



HP Large Format Color Copiers

Color Accuracy in a proofing workflow

Color reproduction for the HP Large Format Color Copier products family



Notes about the document

The settings and examples described in this document apply to the HP Large Format Color Copier products family using the latest version of HP Designjet Scan software available at the time of document development.

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1. INTRODUCTION TO THE DOCUMENT

The aim of this document is to provide customers with a simple guide to getting good color reproduction when using the HP Large Format Color Copier products. By making the process of scanning and printing easier to understand, we believe users will be able to achieve the desired color reproduction results.

This document contains two parts:

- The first part provides a set of guidelines, checkpoints, settings and troubleshooting cases that will help the owner of an HP Large Format Color Copier system with the copying experience.
- The second part (Annex) provides an introduction to color copying concepts, especially those related to the systems under discussion. In addition, the Annex includes:
 - An assessment of which colors can be reproduced
 - A set of guidelines to assist the user in creating or validating media profiles
 - A set of guidelines to the creation of new types of originals

Users who have a good understanding of color copying concepts can use the first part of this document as a practical guide to perform a color reproduction job and as an aid to problem solving.

Users who require more detailed information regarding color copying concepts or who seek assistance for advanced configuration of the system should instead refer to the Annex.

This document does not include features that are not color related, such as: rotating, scaling, nesting, accounting, paneling, tiling, mirroring and alignment. Nor does it provide details about scanner and printer maintenance (please refer to the other guides for questions related to these features).

This document is intended for various HP Large Format Color Copier systems; some settings may not apply to specific products.

We hope this document will be useful for you and will help you to succeed in your business.

Best regards,

HP Designjet printers

2. COLOR COPYING GUIDELINES

The HP Large Format Color Copiers allow an original image to be reproduced using a scanner, a printer and a controller (called touch screen). The reproduction can be done:

- In one step (a Copy process)
- In two steps (a Scan process followed by a Print process) with an intermediate saving of the digitized data into a file

In this document, we will not differentiate between the two cases: we will describe the Scan process and the Print process separately. If you are performing a Copy, please follow both processes sequentially.

To reproduce an image accurately, the following steps should be followed:

- **Checkpoints before starting a job:** you should answer these points before starting the job.
- **Touch screen settings decisions:** you should take these decisions before setting up the touch screen.
- **Running a job:** you should configure the touch screen according to the settings chosen in the previous step.
- **Post-job recommendations and troubleshooting:** some points to consider once the job is finished. If the output is not as expected, you can use this part as a guide to troubleshooting.

2.1 Checkpoints before starting a job

Before starting a color reproduction job, you should answer the following questions to ensure you are in a correct state to proceed. If any of the answers are negative or uncertain, please follow the recommended actions.

2.1.1 Scanner

- Is the glass plate clean and free from dust?** If not, or not sure, please follow the scanner maintenance manual to clean it. Typically, vertical lines appear in the copy if the glass plate is not clean enough.
- Is the white background element of the loading mechanism clean?** If not, the grays will show a color cast in the copy and the system will behave erratically (some copies will be acceptable whilst some others won't).

- Has the scanner been on for more than 1 hour?** If not, the colors may vary during the scan.
- Does the scanner need to run the scanner maintenance process?** If so, follow the scanner maintenance manual. If unsure, see section 3.1.2.2 of the Annex. Typically, the scanner maintenance process should be run every 100 scans or once a month, but it depends very much on the type of originals you are scanning. If you suspect that the scanner may have a problem (colors very different from the original, grays not neutral, broken lines), then run the scanner maintenance process.
- Has the original dried?** If the ink is still fresh, the original may be damaged and the glass plate of the scanner may be dirtied.
- Is the height setting in the loading mechanism adapted to the thickness of the original?** If the original is thicker than 2 mm, follow the guidelines for scanning thick media and always remember to handle the original with care.

2.1.2 Printer

- Is the media properly loaded and with the correct name appearing in the front panel?** If not, change the media name or reload the media, otherwise you risk deteriorated image quality.
- Did you run the printhead alignment and color calibration for the media loaded and the current set of pens?** If not, execute a printhead alignment and color calibration as described in section 3.1.4 of the Annex.
- Is color calibration on?** Follow the steps in section 3.1.4 of the Annex.
- Has the printer been inactive for more than 6 hours?** If so, take into account that the first swaths (ink dropping passes) may show a duller color (less ink delivered) than the rest. To avoid this, run a small print test from the printer's front panel.
- Is there enough ink for the job?** You should look at the ink level indication on the printer front panel. If necessary, replace any empty cartridges; there is no need to do a Closed Loop Color or Printhead Alignment afterwards.

2.1.3 Touch screen

- Do you have a media profile adapted to the media currently loaded into the printer?** If not or not known, please create a media profile as described in your scanning system's documentation. If it is not correct, the output image may have serious defects: too much ink (dark images, smearing, bleeding), too little ink (washed out, low contrast images), wrong colors.

2.2 Touch screen settings decisions

You should now decide what kind of scanning, printing or copying you would like to perform. To do so, you will have to select amongst different options provided in the touch screen menus.

This section can be used as a reference chart, where you can tick and select options that will later be used to configure the touch screen. The terms in bold are the actual options' names that appear in the touch screen menus.

