can be visualised as a

sphere, Hue is represented by rotating around the central vertical axis, saturation as the distance from the central axis, and value as the distance along the central axis, with black at the bottom and white at the top. Since computer graphics hardware utilises the RGB colour model, any HSV description is converted into an RGB form with the use of algorithms.

It is clear that some form of colour management is essential, both in order to reproduce colour accurately if so desired, and to display the colour as closely as possible to how it will output. Calibration hardware and software, trying to remedy potential inaccuracies in the monitor/output relationship, made the fatal error of relying on the appearance of a monitor to colour correct. This Holy Grail has eluded many software colour specialists, and it would be true to say there is no simple software solution that can guarantee an accurate colour match from monitor to output.

As the colour gamut of a monitor display exceeds that of any printed output, it is advisable to choose a colour space that is appropriate to the mode in which the image will finally be viewed. Whereas most printing methods and devices use cyan, magenta, yellow and black ink or pigment, all display devices transmit red, green and blue. Since the expansion of web sites on the Internet and the subsequent use of photographic material that is viewed only on a monitor, RGB colour space has supplied a colour palette suited to standardising web colour display.

5.3.5 Printed Output Options

It is not possible to discuss traditional and digital photography without printed output becoming an issue. The lithographic industry is huge, and servicing the publishing, design and advertising sectors among others. The material, which is made up of single or multiple colour separations for offset printing, is well suited to long print runs. The resulting print characteristics (high fidelity, with a linear dot structure) and production costs of this method do not lend themselves to the digital artist or short run display images.

There are a range of non lithographic alternative output devices which make use of inks, dyes or pigments, which can be applied to either common papers or specialist receptor materials. The majority of the inks and dyes available have a low permanence threshold, and along with paper receptor types of limited archival quality (high acid content), results in an unacceptably short lifespan for material that is being produced for permanent display, or marketed for collection purposes.

There are constantly new inks and dyes being developed with enhanced colour stability and enlarged colour gamut, largely driven by the needs of fine artists, galleries and museums. Contemporary printing devices are also accommodating a need for the use of a divergent range of media stock, which is

very significant to digital artists who work with natural media software[16] or prefer traditional art papers for their work.

For the photographer there is an ongoing dilemma; once images are digitised, there are limited output options. Most do not include traditional photographic materials. Of those that do, there are two conversion processes that result in the creation of a black and white negative. The one process is known as Light Valve Technology and involves a digital file being imaged onto a sheet of film. The cost is high, and the quality does not allow for much enlargement. The other also produces a negative, but makes use of laser technology to produce a negative to final size onto line film, and is discussed at length in a later section.

Colour photochemical images can be produced by machines that use laser or LED technology, both to a very high standard and a reasonable size. However, the media and archival qualities of wet process colour photographic printing materials that are used, are limited when compared to those of silver-based monochrome material. The latter, if archivally processed and toned, can have a life in excess of a hundred years, depending on the storage conditions, and is widely accepted by curators and galleries.

Mechanical and photo-mechanical output devices are part of a fast-growing industry, particularly inkjet "giclee"[17] technology (see figure 3). With the advantage of printing directly from a digital file, a huge range of sizes with 'one-off' capability. Certain inks used in combination with acid free coated cotton papers can result in colour stability exceeding seventy-five years. A quadtone giclee type print (see image 5), which replaces the cyan, magenta and yellow inks with three tones of grey, manages to produce a print of extremely high fidelity, particularly in the pale 'quarter' tones, where black ink dots would start separating.

Other than the issue of image stability, most output options offer low aesthetic appeal, or a high cost factor. It is not unreasonable to assume that amongst fine artists, the decision to utilise digital data techniques (or not) is more highly influenced by the output and viewing options available to that medium, than by any new features the medium itself may offer. Amongst traditional photographers, the poor output options are an understandable objection to working digitally. It would therefore be desirable to return to the darkroom to produce black and white silver (or alternative-process) prints, in any variety of dimensions, from a digital file.

16 Software which simulates the relief and absorption characteristics of paints and inks.

17 French term meaning "to spray".

6. BRIDGING THE GAP

No matter how delicate the resolution and graduation of electronic printers, the aesthetic qualities of silver, platinum and other emulsion types are unique, widely admired, and in addition the archival qualities are proven. It would therefore be extremely significant to be able to translate a digital image from bits to silver, or any other light-sensitive emulsion type, accurately and repeatedly. This opportunity would complete the circle and provide photographers with the computing ability to produce traditional black and white photographic prints that can hang on a wall. To achieve this, there are two hardware devices than can be utilised to produce a negative. The first is an imagesetter, and is used to output images at high resolution onto photographic paper, film or plate material, usually using a dot or stochastic screen (see image 1 and 2), which is part of the preparation process to transfer ink to paper on a printing press.

Using continuous tone black and white image data, an imagesetter can image two types of negatives for printing. First it is necessary to sample-up (enlarge) and sharpen the image by applying an 'unsharp masking', or edge detection filter (see figure 4). This is a function of amplifying pixel brightness differences according to various control factors, which increase the apparent sharpness of an image (increasing he tonal difference between brightness values). This is significant in the production of large digital negatives, allowing the image to be worked with at a lower resolution and then sampled up and re-sharpened.

