Chapter 7.3   Addendum
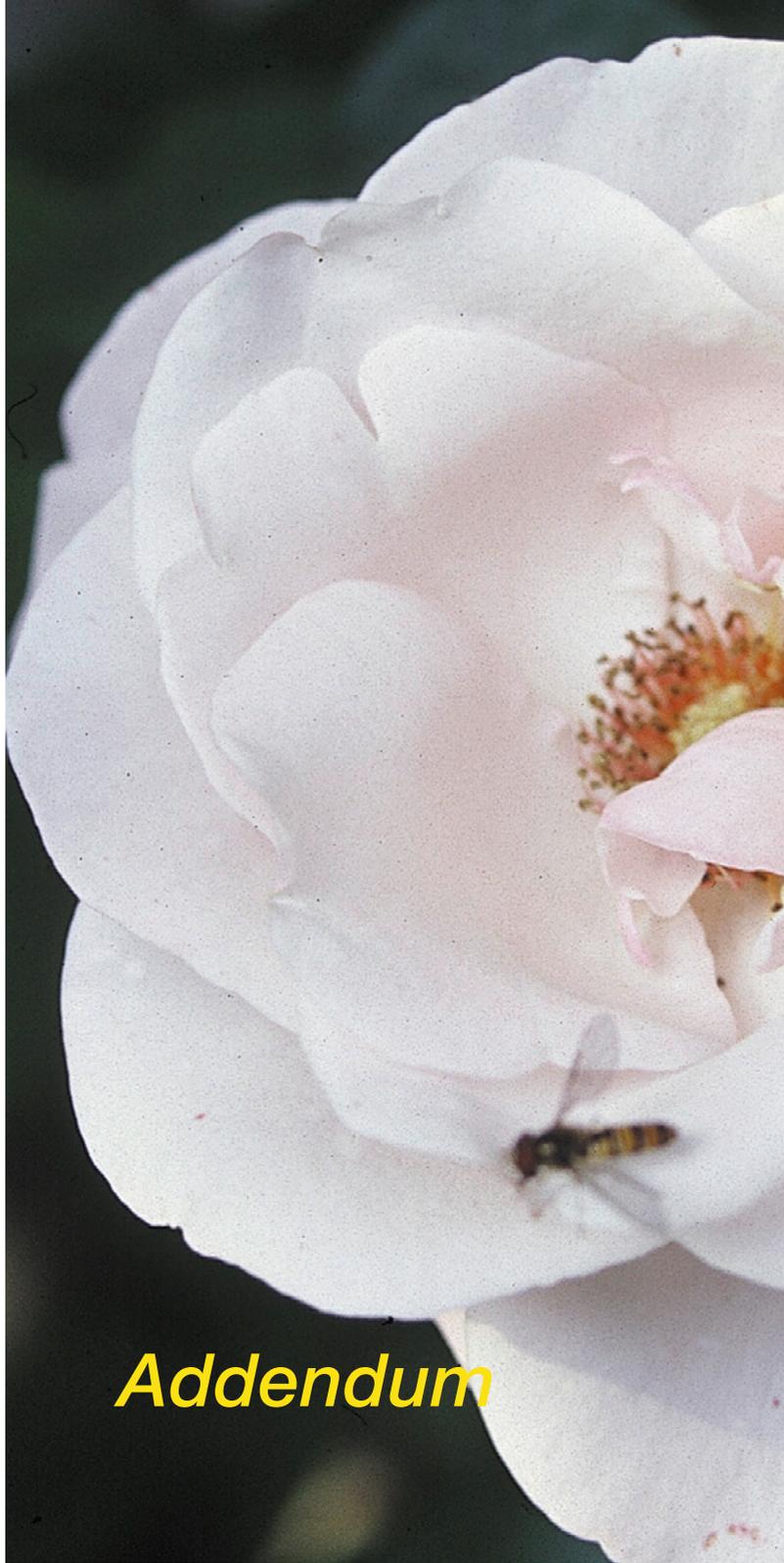
7.3 Addendum

The following chapter introduces into basic scanning concepts and why a good scanner usually has more than 8 bits per colour.

Scanning Concepts

What is a brilliant image? Do I really need very high resolution? What is interpolated resolution?