1. Scanning options

1.1	<p><u>Color mode:</u> Do you want to process the image in black & white or color? (Even if the original is a color image the copy could be B&W.) Many settings depend on this decision.</p> <ul style="list-style-type: none"><input type="checkbox"/> B&W<input type="checkbox"/> Color
1.2	<p><u>Type of content:</u> What is the content of the original? Select the type of content that best matches an entry in the list that follows. This decision will be related to the type of original defined in the touch screen (see section 2.3.1.1). The type of original is specified between parentheses (), first for B&W scanning mode and then in <i>italics</i> for color scanning mode.</p> <ul style="list-style-type: none"><input type="checkbox"/> Pictorial (Photo; <i>Photo</i>)<input type="checkbox"/> CAD drawing with clean white background (CAD Lines; <i>CAD</i>)<input type="checkbox"/> Text or line art with clean white background (CAD Lines; <i>CAD</i>)<input type="checkbox"/> CAD drawing, text or line art with a background that is difficult to distinguish from the lines:<ul style="list-style-type: none"><input type="checkbox"/> Blueprint (blue background) (Blueprint; <i>CAD with advanced</i>)

	<p style="text-align: center;"><i>settings</i>)</p> <ul style="list-style-type: none"> <input type="checkbox"/> Sepia background (Sepia; CAD with advanced settings) <input type="checkbox"/> Other <input type="checkbox"/> Document: mixed text (or lines) and pictures (CAD Mix; Brochure) <input type="checkbox"/> Map (solid areas and lines) (Map; Map)
1.3	<p><u>Definition of own type of original:</u></p> <p>Do you need some extra color management or image enhancement applied to the image? If unsure refer to sections 3.4 and 3.5 of the Annex. Please remember that if you change any of the predefined values for the settings below, the final image may not be color consistent with the original or its image quality could be compromised. The <i>italic</i> items are applicable only when scanning in <i>color mode</i>. Default values are 0.</p> <ul style="list-style-type: none"> <input type="checkbox"/> Lightness (-3 to +6): <input type="checkbox"/> Saturation (-6 to +6): <input type="checkbox"/> <i>Balance</i>. Choose either <i>RGB</i> or <i>CMY</i> values (-6 to +6): <ul style="list-style-type: none"> <input type="checkbox"/> Red: <input type="checkbox"/> Cyan: <input type="checkbox"/> Green: <input type="checkbox"/> Magenta: <input type="checkbox"/> Blue: <input type="checkbox"/> Yellow: <input type="checkbox"/> Background Cleaning (0 to 255): <input type="checkbox"/> Black Enhancement (0 to 255): <input type="checkbox"/> Blur (<i>Color</i> 0 to 12; B&W On/Off): <input type="checkbox"/> Sharpen (0 to 6):
1.4	<p><u>Scan Resolution:</u></p> <p>Which scanning resolution do you need? High (or Best) gives higher quality but produces larger files and has slower throughput; Low (or Fast) gives higher throughput and smaller files but lower quality. Normal is a compromise between the previous two cases. You can also select a custom resolution.</p> <ul style="list-style-type: none"> <input type="checkbox"/> Low (Scan) or Fast (Copy) <input type="checkbox"/> Normal <input type="checkbox"/> High (Scan) or Best (Copy) <input type="checkbox"/> Other:

2. Printing options

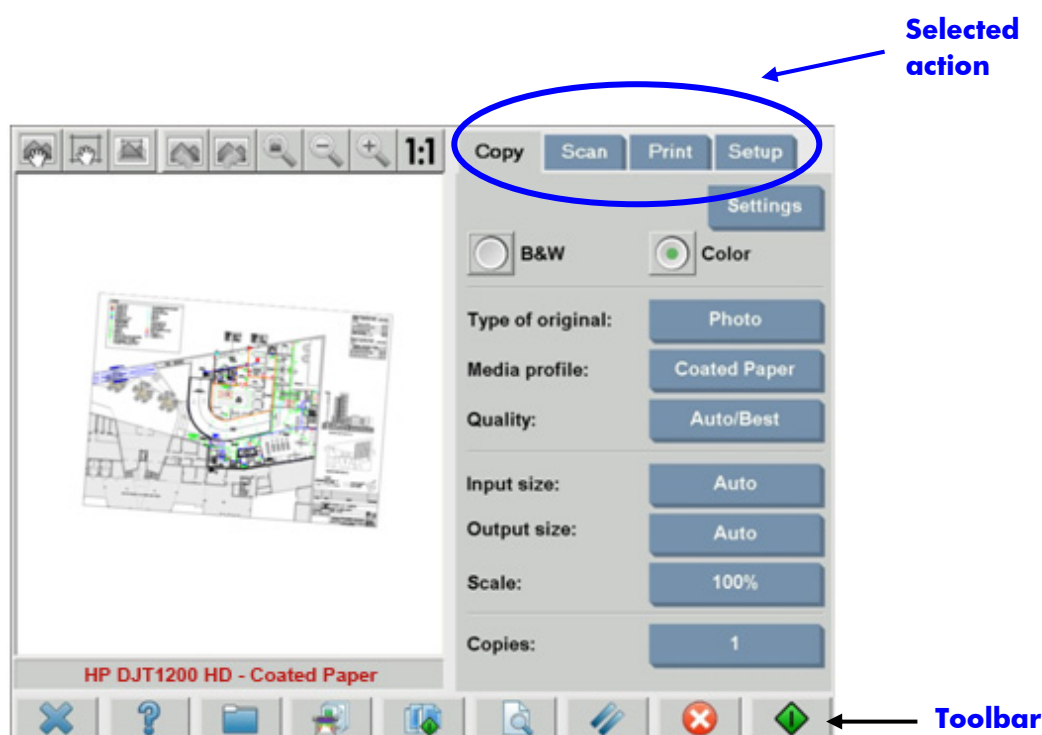
2.1	What is the currently-installed printer name in the touch screen?
2.2	Which media profile are you going to use? (For information see section 0 in the Annex)
2.3	Which print quality do you need? Best gives higher quality but slower throughput; Fast gives higher throughput but lower quality. It is recommended to select Fast for drafts, Normal for non-critical tasks and Best for final presentations. <input type="checkbox"/> Best <input type="checkbox"/> Normal <input type="checkbox"/> Fast
2.4	Do you know which ink technology has been used to produce the original? If not known select Non-Inkjet: <input type="checkbox"/> Inkjet <input type="checkbox"/> Non-Inkjet (Offset, Traditional Photography, Laser Printer, ...)