In order to ensure a complete range of tones, and a representative tonal transfer onto the final negative, the black and white points (points of maximum and minimum density) need to be accurately plotted in order to fall within the contrast range of the printing paper. A black point of 95% is then set in areas where the tone should be just perceptibly lighter than maximum black, and wherever the tone should be perceptibly darker than the paper-base white of the paper type, a 5% value is set. In addition to these tonal endpoints, a predetermined curve (a range of adjustable plotted points representing the tonal spectrum from black to white) is applied that lightens the deep and mid-tones in order to adjust the tonal range so that it resembles that of the receptor paper (see figure 5). To more accurately plot the curve, it is helpful to make use of a step-wedge, with values ranging from 0% to 100% in 10% increments, with a 5% and 95% step for setting the crucial endpoints (see figure 6).

Now that the image has been adjusted, the fist method of output requires the data to be converted into a bi-level form (1-bit depth). When this conversion takes place a noise dithering filter is applied, (dithering involves the addition of small random intensities to an image) to mask the aliasing (stepped) artefacts created by edges of contrasting tones. The grey tones are converted to different quantities of black and white bits, ideally at a resolution of 1200pbi[18] or higher (determined by the imagesetter resolution). In order to make accurate correct

18 Bits per inch

the initial curve, a print of the stepwedge is made using the minimum exposure time required to produce a maximum black in the 0% wedge. Each step of the wedge is then measured using a reflective densitometer, or evaluated by eye, and the curve adjusted to reflect the correct value for each tonal step.

An alternative method is to output the negative using a line screen ruling of four hundred lpi[19] or higher. This produces a high-resolution image, but is very demanding on the imagesetter, and is only successful when the device is finely tuned. Other than the advantage of customising a curve that corresponds to the particular film and chemistry preference of the photographer, a variety of curves can be plotted to compensate for the different paper types and alternative processes.

The other device is an inkjet printer (see image 3 and 4), which prints an inverted image onto paper or rear projection material. A finer resolution is possible by using all four (or six) colour heads, which translates into more dots being printed. To restrict the density of ink, a colour is chose, to which the printing paper is not sensitive. The negative image needs to be printed left to right, since it is placed ink side down when contact printed in the darkroom. Strictly speaking, the imagesetter negatives should not be affected by the polycontrast printing filters, since they alter only grey tonal values. A negative of this kind consists of a bi-level bitmap image, black and white dots only, with no greys. However, due to a certain amount of dispersion from the edges of the dots, grey tones are imaged onto the paper.

For those photographers making use of paper with emulsions other than silver, which are far less sensitive and therefore make enlargement unattractive due to excessively long exposure times, this contact method of image transfer is a unique solution. A negative produced by an imagesetter is sized to the final print dimensions, and printed emulsion-to-emulsion in a darkroom with a light source of an appropriate intensity for the paper type, including the sun if necessary.

Using these methods, image enlargement takes place digitally rather than optically. An optical method of enlargement includes emulsion characteristics inherent in the film type and processing chemistry (grain). Any optical aberrations will also transplant into the print. If undesirable, they can be reduced by making a scan from a negative or a positive print at an appropriate resolution, and then manipulated to remove, reduce or enhance any emulsion characteristics with the use of image-editing software filters.

In essence, digital imaging and manipulation is nothing more than altering the brightness values of pixels. With the use of filters and tonal adjustment tools, computers are therefore well suited to preparing output material for photo-lithography, photo-silkscreen and photo-etching.

19 lines per inch

"Photographers are inspired by the capabilities of electronic imaging, but disappointed at the final output options available to them. They want real photographic prints that have the historic references to traditional photography and the image permanence that electronically produced prints still lack."[20]

7. IMPLICATIONS OF THE ADVANCES IN DIGITAL TECHNOLOGY WITH REGARD TO THE MEDIUM OF PHOTOGRAPHY

7.1 REPRODUCTION

An image recorded as a negative on film would first require the tonal values to be reversed onto paper or film to render it viewable as a positive. Similarly, a photographic image recorded on film as a positive can be exposed onto printing paper or film, creating a second positive image for viewing. These positive photo-chemical images are capable of being duplicated by identical, uninterrupted exposures to film material.

However, it is common darkroom printing practice to include selective exposure and other interventions, both physical and chemical, in order to reflect the photographer's intent. This means that darkroom printing can be considered an integral part of the creative process: a further opportunity to fully express and complete a creative process. Each of these images would therefore be unique. Multiple images produced in this manner would be considered reproductions, rather than duplicates.

One of the implications of a black and white digitally produced negative that any manipulation or alteration (reflecting the photographer's preference/interpretation) takes place prior to the darkroom printing process. Any subjective intervention ceases before the output of the final negative, allowing the final prints to be identically exposed and processed. Providing the printing procedure adhered to is correct, duplicates can be produced in any quantity by a second party with the image authenticity and integrity intact.

Over and above the physical duplication of silver prints, the digital files, which are stored on recording media that is designed to be re-used, can also be endlessly reproduced without any degradation or quality loss. Digital bits remain intact no matter how many times they are copied, whereas analogue data suffers degradation each time a successive duplicate is made. Save for the creation date, which can be altered, it is impossible to distinguish an original digital file from a copy. As Mitchell has noted,

20 Burkholder (1995) p.7

"We must abandon the traditional conception of an art world populated by stable, enduring, finished works and replace it with one that recognises continual mutation and proliferation of variants."[21]

7.2 COPYRIGHT

The copyright issues are complex and far too expansive to be discussed here in detail. However, due to the ease for duplicity of digital data, it is even more crucial that an attempt is made to redefine the parameters for a post-photographic world.

