

How to use the Canon *CanoScan LiDE500F* scanner

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Introduction

These notes have been prepared for a SeniorNet (Wellington) Workshop given by Don Paterson in May 2010 and using SeniorNet's Canon *Cano Scan LiDE500F* flatbed scanner.

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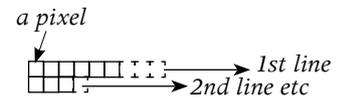
A: General notes on scanners

A1. What is a scanner?

The scanner is an optical device that produces a digital copy of the page (the 'Artwork') that is on the glass platen of the scanner. It does this by taking a sequence of tiny 'snapshots' along each line and repeating this, line-by-line, down the page. The area of each 'snapshot' is called a 'pixel' (ie a 'picture element') and the colour of each pixel is sensed using reflected light and stored as a particular number in the file of the image. (A pixel can have only one colour or shade, and the scanner will automatically calculate the average colour if there happens to be more than one colour within the 'snapshot' area).

The picture file contains lots (millions!) of these sequential numbers and these are converted back to the shades, pixel by pixel, line by line, when the digital file is printed out or displayed on a monitor screen.

Some scanners have a film adaptor that allows transparent negatives to be scanned, using light that passes through, rather than being reflected from, the film.



A2. Scanning modes:

Before we do a scan, we have to decide what type (or *mode*) of scan we need to do. There are three main choices:

1. **Black & White mode** (or 'Line Art'): This is the least demanding mode as each pixel is to be either black or white. This is referred to as a '1-bit' system where the bit is either '1' or '0'. It is used for images that have only black and white elements (eg black text, ink drawings etc).
2. **Grey Scale mode**: Used for scanning where there is a range of grey shades to capture (eg so-called 'B&W photos'). In this mode, each pixel can have one of 256 possible values, ranging from '0' (black) through the '128' midrange value (50% grey) and ending up at the '255' value (white). In digital terms, each of these 256 values can be stored as an 8 bit number, such as '01001101' or '10001011' etc. This 8 bit number is also called a 'Byte'.
3. **Colour mode**: Used for scans where we want the colour of the original to be preserved. During a colour mode scan, the reflected light is sorted into the three primary colours, (red, green and blue), and each of these primaries can have one of 256 shades. The total number of colours possible is therefore 256 x 256 x 256 or over 16 million colour possibilities.

The colour mode is sometimes called 'RGB colour', or '8 bits/channel' or '24 bit (true colour)'. Some scanners may



A good candidate for using the B&W mode.



Use the Grey Scale mode to capture these grey shades.



This coloured picture will be revealed with a colour printer.

use a larger bit number for colour scans, eg 30-bit or 32-bit. These provide a greater number of colours that help maintain image quality during later editing, but many editing programmes cannot handle these extra colours.

There are large differences in the file sizes of these modes. For the same sized image (same number of pixels), *grayscale* files (8-bit) are eight times bigger than *black and white* files (1-bit) and *colour* files (24-bit) are twenty four times the size of *black and white* files.

A3. Scanner Resolution ¹:

The resolution of the scanner is expressed as the number of ‘snapshots’ or pixels or dots per inch (dpi): more dots per inch gives a finer detail of the picture. An analogy is the detail in tiling a kitchen floor: if we have small 1” x 1” tiles we can create a more detailed floor pattern than one using 4” x 4” tiles. The smaller 1” x 1” tiles provide a higher *resolution*.

However, the higher the resolution, the more pixels there will be along each line and the larger the image file. With a scanner, we therefore set the scanning resolution (‘100 dpi’, or ‘150 dpi’ etc) to suit the image quality we want to end up with (see later).

The specification for each scanner generally includes two figures such as ‘300 x 600 dpi’, or ‘1200 x 2400 dpi’ etc. The smaller number is the important one: it is the highest *optical* resolution (dpi) that can be used to pick up the detail in the scan². The larger number is the finest step that the scanning motor makes as it travels down the page.

Choosing a scan resolution and a scan mode are important decisions that you have to make and to do this **you need to know what you are going to with the scanned image**. There are three broad scenarios, each requiring different settings of the scanner:

1. We will display the image on a monitor screen, or send it, via email, to someone else to display on their monitor *or*
2. We will print out the image on paper *or*
3. We will make a high quality image for archive purposes.

These three scenarios have different requirements and will be discussed in the next sections.