2.3 Running a job: operator settings

The third step of the process, after having got through the checkpoints in section 2.1 and answered the questions in section 2.2, is to configure the touch screen.

Firstly, you should choose the tab corresponding to the action you are about to perform:

- **Scan:** scan the original and save the digitized image to a file on CD, hard disk, flexible disk or networked disk. This file may be printed later. We will call this option Scan to File.
- **Print:** perform a printout from a previously digitized image file. We will call this option File to Print.
- **Copy:** scan the original and print it immediately (no intermediate file created). In this case, the settings are a combination of the Scan and Print settings¹.



Please be aware that different tabs may have settings in common and most of them keep their value when you move from one tab to another. However, all settings under the **Settings** button will change their value when moving between tabs, even if their names are the same. Therefore, you should first select the tab according to the action to be performed and then select the settings for that tab.

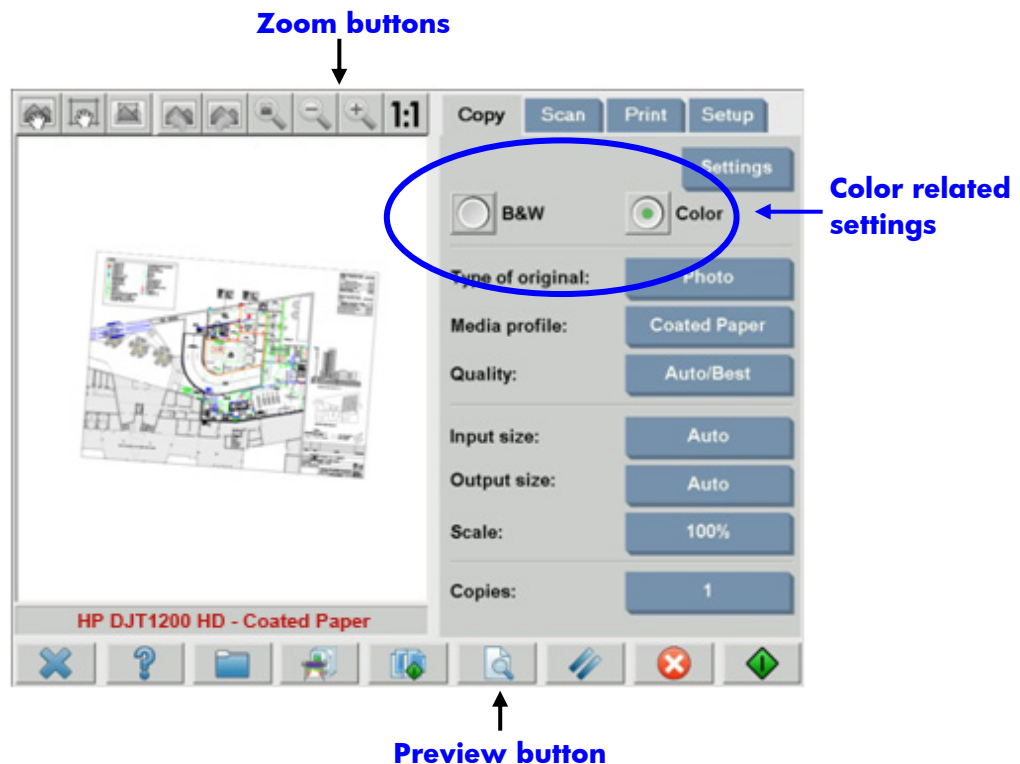
¹ If you select Copy you should follow the guidelines to Scan followed by the ones to Print.

The settings selected in section 2.2 are herein referred to by their line number appearing in parentheses (e.g. (1.1) when setting the Color mode).

2.3.1 Scanning

Scanning is the digitization of the original image. It happens either when we are Copying or Scanning to File (i.e. Copy or Scan tabs). Special attention should be paid to this process where, besides the digitization, most of the image enhancement and part of the color management take place.

It is recommended to preview the image after applying the settings by pressing the preview button (see figure below). You can see more or less detail of the image by selecting the Zoom buttons in the Preview pane.