For example, the provisions of the Berne Convention call for a work to be "fixed in some tangible medium of expression" in order to qualify for copyright protection. The present inadequacies of the existing terms and definitions sometimes makes the protection of intellectual property difficult to apply to the varied characteristics of digital data.

Some of the broader issues are: defining the form of an original digital image; whether the data is required to be in a readable form (a digital image file resides in a storage device as digitally encoded data); the ease of duplication (and thereby the creation of variants) and the transportability of images via the global communications network.

Since the law regarding intellectual property varies considerably from country to country, and the quantity of electronically viewed images is continuing to grow, an effective method of monitoring infringements should be a high priority for all photographers.

8. A CONTEXT FOR "PHOTOGRAPHIC TRUTH"

Perhaps the most contentious issue that has arisen as a result of the growing use of the digital medium, is the issue of photographic truth. With traditional photography, al though not insulated from deception and dishonesty, the techniques used to alter images were generally crude and thus not always that persuasive. Of course what has changed now, with the advent of the digital medium, and all the image editing tools that come with it, is that the degree of deception can be complete.

A range of assumptions, regarding the issue of truth, have become inherent to the medium of photography. It is the intention, and final application of a photograph, which provides the context in which a 'truthfulness' will be accepted, or not. In trying to understand the idea of truth and credibility in photography, it is useful to distinguish between some of the applications of the medium. For example, the commercial recording of personal photographic portraits for family records, have often been embellished by the photographer with the use of props and lighting, or the retoucher, by removing undesirable spots and blemishes.

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21 Mitchell, op cit, p.51.

It was, and still is, common for subjects to be portrayed in a socially elevated manner, momentarily achieving their social aspirations and favourably altering their appearance. One could almost consider this practice a 'projected truth'. If the images were held to be an unfaithful record of the subjects portrayed, however stylised or whimsical they may be, their value would be diminished. It is the photograph as record in this case, and the perceived objectivity that accompanies it, that has meaning and value. Barthes refers to 'the being thereness'[22] of photographs, a perception that reinforces the notion of the 'objectivity' of the lens. Despite these or any other interpretative styles that influenced the images, what we could call the 'situational authenticity' of the scene remains unchallenged.

Particularly in the field of journalism, or any other professional photographic activity whose interests are to be trusted, the issue of truth is further complicated by the advent of digital imaging. The moral issues are certainly not new (photography has been used as a tool of deceit ever since its invention), but because of the ease of alteration and the continued belief in the authenticity of the photograph as a record, misrepresentation and duplicity are easily achieved. The authenticity previously considered implicit in the photographic medium has been called into question.

Continued trust in the veracity of the photograph is most understandable, since photography has played such a pervasive role in our own lives, we see for ourselves that the captured data corresponds with the version of reality that we see with our eyes. This view is summed up succinctly in this quote by Newhall:

> "A photograph is fossilised light, and its aura of superior evidential efficacy has frequently been ascribed to the special bond between fugitive reality and permanent image that is formed at the instant of exposure. It is a direct physical imprint, like a fingerprint left at the scene of a crime or lipstick traces on your collar. The correspondence. with reality is thus causally established"[23]

What digital imaging has changed, is the seamless manipulation that makes it possible for any interference to be imperceptible.

> "However, we have been shown again and again, that this is pure illusion. Subjects can be misrepresented, distorted, faked. We now know it and even delight in it occasionally, but the knowledge still cannot shake our implicit faith in the truth of the photographic record."[24]

22 Barthes in Lister, op cit

23 Newhall (1982) P.94

24 Mitchell, op cit, p.29.

For the advertising industry, the photograph has always served a commercial interest: that of providing visual support or clarification of an idea or concept. The underlying success of communicating this idea rests on both the visual interpretation as well as the power to engage the consumer. Advertisements that do not attract attention cannot fulfil their objective. Advertisers have not wasted the opportunity of exploiting the 'credibility' of the photograph, but they are in no way beholden by any moral obligation to authenticity, unless it in someway dilutes the power of the message or no longer serves their own interests. Pictorially, the requirements of the advertising industry are largely illustrative. Digital imaging is thus particularly suited to this application.

In the context of advertising, the photograph is used to represent a particular version of reality, a special lifestyle that one is encouraged to strive towards. In a way, one can almost talk about an 'advertising world' (in which everything is 'more real than real'). But to what – if any - degree can we assume that the average viewer uncritically accepts the advertising image as 'true'. Or should we instead imagine a kind of negotiated interpretative structure or framework within which the producers of advertising images and the audience interact. Perhaps the audience implicitly gives – and is expected to – give the ad-creators a degree of latitude to mis/respresent reality in the interest of dramatic effect, illusion or humour.

As another example, in scientific applications, an objective intention will influence the credibility of an image, a value that science has expropriated in the recording of events on earth (e.g. aerial mapping of the earth's surface) or the enhancement of images as records from deep space, whether they are analogue or digital.

The notion of automaticity and the absence of human intervention has probably worked most favourably with regard to scientific record, and is reflected in this excerpt from Andre Bazin:

> "For the first time, between the originating object and its reproduction, there intervenes only the instrumentality of a non-living agent. For the first time an image of the world is formed automatically, without the creative intervention of man."[25]

Clearly, throughout the spectrum of human intervention discussed in the image-making process there is a great range of possible influences, and it must be argued that the exclusion of human bias is not as limited as Bazin suggests. Moreover, these interventions can now be digitally applied in a manner that renders them undetectable as alterations, which makes the assumption that a photographic image is a reflection of any real scene or event, even more problematic.