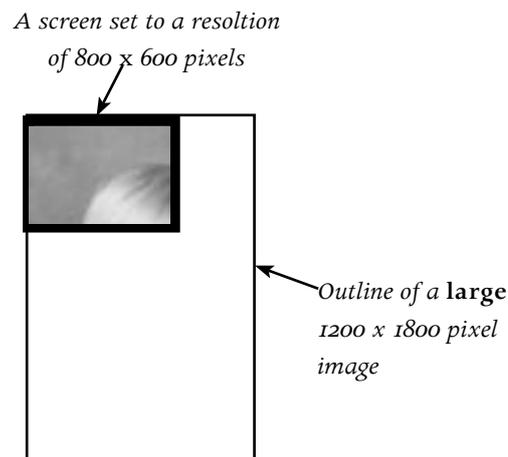
1. Many scanner manufacturers refer to scanners having a resolution of so many ‘dots per inch’ (dpi). Some writers more correctly refer to a scanner having a resolution of so many samples per inch (‘spi’) or pixels per inch (‘ppi’) which are equivalent, as one sample produces one pixel on the screen. However the wayward use of ‘dpi’ will sometimes occur in these notes.
2. If we set the scanner to scan at a resolution greater than its ‘optical’ resolution, it will comply, but the extra pixels are ‘fudged’ and do not add any more detail. This is ‘resampling’. (See later).

A4. Scanning resolution for screen viewing or emailing.

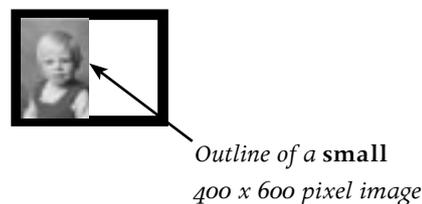
The monitor screen is just an area of pixels that are available to display an image. One pixel on the screen is equivalent to one pixel of the image.

The screen 'resolution' (or size) is measured in pixels, and your screen will be set to one of the standard resolutions, such as 1280 pixels wide x 1024 pixels high. There are several other standard screen resolutions that you can choose from, such as 800 x 600 pixels, or 1024 x 768 pixels. The lower settings produce larger icons on your desktop, (fewer pixels over the screen area, so each pixel is therefore larger). To see or change your screen resolution, right-click on the desktop and select **Properties/Settings**. This will show the screen resolution slider which can be moved to change the screen resolution.

If our scanned image is very large (ie lots of pixels), it will not fit into the monitor screen and we would have to use the scroll bars to view all parts of the image. This is shown below where we have an existing (large) 1200 x 1800 pixel image displayed on a 800 x 600 pixel monitor and it is obvious that only a part of the image can be shown at any one time.



To avoid this we should rescan our image at a lower resolution to create a smaller image that will fit within the 800 x 600 pixel screen area, as shown below.



If the above artwork was a 4" x 6" photo print, the height of the paper original (6") has to provide 600 pixels, so a scan resolution of $600/6 = 100$ pixels/inch (or dpi) will do the job neatly. (The image's width will be 4" x 100 dpi = 400 pixels, which is half of the available screen width).

A general rule for scanning for screen viewing is therefore:

portrait artwork: scanning resolution (dpi) = 600/artwork height (ins)
landscape artwork: scanning resolution (dpi) = 800/artwork width (ins)

1. The latest JPG files are not lossy but most current programmes cannot handle them.

Having a relatively low scan resolution (and consequently fewer pixels) also helps to reduce the image file size, and shorten the download time if the image is used as an email attachment. You should also save the image as a 'JPEG'. Although JPEG files are 'lossy' (some information is permanently lost), the file size is drastically reduced without too much loss of quality¹. The user can decide on various options to get the right balance between 'quality' and file size. JPEG files are therefore a good choice for graphics that are displayed on the monitor or downloaded from email messages.

A5. Scanning resolution for printing out.

There are two ways to approach this: either use a default scanning resolution that will give good printouts with a wide variety of printers, or, use a specific scanning resolution to suit the particular printer that will be used.

1. **Default scanning resolution:** a figure of 300 dpi is often used for scans that will be printed out. This is quite a generous figure that will provide good quality prints using a wide range of ink-jet or laser printers.
2. **Using a specific scanning resolution:** if we know the type of printer we will be using we can specify the scanning resolution more closely. For ink-jet printers the scanning resolution should be one third of the printer's resolution. For example, to print out on a 720 dpi ink-jet printer you would scan the artwork at a resolution of $720/3 = 240$ dpi. For laser printers, scan at a resolution that is twice the laser printer's line frequency². For example, using a 600 dpi laser printer that has a line frequency of 85 lpi (lines per inch) you would scan at a resolution of $2 \times 85 = 170$ dpi. These 'specific' scanning resolutions are quite a bit lower than the above 'default' value of 300 dpi and the image files will be a lot smaller, without any loss of image quality (file size is related to the square of the scan resolution). For example scanning at 170 dpi (rather than 300 dpi) reduces the file size down to $(170/300)^2$ or 32% of what it was.