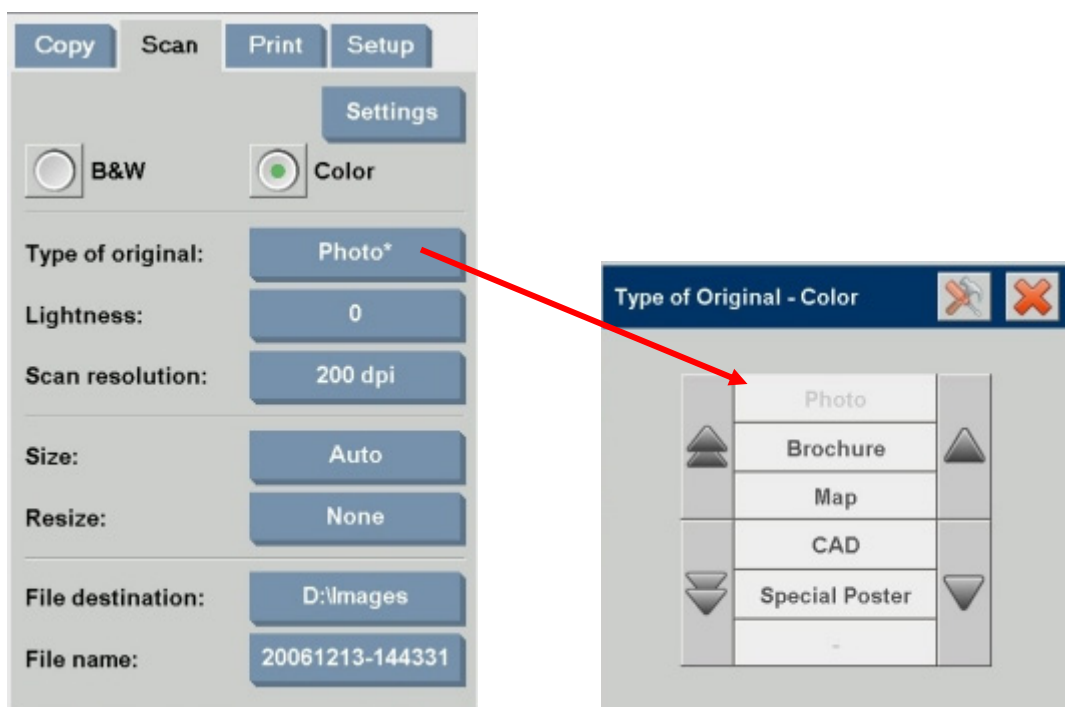
Before scanning, you will have to make three color-related selections from the Copy tab:

- **B&W** or **Color** (1.1): defines whether the scanning result will have color information or just grayscales.
- **Type of original** (1.2): is a template for image enhancement and color management. Please refer to the following section for more details.

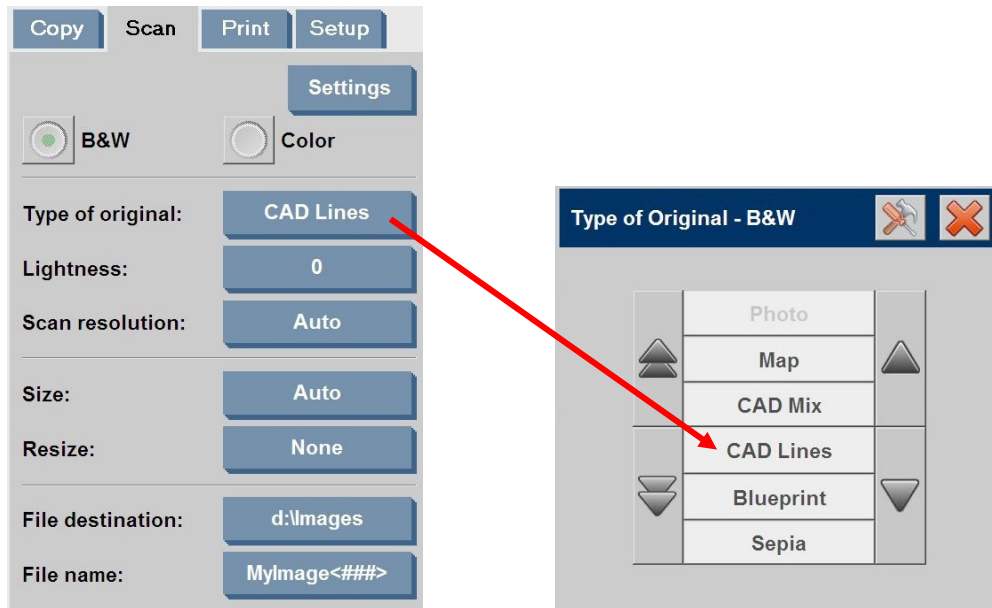
2.3.1.1 Type of original (1.2)

Since there are many settings which are used for image enhancement and color management, templates (or groups of settings) are provided through the **type of original** setting in order to ease this task. It consists of the definition of archetypes of different originals to which specific settings' values have been associated. Depending on whether you are trying to scan in B&W or Color, you may choose between different "type of original" templates:

- Color scanning
 - **Photo**
 - **Brochure**
 - **Map**
 - **CAD**



- B&W scanning
 - **Photo**
 - **Map**
 - **CAD Mix**
 - **CAD Lines**
 - **Blueprint**
 - **Sepia**



In most cases, choosing the correct “type of original”, as specified in point 1.2 in section 2.2, is enough to obtain a good scan and, subsequently, a good print.

A description of when each type of original should be used is provided in the following tables.

Color Mode	
<p>Photo</p> <p>Should be used when copying color pictorial images, characterized by having many colors, transitions between colors or shadings. The main intention is to have a copy as perceptually similar to the original as possible, even though the colors are not exactly the same.</p>	

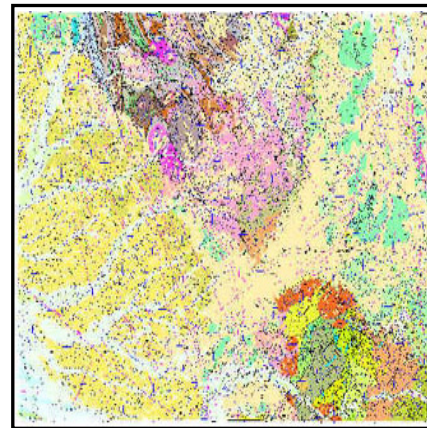
Brochure

Should be used when there is a mix of text (sharp and crisp contrast) and pictures. It is a compromise between having good perceptual reproduction of the pictures and crisp text.