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25 Mitchell, op cit, p29

8. IN CONCLUSION

> "... while there are differences to attend to, there is no clean break, except in the trivial 'mouse clicking' sense and the assertive myths of marketing hype, between the older analogue photographic media and the digital."[26]

Whilst there is no denying the dramatic impact that advances in digital technologies have had on the production and dissemination of images, particularly photographic, one must guard against a tendency to represent these technological advances as being discontinuous with the photographic tradition as a whole. It is perhaps more accurate to see and acknowledge these advances as being additional tools available to the photographer as an image-maker.

The space that has been occupied by traditional photography has, since the late 1980's, rapidly dissolved and been absorbed by a much larger expanse, one that does not recognise the boundaries of traditional photography. The causal perceptions of "real world" image making, however inaccurate in the past, are now rendered totally untrustworthy.

The distinction between the "truthful" record and the fanciful invention has become increasingly difficult to distinguish, as the crossover between mediums continues with the growth of digital imaging.

Traditional photography can be and still is, used to reflect some kind of 'object reality' as it did in the past. The fact that alteration can be seamlessly executed only places more responsibility on photographers to apply their moral judgement. For photographers, the digital medium offers access to additional creative options, without forfeiting any of the characteristics that pertain to traditional photography. In addition, there is the opportunity to work with digital imagery and all it encompasses, and still continue to produce images with the enduring attributes that photo-chemical darkroom prints embody.

Rather than diluting the methods of traditional image making, these technology driven explorations have inspired new styles and techniques. The output procedures discussed – namely digital negatives and quadtone giclee prints, illustrate how technologies can be expropriated and embraced to realise the image maker's creative vision.