2. Note: it is not always easy to find out the linescreen figure for a laser printer! Appendix 1 has notes on laser printer linescreens.

The above figures assume that the printed image size will be the same size as the scanned original artwork. If not, you will need to scale the scanning resolution to suit. For example if the print out size is going to be twice the size of the original artwork, you will need to double the scanning resolution to provide the required number of

dots over the larger sized printout.

The TIFF ('Tagged Image File') format is a good choice for saving files that will be used for printing or archive purposes. This format is widely used in the printing industry, and will save all of the image information without any loss (unlike the JPG format).

We can now combine the above into a formula for scanning for printing out:

$$\text{Scan resolution (dpi)} = N \times (\text{printout width/artwork width})$$

where $N = 300$ dpi (Default resolution)

or $N =$ one third printer resolution (*for ink-jet printers*)

or $N =$ twice the line frequency (*for laser printers*)

An aside: the default printout size

Although *you* may know what the final printout size is going to be, your computer doesn't, and it has to assume that the printout size will be the same size as the original Artwork. If this is not what you wish, you will later have to get into the image file and change the default printout size to suit your requirement. This can be done at any time after the scan has been saved, and can be changed as often as you wish without any loss or degradation. You can think of the image pixels being on a rubber membrane which can be stretched to give the physical size you want printed out. (§C.1 has a practical example of this).

A6. Scanning resolution for archiving

Sometimes we may not know how we are going to use a scan later and therefore wish to make a scanned archive copy that has a high fidelity to meet whatever unknown future needs arise.

Generally this means that we need to scan the image at a relatively high resolution (perhaps 600 dpi) to anticipate all possible needs. Either colour or grayscale mode is used, depending on the original. It is usual to save the archive copy as a tiff file.

A note about editing images after scanning:

These notes deal only with obtaining the correct initial scan for your purposes (screen viewing, printing, archive). Image editing programmes such as *GIMP*, *PhotoShop Elements*, *PhotoShop*, etc allow you to modify an existing image later. However some background points may be of interest at this stage:

1. Colour scans can be quickly converted to Grayscale, and Grayscale converted to Black & White. (But not in reverse).
2. The pixel size of an image can be reduced by discarding pixels. (GIMP calls this 'scaling down'). This is equivalent to scanning at a lower resolution originally.
3. The pixel size of an image can be increased by creating extra synthetic or false pixels. (GIMP calls this 'scaling up'). This does not add any additional detail that was in the original, but does help to reduce the 'jaggy' look of images that are to be printed out at large sizes.

B: Using the SeniorNet Canon CanoScan LiDE500F scanner.

B1. A brief description.

This is a flatbed scanner that can scan up to A4 size. It also has an optional attachment for scanning 35mm film strips (but not 35mm slides). The scanner lid hinge is double jointed to allow thick and oversize publications to be scanned. The scanner can also be mounted on one edge in a stand to save bench space.

No external power adaptor is required as power is supplied from the computer via the scanner's USB connection .

The scanner's optical resolution is quite high (2400 × 4800 dpi) and this can be extended up to 19200 dpi by scaling (ie creating extra false pixels). The scanning bit depth is either 8-bit or 16-bit for each colour, and 8-bit or 16-bit (film only) for grayscale.

The scanner driver (*ScanGear CS*) allows the scanner to be used in five different ways:

1. Simple Mode: a limited number of settings can be set up.
2. Advanced Mode: a full range of settings can be set up by a more experienced user.
3. MultiScan mode: allows several items to be scanned at once.
4. CanoScan Toolbox: an on-screen programme that streamlines the scanning process.
5. Scanner buttons: four buttons for carrying out separate tasks (Copy/Scan/PDF/E-Mail)

As is usual, the scanner comes with extra bundled software, including *PhotoStudio* for opening and editing images, and *OmniPage SE* for converting scanned text to editable text (Optical Character Recognition or OCR).

B2. Setting up and positioning items on the scanner.

For this workshop, the arrangement will be:

1. The scanner will be used in its normal position (ie flat on the desk).
2. The film adaptor will not be used. (It is not available at SeniorNet).
3. Scanning will be done using the 'Advanced Mode' option.

Use the USB interface cable to connect the scanner (small square socket on the front) to a USB port on the computer (*Canon Quick Start Guide p8*) and switch on the computer. This will power up the scanner via the USB cable.

Lift the scanners cover to its fully open position and place the item to be scanned (the 'Artwork') face down on the glass, with the item's top corner at the alignment mark. Gently close the cover. Note that the cover will accomodate a book or magazine that is up to 24 mm thick (*Canon Quick Start Guide p9*).