Imaging has been an abstract science which was practised by well trained professionals. Now with the advent of low price PCs, scanners, printers and digital cameras imaging has become a mass phenomenon.

It is exciting to see how this technology is impacting and changing economy and society. It seems that in an information society imaging is becoming the premier tool to convey ideas and compact messages.

This recognition emphasises the importance to learn more and become familiar with the basic imaging concepts. It will help you to realise your visions and ideas much more quickly!

So for your own advantage do study the following pages carefully!

Scan resolution (dpi)

Some important definitions are clarified here. They form the vital basics of image reproduction theory.

Input Resolution

Resolution is a common expression that refers to the number of finest elements of an image or pixels (pixel is an artificial word made of picture and element), which a sensor, for instance a scanner, can record or distinguish. The unit of measure is in general „dpi" = dots per inch or „dpcm" = dots per cm. The higher the resolution, the greater the number of pixels can be scanned.

Optical Resolution / Interpolated Resolution

The optical resolution is also called physical resolution. It defines how many lines or points per inch or cm the CCD and optics of the scanner can clearly distinguish. This can be seen when two lines, being very close to each other, can still be seen as two different lines and not as one.
Interpolated resolution is mathematical resolution which, as we will see later, is only important for line art scans, not for greyscale scans. It is calculated via hardware or software.

Greyscale

Greyscales are of very high importance for scanning technology because, in order to reproduce a greyscale image, the scanner has to sense every single image point with a certain depth of data in order to reproduce the different levels of grey correctly. A good scanner should be sufficient to distinguish 256 levels of grey (8 bit), but as we will see on the next page, this is not enough. The scanner should distinguish more than 256 levels of grey internally.
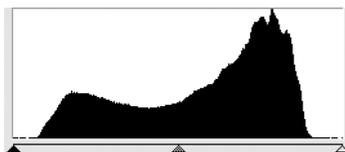
1. Histogram without spreading in Photoshop
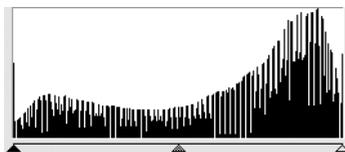
2. Histogram with spreading in Photoshop
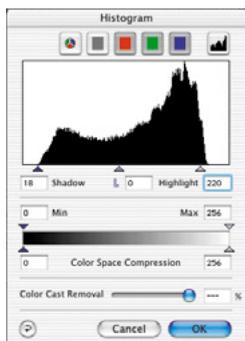
3. Histogram in SilverFast with automatic optimisation

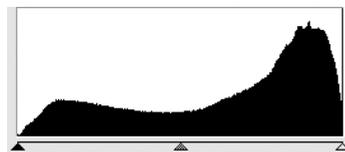*4. Histogram after scan with SilverFast and 10 bit*

Need for More than 256 Levels of Grey

Images are rarely ideal. Furthermore, the scanner itself can deviate (in itself) while scanning images. Adjusting the highlight–shadow values of an image on a prescan lets a scanner with an internal 10- to 8 bit transformation expand the reduced tonal range (fig. 1) to a full range of 256 levels of grey. By expanding a reduced tonal range with only 8-bit transformation, gaps in the tonal scale are produced where grey values are missing. Detail and sharpness of the image are lost or reduced. This can also happen when the transformation-algorithm from 10- to 8-bits is not optimised. The gaps in the histogram (fig. 2) also called spikes, become clearly visible.

Through an optimised transformation of the expansion of tonal values with 10- or 12-bits in *SilverFast*, the end result, that is to say, the final scan displays a gapless distribution of grey levels across the entire greyscale (see fig. 4).

The correct adjustment of highlight and shadow, for instance which values on the prescan become white and which become black, has a strong influence on the quality of a reproduction. *SilverFast* helps locate the brightest and darkest points in two ways: First, the densitometer can be set to CMY% and, by moving across the prescan, indicates where the brightest and darkest points are. Second, the highlight / shadow tool displays the brightest point when the "Ctrl" key is pressed, and the darkest when the "Alt" key is pressed (together with the "Command" key on Mac and the "Alt" key on PC, respectively). For displaying the brightest and the darkest point of the image on the prescan in combination with the highlight/shadow tool, click and hold the white or black square respectively.