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26 Mitchell op cit p 85

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CIE L*a*b* Model

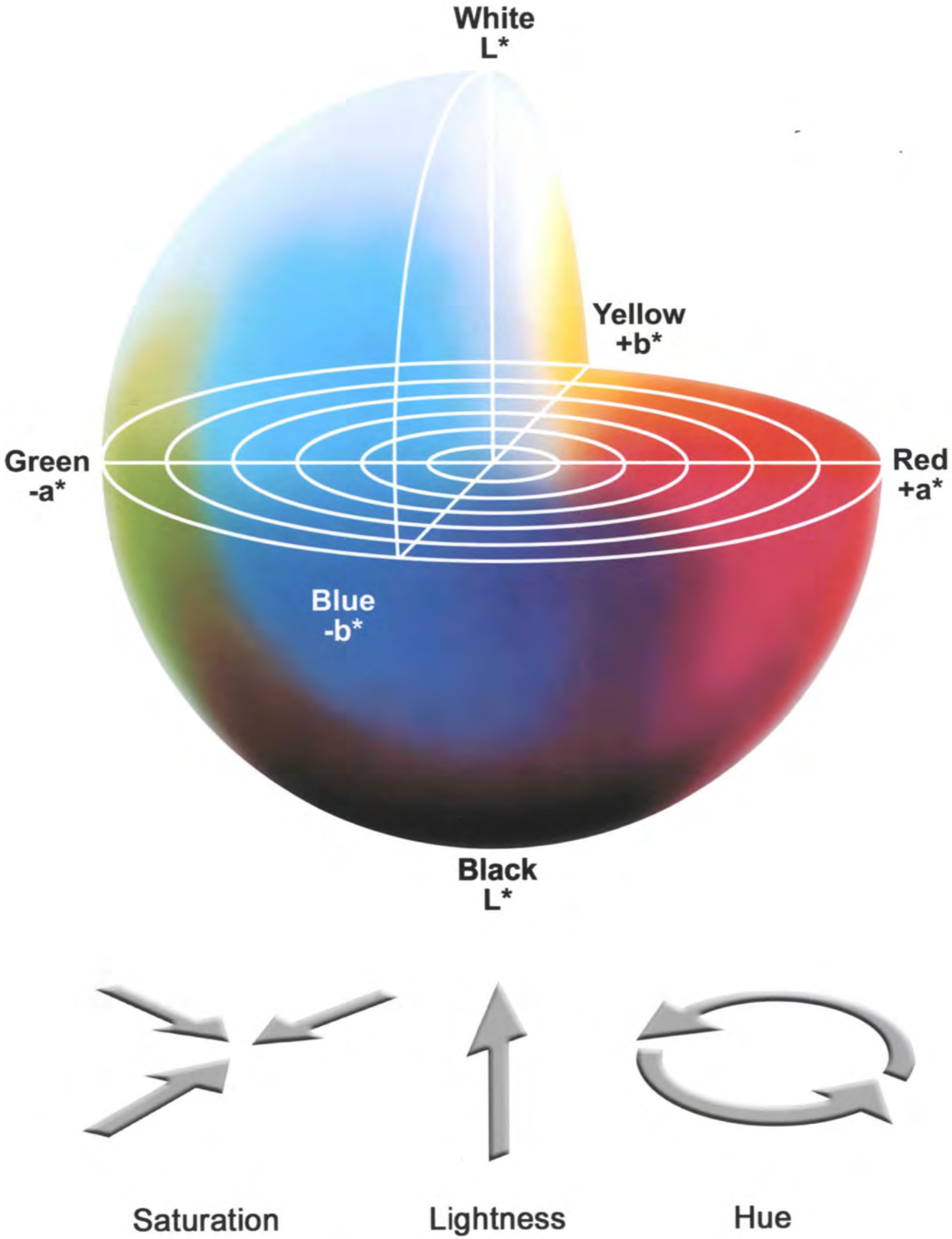