To avoid confusion, these notes use the term 'Artwork' to describe the items placed on the scanner glass.

If the Artwork is larger than A4, (eg a newspaper), the scanner cover can be moved away from the glass by opening the cover by about 60 degrees and then gently pulling it up and away from the hinge a short distance that will then allow you to keep opening the cover until it is flat on the desk away from the glass. You can then place the Artwork to straddle the glass for scanning. If needed, use another light weight (eg a book) to hold the Artwork against the glass. Cover the scanner with a black cloth if external light enters around the scanned item. (*Canon Quick Start Guide p10*).

B3. Good Housekeeping practises with scanners.

The following notes will help you get the best out of your scanning projects:

1. Keep the scanner glass and cover clean and free of dust and fingermarks. Canon recommend using a damp well rung soft cloth to remove dust etc from the platten glass, and both sides of the cover. If required finish off with a dry soft cloth. Do not use any sort of liquids!
2. Do not put any hard objects on the glass: any resulting scratches will permanently degrade your scans.
3. Look after your artwork originals: any dust, fingerprints etc will degrade the scan you will do of them.
4. Glossy (rather than matte) artwork will give you better scans.
5. Line up your artwork accurately against the glass edge before scanning: although later editing will enable you to rotate the image slightly, this process will degrade the image. Therefore get it aligned right to start with and reposition if you need to. Having strips of cardboard alongside the artwork may be useful in some cases. (Note that rotating the image by multiples of 90 degrees does not cause degradation as all you are doing is interchanging rows and columns of pixels).
6. For best results, have the artwork firmly against the glass before you scan. In most cases the weight of the cover will be enough but there may be situations where a little extra weight on the cover (using a book or something similar) is needed to flatten out a piece of stubborn artwork. Any extra weighting should be quite modest however—say no more than 1kg—so that it does not damage the scanner.

B4. Opening ScanGear (Advanced mode).

Working through the Advanced Mode options of ScanGear will give you the greatest flexibility to suit your particular needs, and therefore will be used during the Workshop.

To open *ScanGear*, first open *PhotoStudio* by double clicking its Desktop icon or from its *Start/All Programmes* listing. Next use *File/Acquire* which will start *ScanGearCS*. (Fig B1). Select the *Advanced Mode* tab to bring up the advanced dialogue box (Fig B2).

(This is a standard way of opening a scanner: you first open the imaging programme you want to use (GIMP, PhotoShop, FastStone, PhotoStudio etc) and then use its File/Create or File/Acquire or File/Import or File/Scan board menu to open the scanner window.)