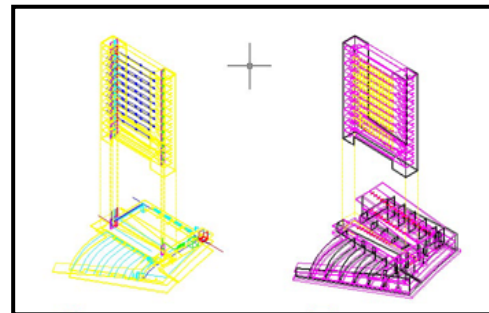
Map

Should be used for maps, graphics and other documents that have area fills: areas of one color surrounded by areas of another color. The edges between adjacent color areas are enhanced (sharpened) and, assuming that the background is white, a background cleaning feature is applied.



CAD

Should be used for line drawings (architectural, mechanical, electrical drawings) or text documents. Lines may be thin, and should be copied as sharply as possible. The same image enhancements as the **Map** type are applied.



Black and White Mode

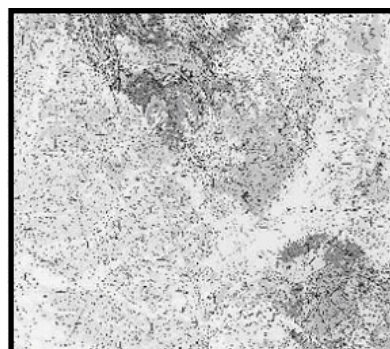
Photo

Should be used for pictorial images that have many shades of gray. In principle, this is equivalent to the **(Color) Photo** type.



Map

Should be used for maps, graphics and other documents that have area fills: areas of one shade of gray surrounded by areas of another shade. The edges between adjacent gray areas are enhanced (sharpened) and, assuming that the background is white, a background cleaning feature is applied.



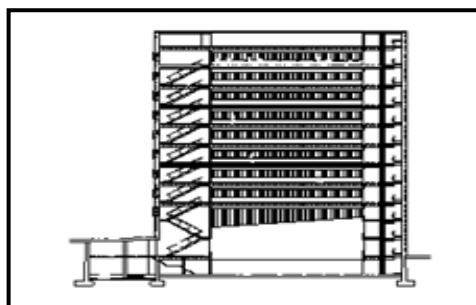
CAD Mix

Should be used for line drawings, text and shades of gray. It is similar to the **Brochure** type seen before, but for black and white content.



CAD Lines

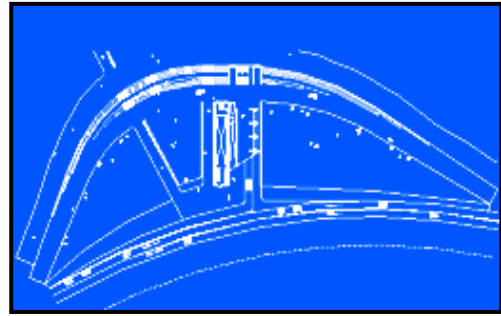
Should be used for line drawings and pure black text. It is not suitable for pictures and it is the equivalent of the **(Color) CAD** type seen before, but for black and white content.



Blueprint

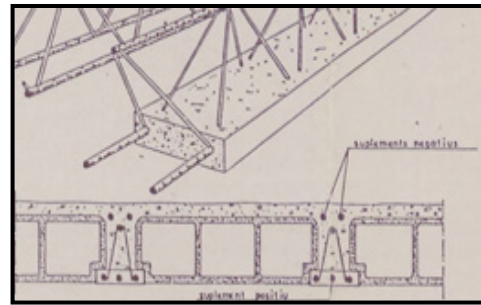
Should be used when the original has very similar bluish background and foreground. If you selected **Photo** for this type of original the output would be very noisy and it would be hard to distinguish the lines.

This “type of original” setting includes a process to clean the background in order to make the output clearer.



Sepia

This option uses the same principles as **Blueprint** but it is designed for sepia color backgrounds.



At this point, if you don't like how the original appears on the preview pane, or if you have already made a copy and the result is not what you expected, you can try to do one of the following:

- Try a different pre-defined type of original.
- Modify the current type of original.
- Create your own type of original (same as the above, but saving the new type of original under a new name, thus preserving the predefined one).

To create your own new type of original, please refer to sections 3.4 and 3.5 of the Annex.

2.3.1.2 Scan resolution (1.4)

You can specify the scanning resolution decided in point 1.4 of section 2.2 in the **Scan Resolution** setting of the Scan tab (or in the **Copy Quality** setting under the Settings button of the Copy tab).

As a rule of thumb, the scanning resolution (for best print mode and large format images) should be $150 \text{ dpi} \times (\text{Output Size}/\text{Input Size})$; therefore, if the original is not enlarged (Output Size = Input Size), a 150 dpi resolution is sufficient. If the original is enlarged four times, a 600 dpi resolution is needed.

If the image contains fine details (CAD drawings, fine art, maps), you may consider scanning at a higher resolution.

2.3.2 Printing

Printing is the materialization of the image and can be performed whether you are in the Copy or Print tabs of the touch screen. Please remember that, besides the formatting required to send the image to the printer, most of the color management takes place in this phase.