 Show brightest point   *Show darkest point*

Thus, the end points are easily set onto the correct spots in *SilverFast* (fig. 3).
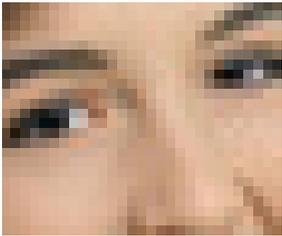

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Screen Resolution (lpi)

In order to reproduce different shades of grey, the printing technology uses the screening technology. A dot matrix is the most economical way to produce shades of grey.
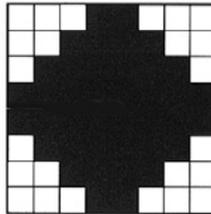
Screening Matrix
of an image point simulating grey through single image setter dots

An image dot from the scanner is transformed into a screening matrix (in general a 16x16 Matrix). If a screening dot is black, up to 256 image-setter pixels can be set in a screening cell. In a screen of 152 lpi there are 152 screening dots in a line. The unit of measure lpi (lines per inch) is often confused with printer resolution. The unit of measure for printer resolution is generally dpi (In some countries, lpcm (lines per centimetre) is the unit of measure for the image setter´s resolution as well as for the screening frequency). Once again the units of measure:

Printer resolution: **dpi / dpcm   (lpcm)**
Screening resolution: **lpi / lpcm**

The images on the left show the effects of different scanner and screening resolution. Image 1 shows a normal scan with 220 dpi printed on a laser printer with 120 lpi. Image 2 shows an enlargement of a selection. Image 3 shows a scan with very low resolution (under 72 dpi) printed with 120 lpi. Image 4 shows a scan from image 2 printed with a line screen of only 20 lpi.

Calculating the Scan Resolution

The best possible scanning resolution is very important and should be well thought out "the more the better" does not always hold true!

To Clarity:

Shades of greyscale images are converted into dots made of a 16x16 matrix when imaged on to an image setter. Ideally, a screening dot contains 256 individual pixels. When a photograph is scanned and printed onto a 150 line screen, each greyscale dot is converted into a 16x16 matrix. An image setter with a resolution of 2540 dpi is just capable of imaging such screening dots.

Since there are losses in the process of analog-digital conversion, an additional Q-factor (Q for Quality) is introduced. This factor is generally 1.4, and, with exception, 2.0.

As a result, the following formula for the calculation of the ideal scan resolution may be used:

> **Scan resolution = output screen x 1.4 x scale-factor**

For Example:

The scan resolution for a 150 line screen with a 1:1 scaling-factor has to be calculated.

> **Scan resolution = 150 x 1.4 x 1 = 210 dpi**

The resulting file size for an A4 page for black and white greyscale is 5.77 MB, for colour 17.3 MB.

300 dpi would roughly double the file size. This shows the importance of setting the optimal resolution since memory requirements and processing time increase dramatically.

High scan resolution

High scan resolution is important only in line art scans. It should be between 800 to 1000 dpi depending on the printer resolution.

Automatic Calculation of Optimal Scan Resolution in SilverFast.
The calculation of optimal scan resolution results in maximum quality, less memory load and faster processing. For this very reason the automatic calculation of optimal scan resolution was integrated into SilverFast. Having chosen the quality factor of 1.5, you only have to input the desired output line screen (150 line screen) and the required output size. SilverFast automatically sets the optimal scan resolution for you.
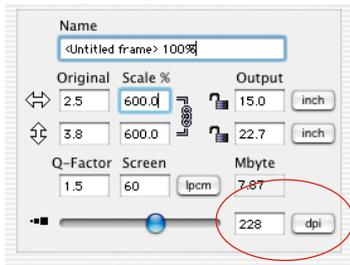
For a 121 line screen for a newspaper and a scale-factor of 50% the calculation is as follows:

Scan resolution = 122 x 1.4 x 0.5 = 85 dpi

If you want to double the image size :

Scan resolution = 122 x 1.4 x 2 = 341 dpi

The images on the right show, what has been explained earlier: that higher image resolution is not significant for better image quality.

Which "Resolution" does *SilverFast* indicate?