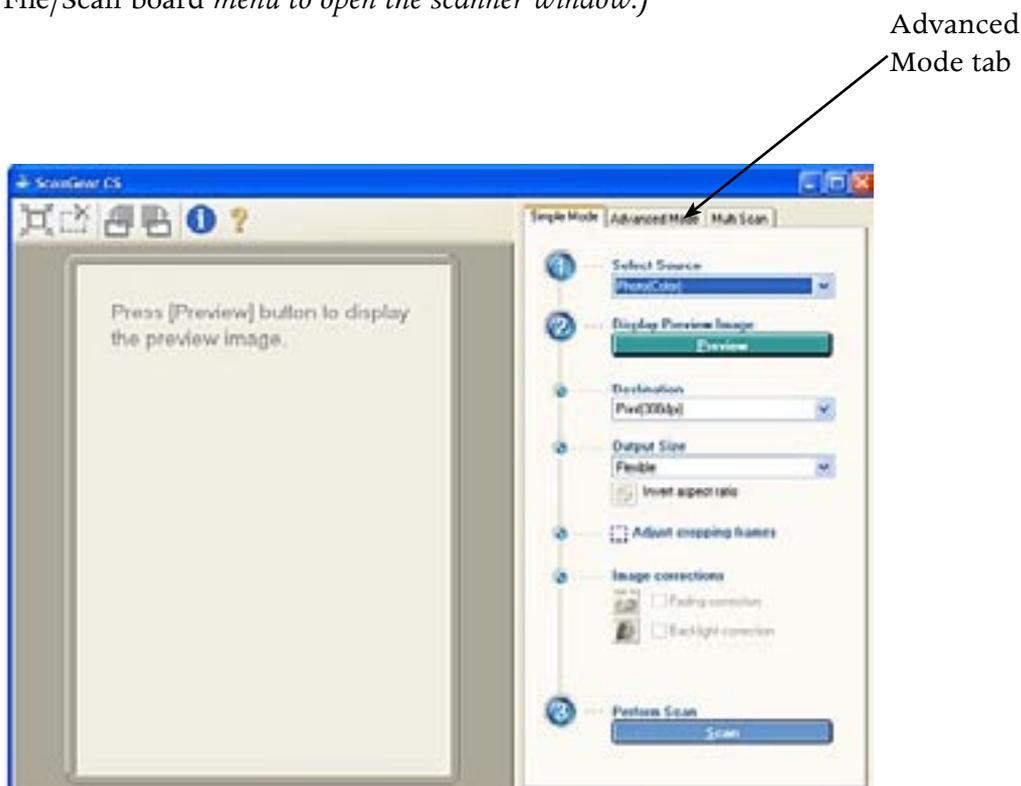


Fig B1: The default 'Simple Mode' window for ScanGear.

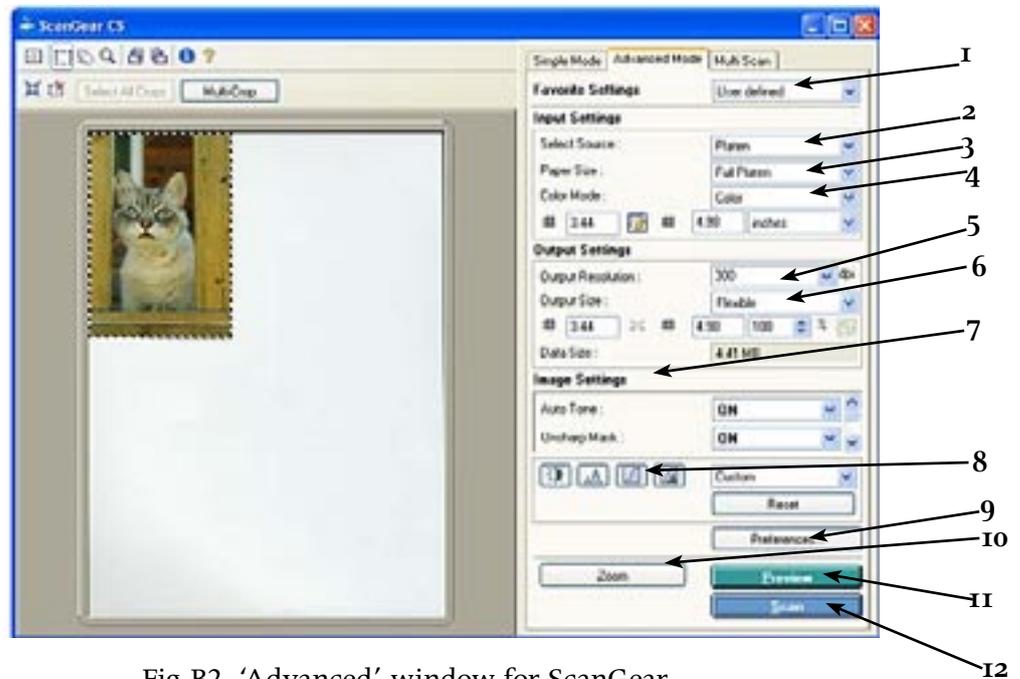


Fig B2. 'Advanced' window for ScanGear.

B5. Setting up the Advanced Scan settings.

The Advanced settings of Fig B2 above shows the choices we need to make, as follows:

1. *'Favourite setting'*: ignore as we are going to take each scan on its own requirements.
2. *'Select Source'*: select 'platen' (the main glass area) as we will not be scanning 35mm film.
3. *'Paper size'*: leave at 'full platen' as it will give a preview scan over the whole glass area and you can reduce this down later after the preview scan.
4. *'Colour Mode'*: six choices:
 - a. *'B&W'*: 1-bit colour (ie pixels to be either black or white). Used for line drawing scans, where there is no colour or grayshades.
 - b. *'Grayscale'*: 8-bit gray, where there are 256 possible shades of gray in the image.
 - c. *'Colour'*: the basic 24-bit colour system for coloured pictures, specifying 8-bits for the Red shades, 8-bits for the Green shades and 8-bits for the Blue shades.
 - d. *'Colour (documents)'*: the mode that caters for a mix of colour pictures and black text.
 - e. *'Colour (48-bit)'*: scanning that has 16-bits for each of the RGB shades, thereby producing more possible colour shades than c. above.
 - f. *'Text enhancement'*: used to scan text that will be later used for OCR purposes.
5. *'Output Resolution'*: sets the number of samples ('dots per inch' or 'dpi') that the scanner does over the scanned item. You can click on one of the preset values (eg '300 dpi') or type in a particular resolution figure (eg '240 dpi').