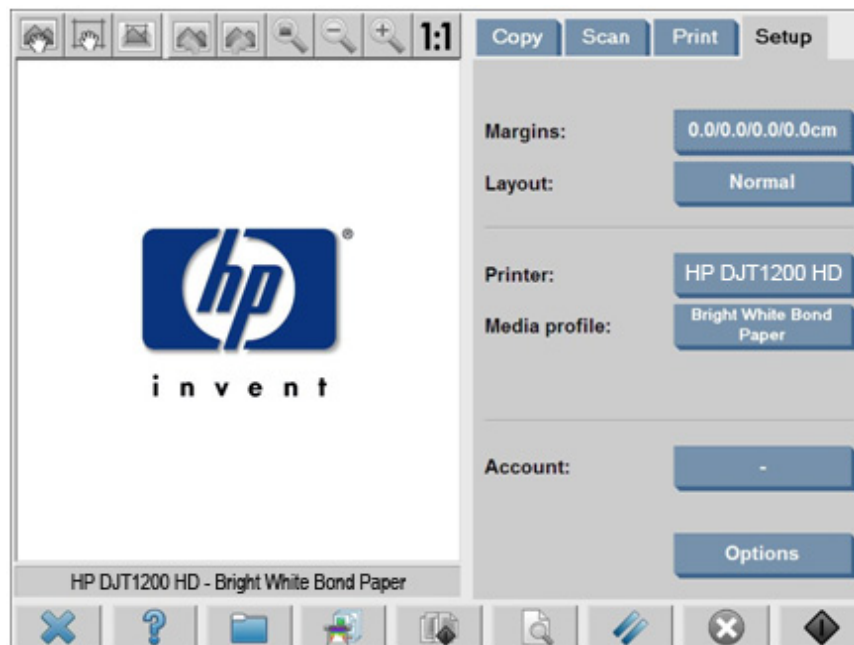
With regard to color management you should define:

- Which **printer** will be used (2.1)
- Which **media profile** defines the media loaded in the printer (2.2)
- What **print quality** is required (2.3)
- Whether the original image comes from an **inkjet printer** (2.4)

All these settings can be specified in the touch screen menu.

2.3.2.1 Printer and media profile (2.1 and 2.2)

Printer name and **media profile** can be specified in the Setup tab, as shown in the picture below.



2.3.2.2 Print quality (2.3)

The **Print quality**, **Ink printer original**, **Black Ink only**, **Optimize for drawing** and **Max detail** settings are specified under the **Settings** button in the Copy or Print tab.

Note: The list of options depends on the printer installed. Not all settings are available in all printer models.



To get the best possible image quality and in order not to lose any of the reproducible colors, you should choose **Best** print quality together with a good media such as **Photo Gloss**. For all other cases, you should decide whether to favor image quality (**Best**), print speed (**Fast**) or balance the two (**Normal**).

The **Ink printer original** setting should be specified when the original image comes from an inkjet printer. If the original is a traditional silver-halide photo, or comes from an offset press, a laser printer or some printer other than inkjet, then this option should not be set.

2.4 Post-job recommendations and Troubleshooting

2.4.1 Post-job recommendations

➤ **Handle the copy with care, letting it dry completely.**

It is recommended not to expose it to direct sunlight (or any other source of UV rays) or other extreme conditions (humidity, temperature). If appropriate, it is recommendable to laminate it in order to avoid scratches and to increase its “light-fastness” (durability of colors).

➤ **Clean the glass plate**

If you suspect that the original has left some dust on the glass plate, clean it with a soft cotton tissue.

2.4.2 Troubleshooting

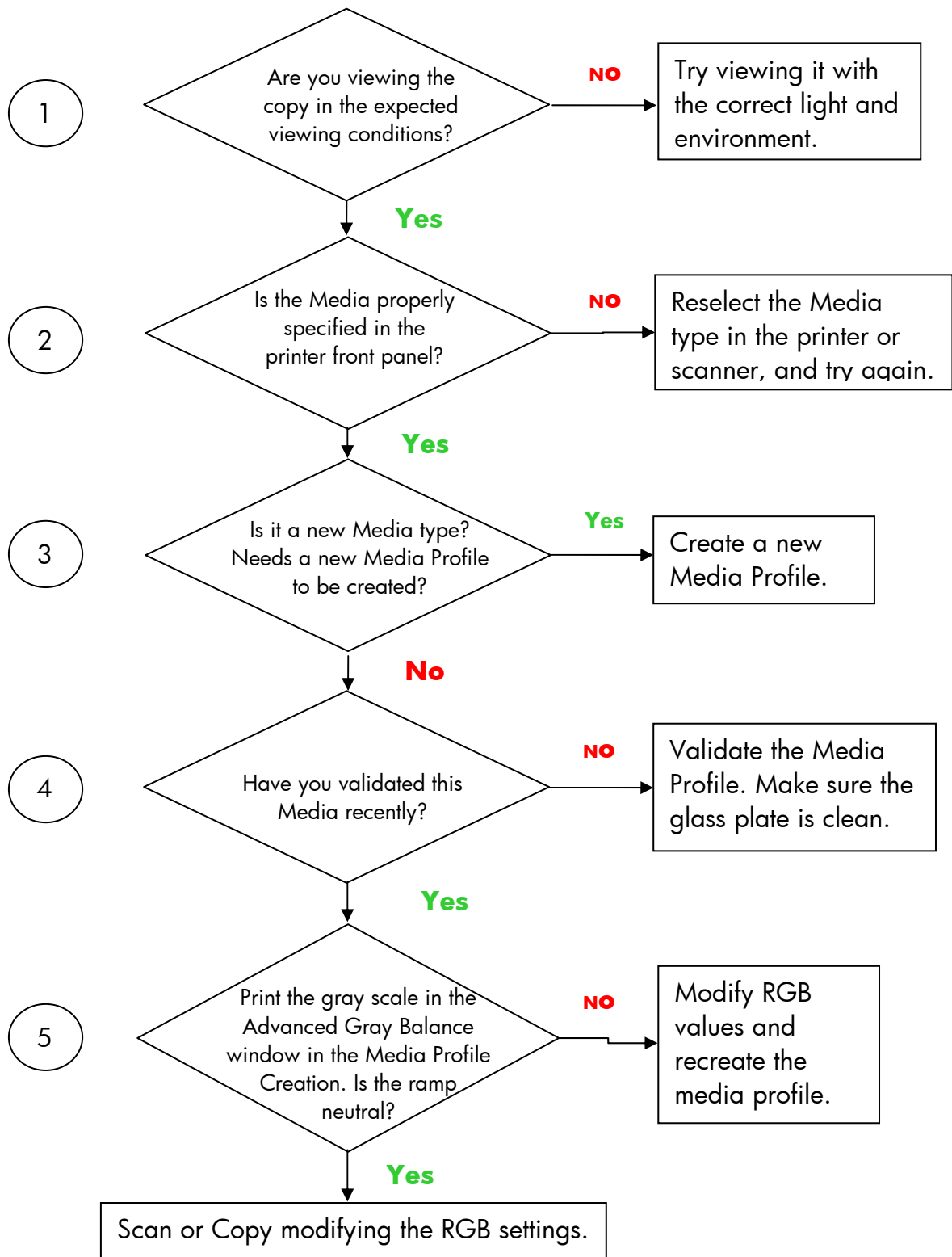
If the output is not as expected, please check whether your problem is one of those listed below, and if so, consult the following sections for a deeper diagnosis and a potential solution. Alternatively, please contact the HP Support Organization.