In *SilverFast Ai* you can monitor three different aspects of scan resolution:

a) **Output Resolution**: Will be continuously displayed. This represents the resolution, which the image will have after the scan, eg. in Photoshop. The value is derived from *SilverFast's* integrated formula, which relates quality factor and output-line screen.

b) **Optical Resolution**: Depressing "Ctrl" key will display the optical resolution the scanner is using currently. Every Scanner can only use certain optical resolution increments, depending on the hardware. Eg. 300, 600, 1200 ppi, but not 249 ppi. *SilverFast Ai* will always use the next higher hardware resolution, here 300 ppi, and will then interpolate down. This way the full quality is preserved. This way any loss in quality is eliminated .

c) **Interpolated Resolution**: To check whether the scanner does not interpolate "up", you can depress the keys "Ctrl + Shift". Now you can see the internally used, "calculated" or "interpolated" resolution. Here all values are possible such as 249 ppi from our example above.

Be alerted once the second value (with "Ctrl + Shift") is higher than the first value (only with "Ctrl"). This indicates the scanner would interpolate "up" and generate new pixels which are not present in the original image. Moderate interpolation up to 1.3 times max optical resolution puts you on the save side normally, depending on the quality of your scanner, of course.

Generally **SilverFast** inhibits "Misuse" by limiting the max resolution to a factor of 2 or 2.5.

Images with Varying Resolution

100 dpi

200 dpi

300 dpi

400 dpi

Optimum Scan Resolution for Inkjet Printers

In order to print image scans with an inkjet printer without Post-Script and without simulation of offset screens, effectively a few points should be observed already before the scan.

⚠ Please note: You should scan with reference to file size really needed, i.e. Scan size (file size) should ideally reflect the number of pixels needed for the print. Larger than necessary files only congest the computer system and do not lead to a better printing result! All necessary tools to get to ideal file size are built into **SilverFast**. There are no complex formulas and no conversions required.

In order to get optimum results it is recommended to do an initial test. With this test you will find the optimum resolution fur the current printer (the printer connected), with relation to a special paper:

1. In the **SilverFast** main dialogue the "Quality factor is to be set" to 1.5 and "Scaling" is to be set to 100%.

2. The original to be scanned should be a contrasty slide with lots of details or a similar reflective halftone. do not use printed samples from magazines or books!

3. After the preview scan create a small scan frame (eg. 9x6cm) over an area with significant details.

4. The image will be optimized as usual: image auto-adjust, Gradation, colour correction. Under "Filter" the "Unsharp Masking", if active should be switched off.

5. In the **SilverFast** main dialogue ("Frames" panel) under "Screen" input a value of 20 lpcm.
   In the same dialogue input "20 lpcm" as well as the file size as "Name" for this scan frame.

6. While depressing the "Alt" key and dragging the scan frame will be copied. Position the new scan frame exactly onto the same position as the first frame.

⑦
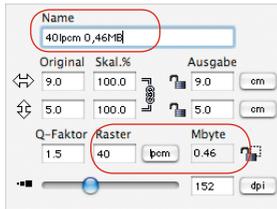
⑨
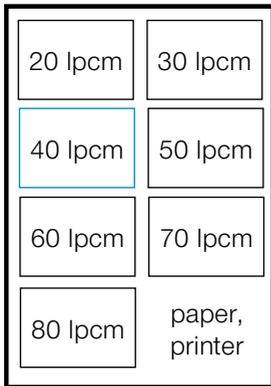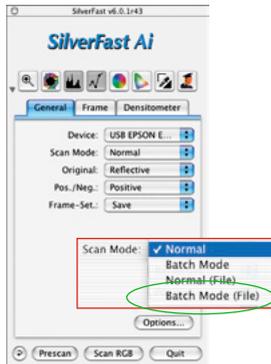
Example of positioned test scans on a DIN A4 format sheet.

7. For the new scan frame input "30 lpcm" under "Screen". Then input "30 lpcm" for "name".

8. Now repeat steps 6 to 7 for the values "40 lpcm" until "80 lpcm", with steps of 10 in between.

9. In the main dialogue change to the "General" panel and select "batch Mode (File)" under "Scan Mode".

10. Start processing of the seven scan frames with clicking on "Scan Batch". A dialogue will come up asking you for a destination for the final scans.