Note that the highest optical resolution of this scanner is 2400 dpi, which is the highest figure we will use on the Workshop. Any higher resolution (fudged!) can be created later when editing your images (A6 note 3).

6. *'Output size'*: set to the *'Flexible'* option which enables you to drag (with the mouse) or set the area to be scanned in the display boxes underneath.
7. *'Image settings'*: these are subjective correcting techniques that make changes to the image as it is scanned. At this stage check that they are all inoperative, as any changes required will be made later when editing your images.
8. *'Colour Correction'* buttons: these enable you to make changes to brightness, contrast, colour etc during the final scan. Again, leave them all inoperative.
9. *'Preferences'* button: click on this to change/ensure that the following is set up:
 - Preview Tab**: select *'Display Saved preview Image'* and *'Display last Frame on Previewed Image'*.
 - Scan Tab**: have *'Enable 48/16 bit Output'* selected.
 - Colour Setting Tab**: have colour setting at *'None'*, and have *'Always execute the Auto Tone'* switched off.
 - Scanner Tab**: for the purpose of this Workshop, create a Desktop folder called *Scanning Workshop* and select this folder as the default destination.
10. *'Zoom'* button: with an area selected in the preview area, clicking the zoom button forces a rescan at a higher level of magnification. Click on the Undo button to return to the normal state.
11. *'Preview'* button: clicking this creates a preview of the selected area.
12. *'Scan'* button: Enables the scan to be done, which appears in the associated image programme, in our case *PhotoStudio*.

Note that operating the scanner will be quite simple, using the six steps:

- Set the Colour Mode
- Set the Output resolution
- Click the Preview button
- Drag the mouse to select the scan area
- Click the Scan button
- Use the PhotoStudio File/Save menu to save the image

C: Some scanning projects.

The following (hypothetical) scanning tasks may help to reinforce the previous notes and help you in your specific scanning tasks. A common theme is to first decide on what the scan is for.

Cr. Scanning a postage stamp for printing out at a larger size.

The requirement is to scan a small postage stamp (1½" x ¾") in colour, to provide an image that is to be 7" wide printed out across an A4 page. The printer to be used for printing the book is an ink jet printer having a resolution of 720 dpi.

For simplicity we will use the 'default' formula of page 7 to determine the scan resolution. This gives 300 x 7 inch/1.5 inch = 1400 dpi as the scanning resolution.

This is the scanning resolution that we have to set on the scanner, so that the small artwork provides the number of dots needed to print out the 7 inch wide image with the printer.

For this particular scan we would set the Colour Mode to 'Colour', the Output Resolution to 1400 dpi (as determined above) then click the Preview button, drag the mouse over the preview window to select the stamp area and then click Scan. Finally we would save the image as (perhaps) 'Stamp1.tiff'.

Re-opening this image later (here using the *Firestone* programme) and using the File/Print menu we would get a printout (Fig C1a) at the same size as our original scan. This is the default (same size) printout size.



Fig C1a: Default Printout

To change the print size to what we wanted (7 inches wide) we need to open *Firestone's* Resize/Resample dialogue box (Fig C1b), click on the 'Print Size' button, and change the resolution figure from 1400 dpi to 300dpi (Fig C1c). This automatically increases the print width to 7 inches (see Fig C1c) which is what we want (remember the rubber sheet analogy: fewer dots per inch produce a coarser and bigger printout). If we now print out this file it will appear the right size (Fig C1d).

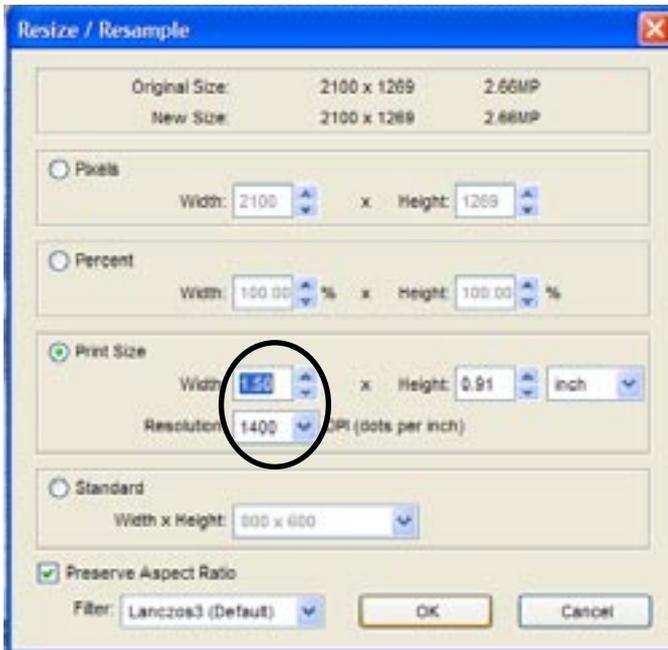


Fig C1b: Default print size (1.5 inches wide)