The most common issues in color reproduction are:

1. The colors of the copy are very different from the original:
 - a. There is an overall color cast (e.g. bluish, pinkish).
 - b. Most of the colors are OK but certain ones are very different.
2. Grays are wrong in a color copied image.
3. The copy is not as shiny as the original.
4. There is a big difference between right and left sides of the copy.
5. The background comes out colored when copying newspapers.
6. Vertical bands appear in the copy.
7. A B&W image appears greenish (or pinkish, or bluish).

2.4.2.1 The colors of the copy are very different from the original

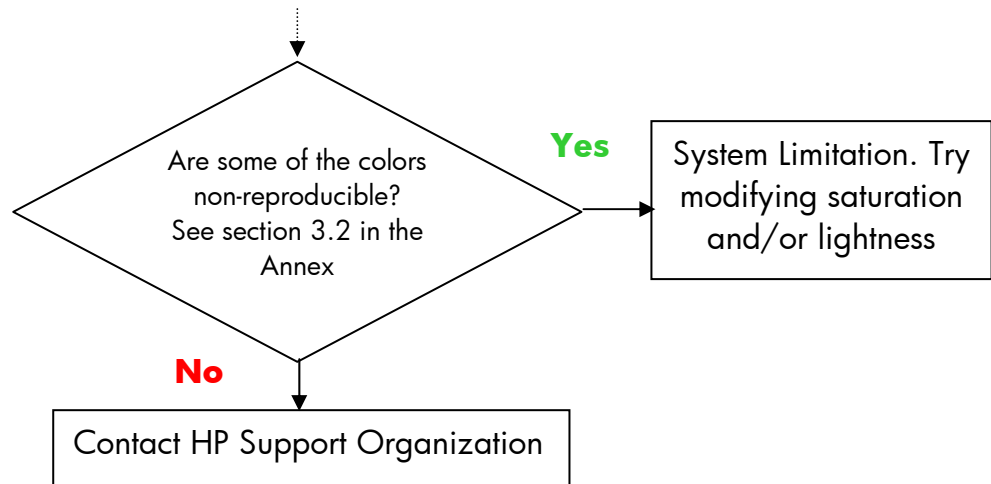
1.a There is an overall color cast



Note: the Advanced Gray Balance window may not appear with some printers.

1.b Most of the colors are OK but certain ones are very different

Follow the steps 1 to 5 as in 1.a and proceed from there:



2.4.2.2 Grays are wrong in a color copied image

Follow steps 1 to 4 as in 1.a *There is an overall color cast* in section 2.4.2.1. If the problem persists, try cleaning the white background plate that is on the top assembly of the scanner over the glass plate. Alternatively use the **Black ink only** setting in the Print settings dialog box, if your printer has this setting.

Note: the **Black ink only** setting is not available with some printers.

2.4.2.3 The copy is not as shiny as the original

This may be due to not using the correct media: High Gloss or Semi Gloss media should be used in this case.

2.4.2.4 There is a big difference between right and left sides of the copy

This may be due to the some miscalibration of the cameras. Try performing scanner maintenance. If this does not solve the problem, please contact the HP Support Organization.

2.4.2.5 The background results colored when copying newspapers

To avoid copying the background of a background-colored document (typically sepia) you should use the background cleaning option when scanning in color mode; if you are interested in B&W copying you should use either Sepia or Blueprint type of original.

2.4.2.6 Vertical bands appear in the copy

This normally happens when the glass plate is dirty (either because it was dirty before the scanning or because the original left tiny bits of coating as it moved over it). In the first case, clean the glass plate according to the scanner maintenance procedure, and calibrate the scanner; in the second case, laminate the original (if possible) or place a transparent cover over it before scanning again.