11. When the seven scans are done, mount them in a layout-program onto one paper, e.g. letter format. It is important that all scans get exactly the same frame size! Mark each scan frame with the full name of the image file respectively!

12. The test chart can now be printed and evaluated.

13. Evaluation of results:
Which image, resp. which "screen", will get the best result with the current paper ?
Where can you distinguish fine resolution just about?

What is the optimum screen? Notice how rapidly file size increases with higher line screens!

In reality the limit for recognizing any enhancement in print quality will be between 40 to 50.

It will be interesting to see the comparison print of the same image file on different paper or other printers.

Selective Colour Correction

Colour in Colour Correction

Selective colour correction was developed for high-end scanners, and consists of a changing colours within a colour. The colours red, green, blue, cyan, magenta and yellow are corrected. The cast colour can be reduced and the current colour can be increased. The cast colour of red is cyan, of green is magenta, of blue is yellow.
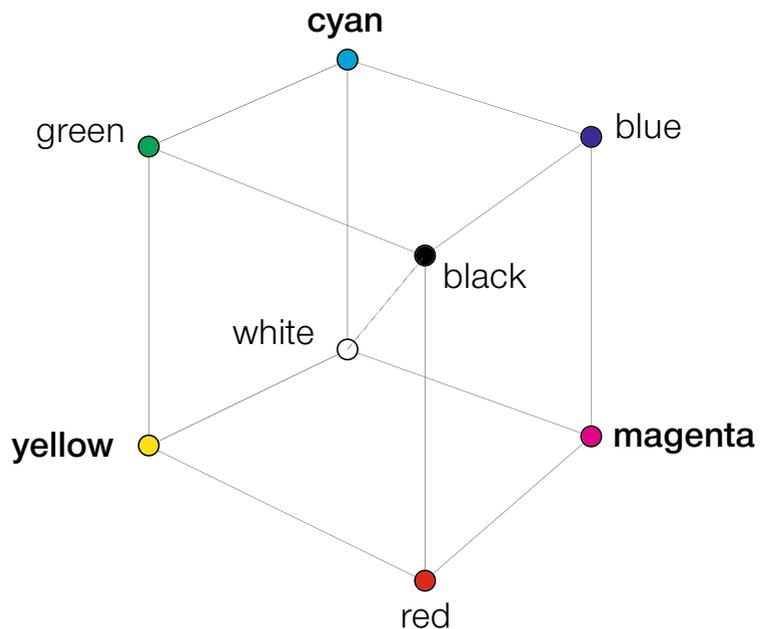
The diagram above shows the relationship between colours.
The primary colours red, green, and blue have opposite colours as their complementary colours.
The neutral tones between black and white lie on a grey axis.

Colour Model Relations

The following model shows the relation between primary colours and contaminating colours (complementary colours). In the selective colour correction these colours can be increased or decreased.
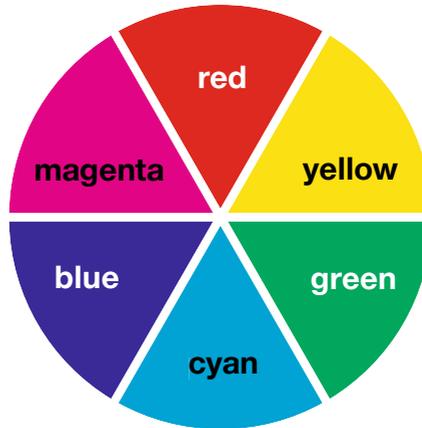
Contaminating Colours

Contaminating colours are those which lead to a "dirtying" also referred to as a "blackening". The colours lose their brilliance and tend to grey. The following table shows the relations:

Colour		Contaminating colour
Red	➜	Cyan
Green	➜	Magenta
Blue	➜	Yellow
Cyan	➜	Magenta / Yellow
Magenta	➜	Cyan / Yellow
Yellow	➜	Magenta / Cyan