Figure 1

CIE Yxy Model

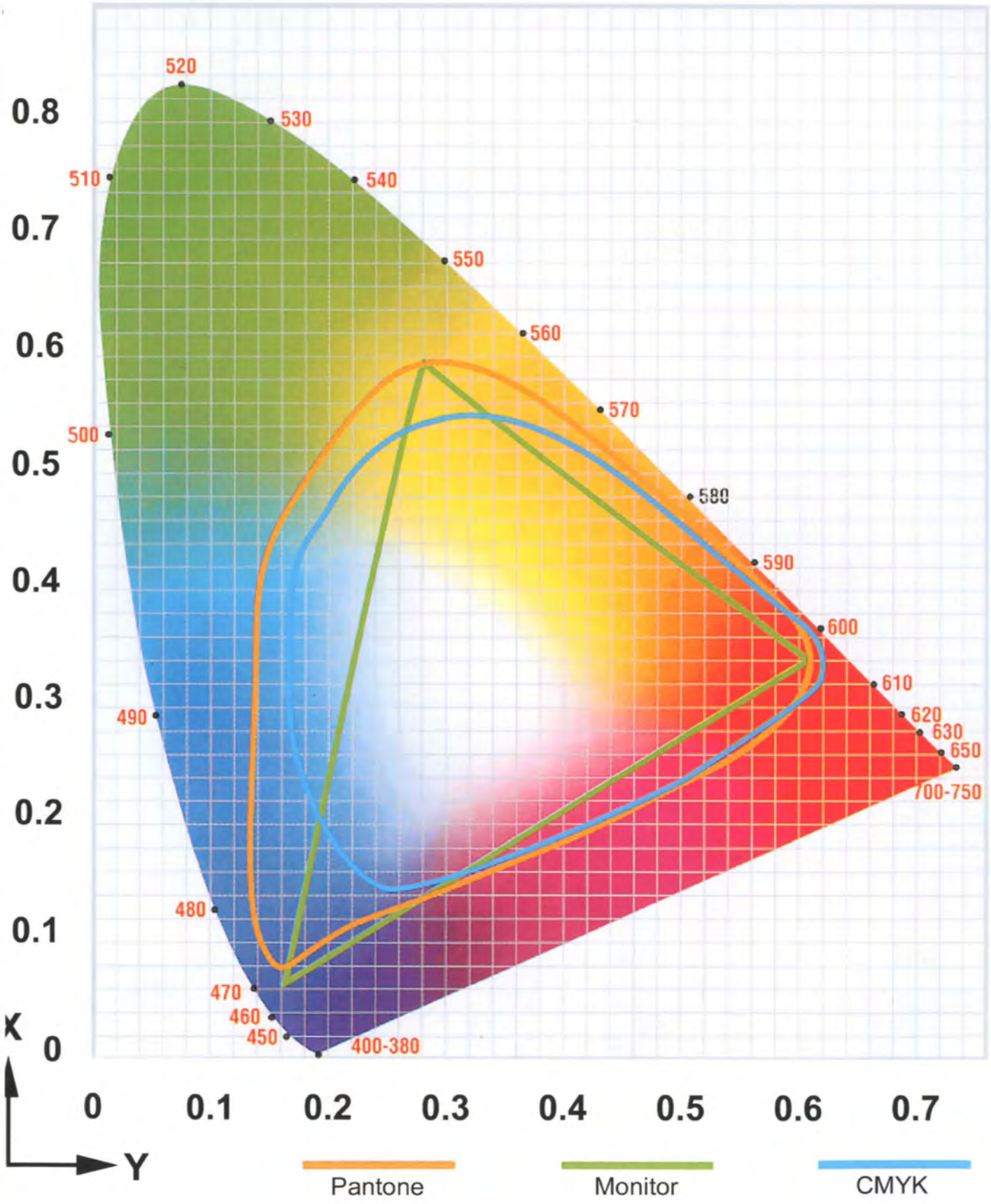

Figure 2

Quadtone separations and inks

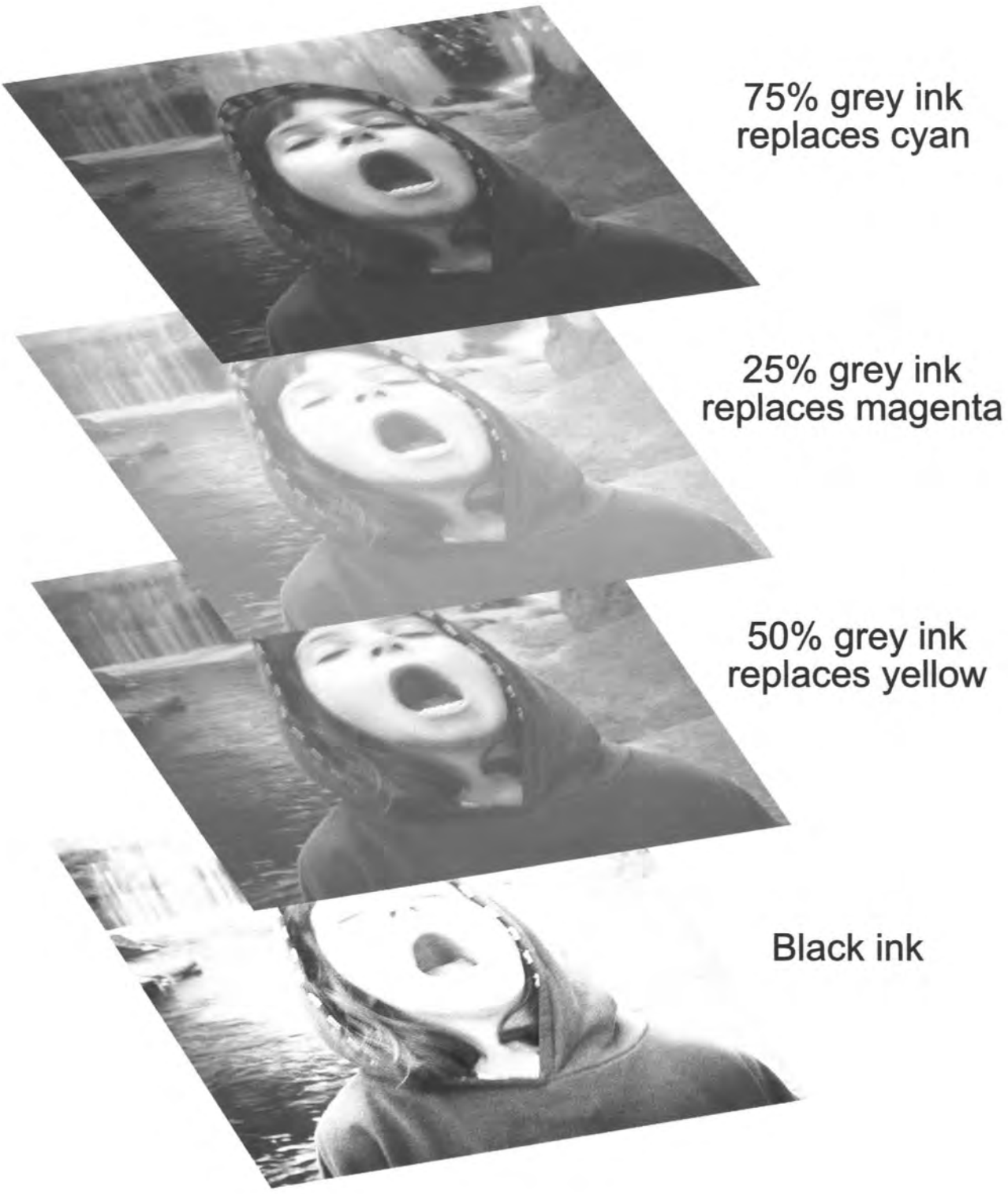

Figure 3

Unsharp masking (USM)