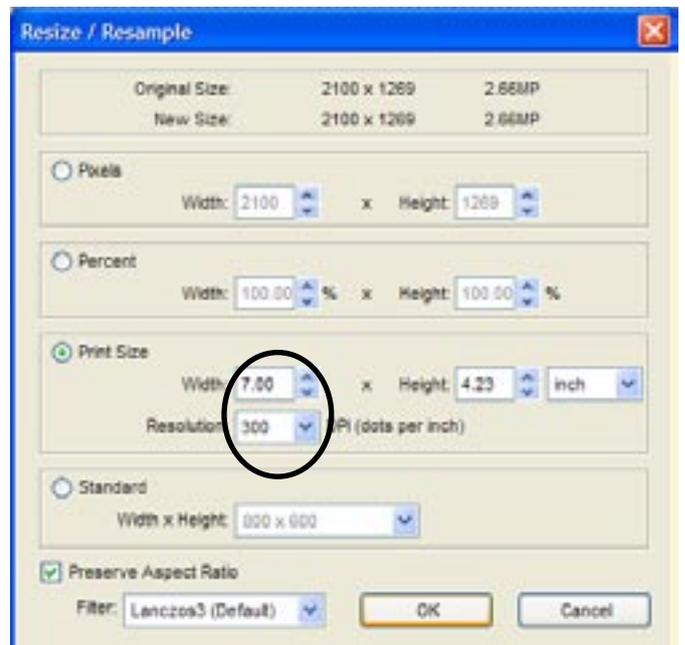


Fig C1c: Changed print size. (7 inches wide)



Fig C1d: Desired Printout

C2. Scanning a coloured 4" x 6" photoprint for displaying on the screen or sending by email.

This is a portrait orientated artwork that has to fit into a 800 x 600 pixel screen. The artwork's depth (6") therefore has to provide 600 pixels. Therefore the scanning resolution has to be 600 pixels/6" = 100 dpi.

The scan mode will be 'Colour', although we could consider using 'Grayscale' mode to reduce the image size to a third and speed up the email downloading.

After scanning, the image would be saved in PhotoStudio as a JPEG to keep the file size low.

Before removing the artwork from the scanner glass you may consider doing a repeat colour scan at (say) 600 dpi for (unknown) future use, especially if you will not be able to access the original artwork in the future. This would be saved as a TIFF.

C3. Scanning an oversized English birth certificate.

If our artwork is oversized (ie bigger than A4) and is stiff, or glued to a cardboard backing, we would have to take it to a printshop that has a scanner big enough to do this scanning for us. However if the oversized artwork is (flexible) paper, we can do several separate scans (with different saved file names) and then combine (or 'stitch') them together later in an editing programme (such as GIMP), to form a final composite image. The following shows how we prepare for this, using the example of an (oversize) English Birth Certificate.

The Birth Certificate is 6½" x 14" which exceeds the A4 area (8¼" x 11½") of the scanner, so we put half of the artwork horizontally across the scanner glass, close the lid and do a scan at say 300 dpi (in colour if we want to preserve the document's pink colour, otherwise use grayscale). Save this as (say) *BthCertA.tiff*. Lift the lid, shift the birth certificate to the left and repeat the scan, saving it as (say) *BthCertB.tiff*. Ensure that both scans are truly horizontal and have a generous overlap so that they can be correctly lined up later when they are combined ('stitched') to create a final document in GIMP, or other editing programme.

C4. Scanning existing printed artwork (not line art).

Most existing printed images (in books, newspapers, magazines etc) have been printed using a halftone pattern to produce the various gray and colour shades. Appendix 1 refers.

When you scan this type of artwork the scanners sampling, (so many 'dots per inch'), can combine with the artwork's halftone pattern (so many 'lines per inch') to produce an interference, called a *Moiré* pattern that may degrade the image. (Note that inkjet printers—which do not have a linescreen pattern—do not have this problem.)

Image editing programmes can later reduce the *Moiré* effect by a 'Descreening' process, although the results may not always be effective. Therefore it is worth considering doing an additional scan with the scanners 'Descreen' option turned ON. Refer to Fig B2, Item 7. It may give you a better result than anything you do later while editing. Save this additional scan with a distinctive name, eg *John4(descreened).tiff*, so that you will be reminded that a Descreen process was involved.

C5. Scanning existing printed line art.