Keystrokes in *SilverFast*

Action	Macintosh	Windows
Description of keyboard shortcuts and their respective counterparts		
Command.	Command-/Apple-Key	–
Alt.	Opion-/Alt-Key	Alt-Key
Shift	Shift-Key	Shift-Key
Ctrl	Control-/Ctrl-Key	Control-/Ctrl-Key
Return	Return-/Enter-Key	Return-/Enter-Key
Esc.	Escape-/Esc-Key	Escape-/Esc-Key
ScanPilot / ImagePilot		
Apply / Execute current tool	Return	Return
Scroll / Next action	Up and Down arrow	Up and Down arrow
Prescan, scan / Preview, process		
Stop prescan / stop scan.	Command+Period.	Strg+Period
Switch to other colour space.	Ctrl+Click on.	Right mouse button+Click on
	Scan-/Process-button	Scan-/Process-button
Zoom	Ctrl+Click&Drag	Ctrl+Click&Drag
Image frames		
Duplicate frame	Alt+Click&Drag.	Alt+Click&Drag
Entire Window in one frame	Command+A	Ctrl+A
Delete frame (extended keyboard)	Delete	Delete
Delete frame (normal keyboard)	Alt+Backspace.	Delete
Frame reset	Reset-button	Reset-button
Copy settings of one frame	Alt+Click on active frame, . . .	Alt+Click into inactive
into an other frame	click then into target frame . .	target frame

Action	Macintosh	Windows

Auto-adjust

Resetting auto-adjust	Alt+click on	Alt+Click on
	Auto-adjust button	Auto-adjust button

Highlight / shadow / midtone tool (HSM-tool)

Set highlight	Click on white triangle of HSM-tool
Set midtone	Click on pipette of HSM-tool
Set shadow.	Click on black triangle of HSM-tool

Multiple attempts with pipette

Hold down pipette for multiple . . . . attempts (only highlight, shadow)	hold down Alt.	hold down Alt
Reset highlight / shadow	Alt+Pippette of HSM-tool	
Display brightest point	Click on white square	F6
Display darkest point.	Click on black square	F5

Histogram

Show result histogram	Alt in the histogram dialogue .	Alt in the histogram dialogue

Selective colour correction

Select all colours	Command+A	Ctrl+A
Select additional colour	Shift+Click into prescan	Shift+Click into prescan
Select additional colour column	Shift+Click on LED	Shift+Click on LED
	below column.	below column
Show inactive mask area . . . . (dialogue must be closed)	F7.	F7

Reset

Reset all parameters	Shift+Click on Reset-button . .	Shift+Click on Reset-button
Frame reset.	Alt+Click on Reset-button. . . .	Alt+Click on Reset-button
Undo/Redo last operation	Command+Z	Ctrl+Z

Action	Macintosh	Windows
Opening a dialogue window		
Zoom in preview	Command+1	Ctrl+Alt+1
Image auto-adjust	Command+2	Ctrl+Alt+2
Histogram dialogue.	Command+3	Ctrl+Alt+3
Gradation dialogue	Command+4	Ctrl+Alt+4
Global colour correction.	Command+5	Ctrl+Alt+5
Selective colour correction.	Command+6	Ctrl+Alt+6
Expert dialogue	Command+8	Ctrl+Alt+7
Leave dialogue/Leave SilverFast	ESC or Command+Period . . .	ESC or Ctrl+Period
Start scan / Process image	Return/Enter.	Return/Enter

Action	Macintosh	Windows
Main dialogue		
Undo/Redo last action	Command+Z	Ctrl+Z
Show current hardware resolution	Ctrl	F5
Show calculated scan resolution	Ctrl+Shift	F6

Action	Macintosh	Windows
Masks in *SilverFast SRD*		
Hide mask frame	Ctrl	Ctrl
Shade inactive mask area	Alt+Ctrl.	Alt+Ctrl
Reduce mask.	Alt.	Alt
Extend mask.	Shift	Shift

Action	Macintosh	Windows
JobManager		
Select all job entries	Command+A	Ctrl+A

Action	Macintosh	Windows

VLT (virtual light table)

Context menu in album and overview . .	Ctrl+Click	Right mouse
Preview mode, full screen, ... fit to screen	Command+Shift+F	Ctrl+Shift+F
Display EXIF infos	Command+I	Ctrl+I
Album, mark all images	Command+A	Ctrl+A
Album, delete image	Command+backspace	Ctrl+backspace

EP (extended printing dialogue)

Crop opposing edges / corners . . . . simultaneously	Shift+Click&Drag	Shift+Click&Dra

SilverFast Launcher

Terminate	Command+Q	Ctrl+Q

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