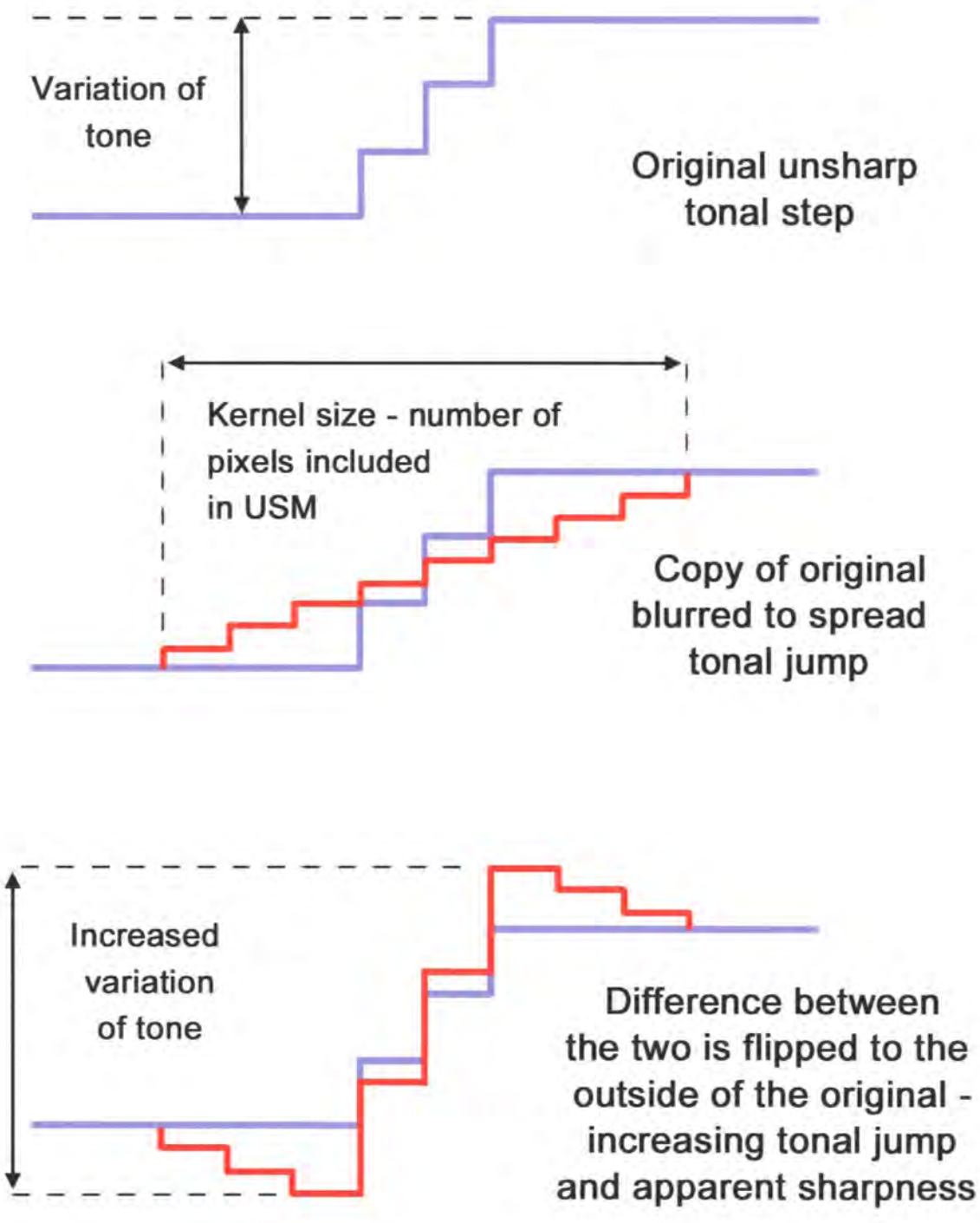

Figure 4

CURVE FOR SILVER

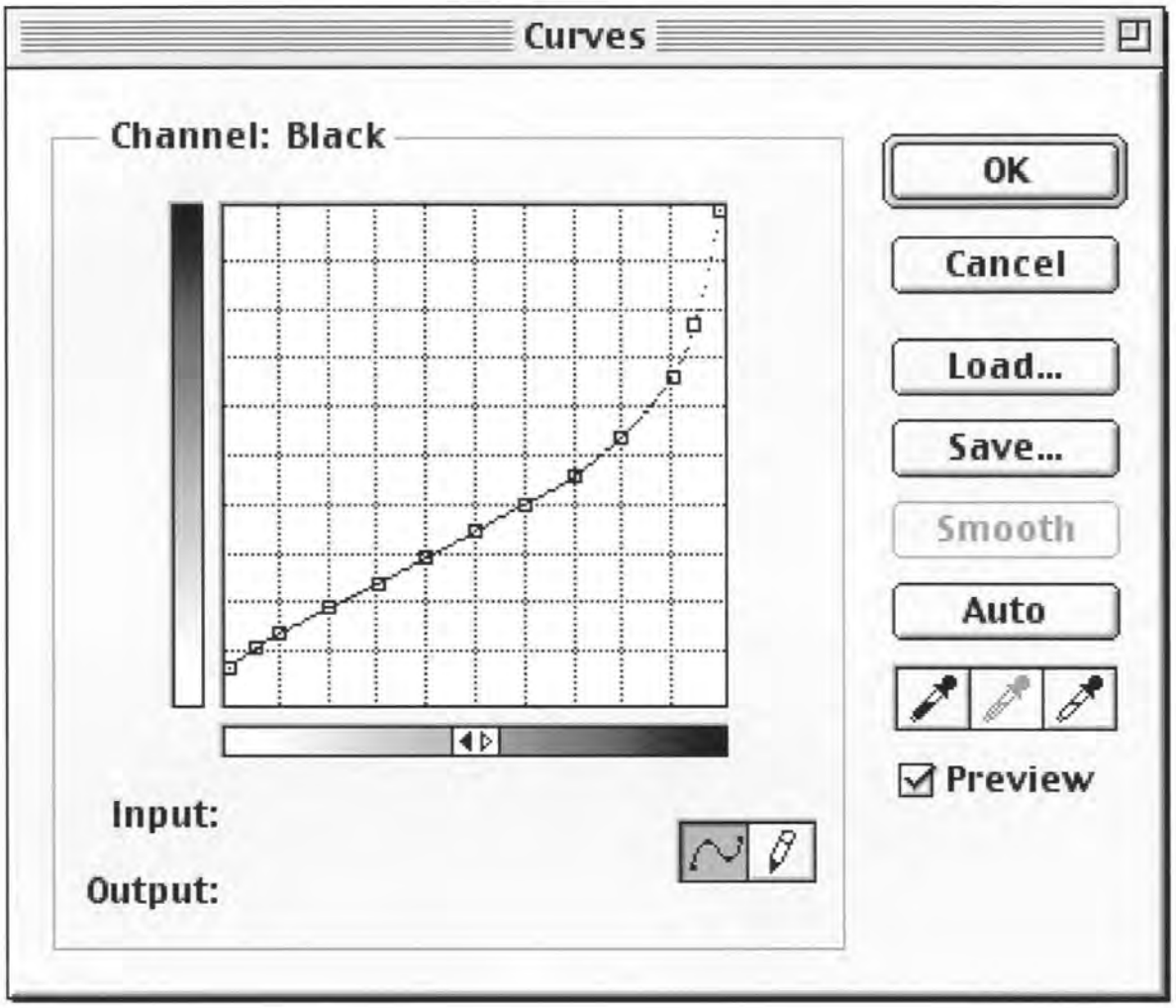

Figure 5

STEPWEDGE

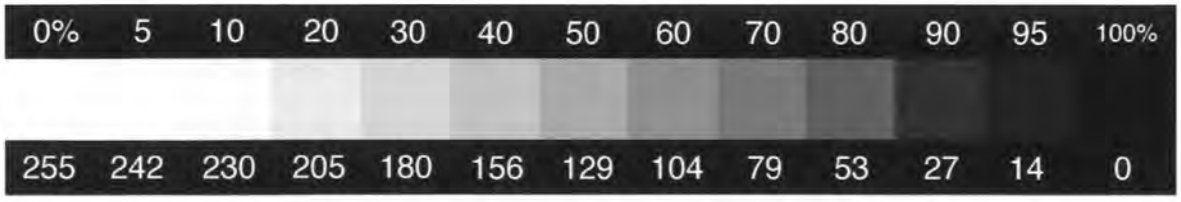

Figure 6

Stochastic screen - 30% tint

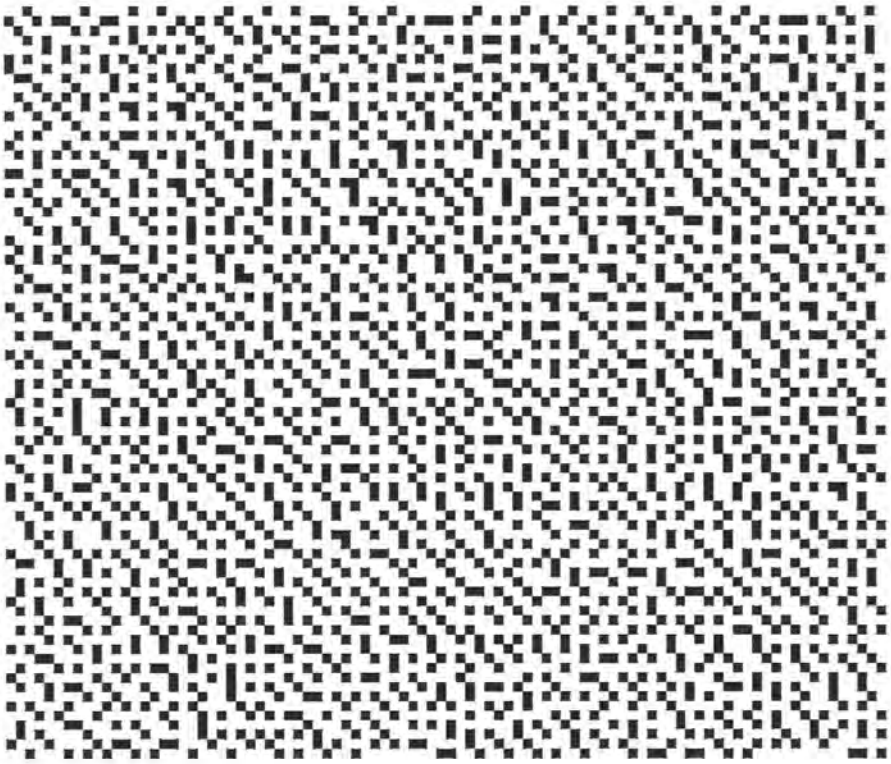

Figure 7

Halftone screen - 30% tint

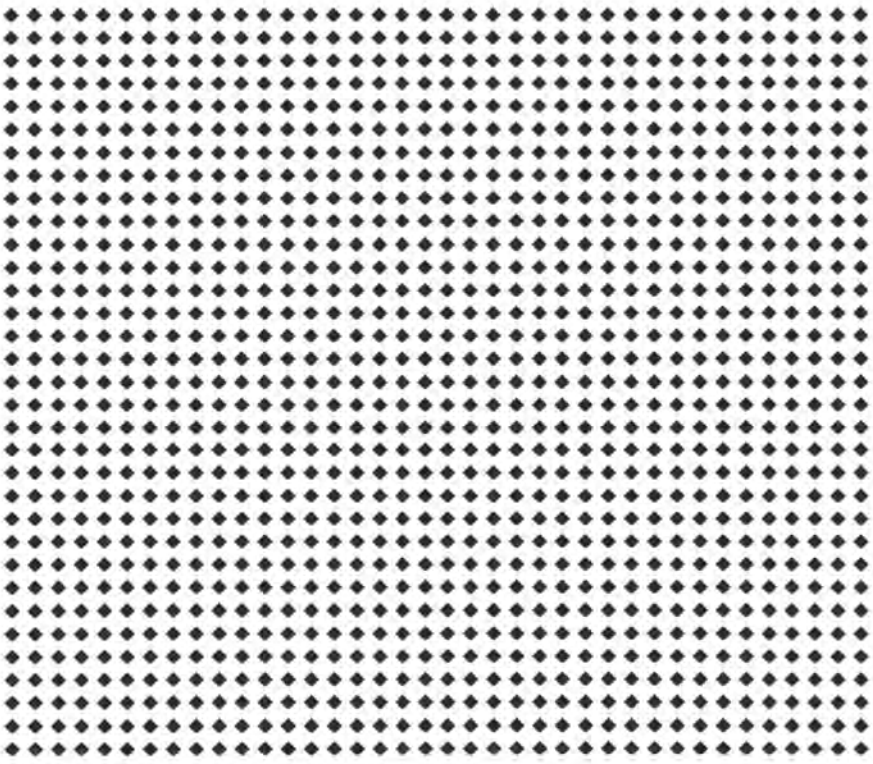

Figure 8

Digital Negative: Image-setter

0%	5	10	20	30	40	50	60	70	80	90	95	100%
255	242	230	205	180	156	129	104	79	53	27	14	0

mage 1

Digital Positive: Image-setter

0%	5	10	20	30	40	50	60	70	80	90	95	100%
255	242	230	205	180	156	129	104	79	53	27	14	0

age 2

Digital Negative: Giclee

0%	5	10	20	30	40	50	60	70	80	90	95	100%
255	242	230	205	180	156	129	104	79	53	27	14	0

Digital Positive: Quadtone Giclee

0%	5	10	20	30	40	50	60	70	80	90	95	100%
255	242	230	205	180	156	129	104	79	53	27	14	0

Image 5