The difference here is that *the artwork does not have a regular linescreen pattern* and the image consists of the random small black or white pixels that make up the image. Therefore scan the artwork in 'line art' mode (see A2.1) and *set the scanning resolution (in dpi) to the maximum dpi resolution of the printer that will be used to print out the scanned image*. For many laser printers this will be either 300 or 600 dpi. An inkjet printer may require 720 dpi. Check your printer specification.

These somewhat mysterious terms have been around for decades in the printing industry and are important parameters in the printing of newspapers, magazines, pamphlets, books etc.

Halftones:

As a starting point, take the case of a black and white printer that is required to print out shades of gray, using only black ink (or toner). The printer does this by printing the image as a regular grid of different sized black blobs (the 'halftones') that represent the darkness at that point in the image. These half tones can be seen in the enlarged grayscale image (Fig 1) where there are no halftones in the white area (the white of the eye), and different sized halftones elsewhere running up to their maximum size (the pupil of the eye) where the halftones touch to give a solid black printout.

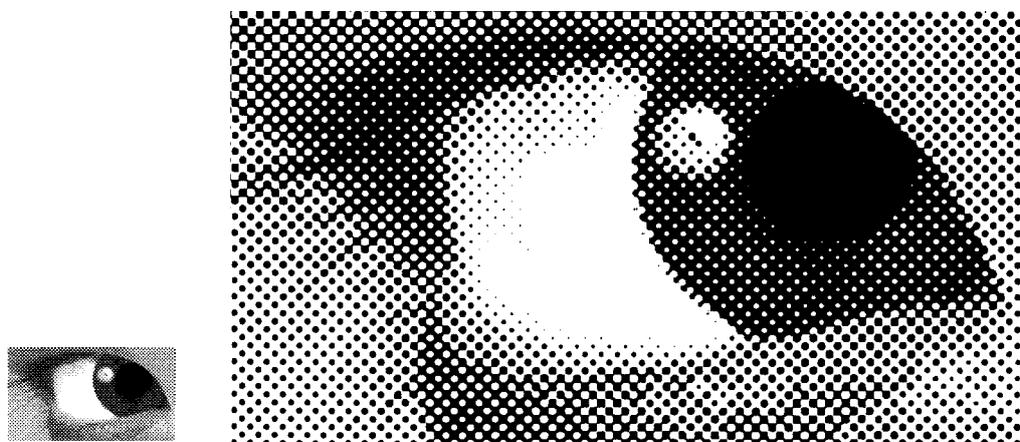


FIG 1

Each halftone is formed from a group of printer dots that are individually turned on or off, depending on the grayshade required. Fig 2 shows these groups of dots for a printer that has nine printer dots for each halftone.

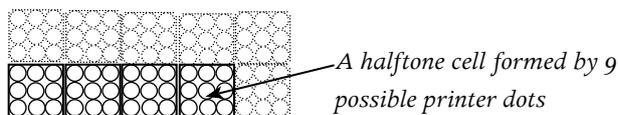


FIG 2

Therefore there are nine possible halftone shades possible (plus white) for this particular printer and some of the possibilities are:

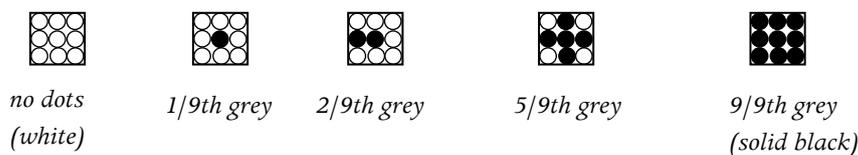


FIG 3

Linescreens:

Fig 1 shows that the halftones lie on regular lines down the page and this linespacing, in lines per inch or 'lpi', is the particular 'linescreen' of the printer. Different printers have different linescreens, for example, newspapers often use a coarse 85 lpi, glossy magazines may use 150 lpi and museum-quality art books may use 200 lpi. The higher the linescreen, the finer the halftone pattern and the finer the detail. Knowing the linescreen is not just an academic exercise: the dpi resolution of an image to be printed out should be twice the frequency for optimum print quality.

The example for Figs 2 & 3 (nine grayshades) is a gross simplification: my domestic B&W laser printer (a Brother HL1430) has a resolution of 600 dots per inch (600 dpi) and a linescreen of about 86 lines per inch. Therefore the side of each halftone cell is $600/86 = 7$ printer dots, and the cell will therefore have $7 \times 7 = 49$ printer dot possibilities, giving 49 possible grayshades. This is more than enough for most of my needs, but it may cause posterisation or 'banding' for grayscale images that have smooth changes of shades.

For colour printing, there are four different linescreen plates inked separately with cyan, magenta, yellow and black ink. The plates are carefully aligned so that they overprint to produce the required colours on the page.