2.4.2.7 A B&W image appears greenish (or pinkish, or bluish)

If you selected scanning in B&W and the output image has a noticeable color cast, then probably the problem is in the printer itself. Some products of the HP Large Format Color Copier family have an option to print using "Black ink only", instead of a composite black made up of other colors available in your printer; this is a possible solution. If not available, make sure that the printer CLC (Closed-Loop Color) has been performed and is active. See section 3.1.4 for details on the CLC process. If this does not solve the problem, consider copying in Color mode. If the problem persists, follow the steps described in section 2.4.2.2.

3. ANNEX

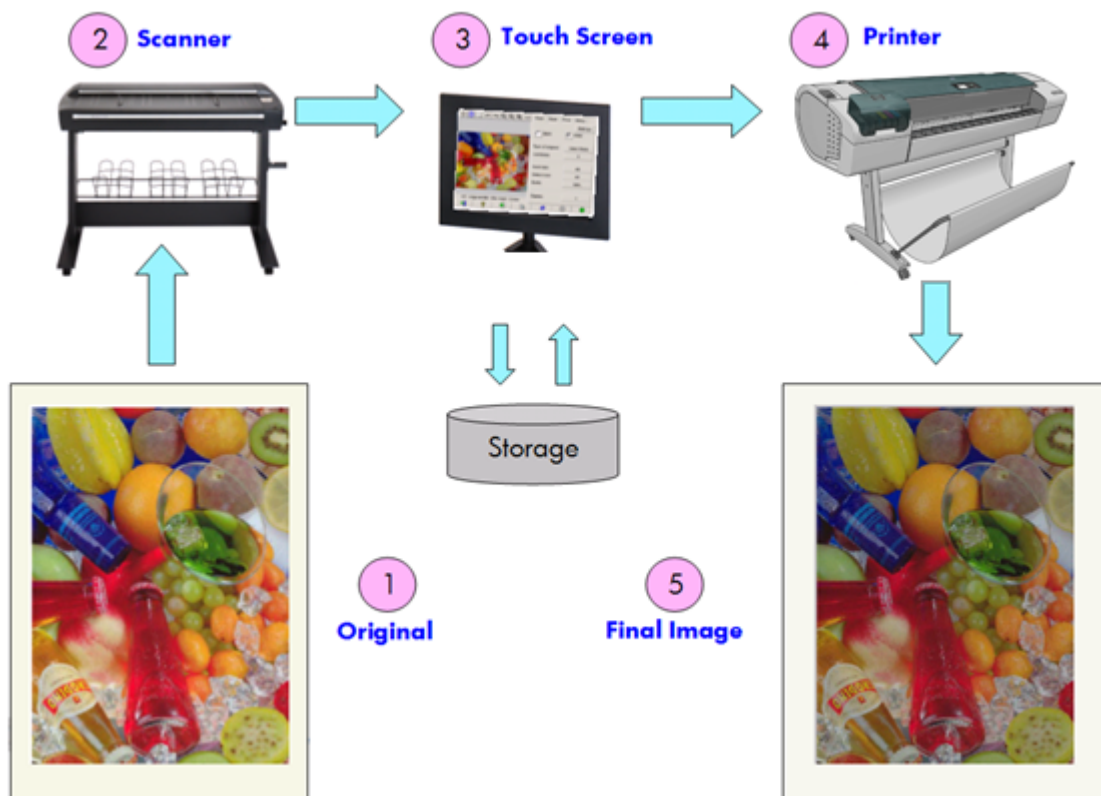
3.1 Color reproduction: theory of operation

The following is a theoretical treatment of the technology involved in the scanning and reproduction of images. The technology at work in your particular product may be slightly different from that referred to the description that follows.

Color reproduction consists of transferring an original image that resides on a substrate onto another substrate (paper or other media), as accurately as possible. With HP Color Copier systems reproduction is done by digitizing the original image with a large format scanner, applying color transformations and image enhancements, and finally sending the data to a large format printer to generate the reproduction of the image.

There are five components involved in this process as depicted by the following picture:

- 1) The original image
- 2) The image digitizer (large format scanner)
- 3) The color transformation and image enhancement engine (touch screen)
- 4) The image producer (large format printer)
- 5) The reproduced or final image



The principle behind color reproduction is that the original and the final image relate to each other according to the desired reproduction intent.

It is also important to underline that the process includes image enhancement. This feature is included so that when the original is noisy, badly contrasted or imperfect, the resulting output can be enhanced (smoother, better contrasted, with enhanced edges and lines). In this case, the process is mainly driven by image enhancement rather than color reproduction fidelity.

The following sections describe in more detail each component of a HP Color Reproduction system.

3.1.1 Original

The original is where the image to be reproduced resides. In relation to color and image enhancement, originals can be classified as follows:

- According to the way the image was created:
 - Inkjet originals
 - Thermal Inkjet
 - Piezoelectric Inkjet
 - Continuous Inkjet
 - Non-Inkjet originals
 - Press/Offset
 - Silver Halide (traditional photography)
 - Electro photography:
 - Dry ink (toner): laser printers
 - Liquid ink: Digital Press
 - Others
- According to the contents of the image:
 - Pictorial images
 - Maps and graphic images with solid areas
 - CAD and drawings with solid lines
 - Text Documents
- According to the color content:
 - Color images
 - Monochromatic images:
 - Black and white
 - Sepia
 - Blueprint

- According to the shadows or contrast levels:
 - two levels: only black and white (e.g. text document)
 - multilevel: many gray levels (e.g. picture)

- According to the original's conditions:
 - Clean image
 - Damaged or noisy original:
 - Stained, marked, smudged, spotted, ...
 - Scratched, torn, ...

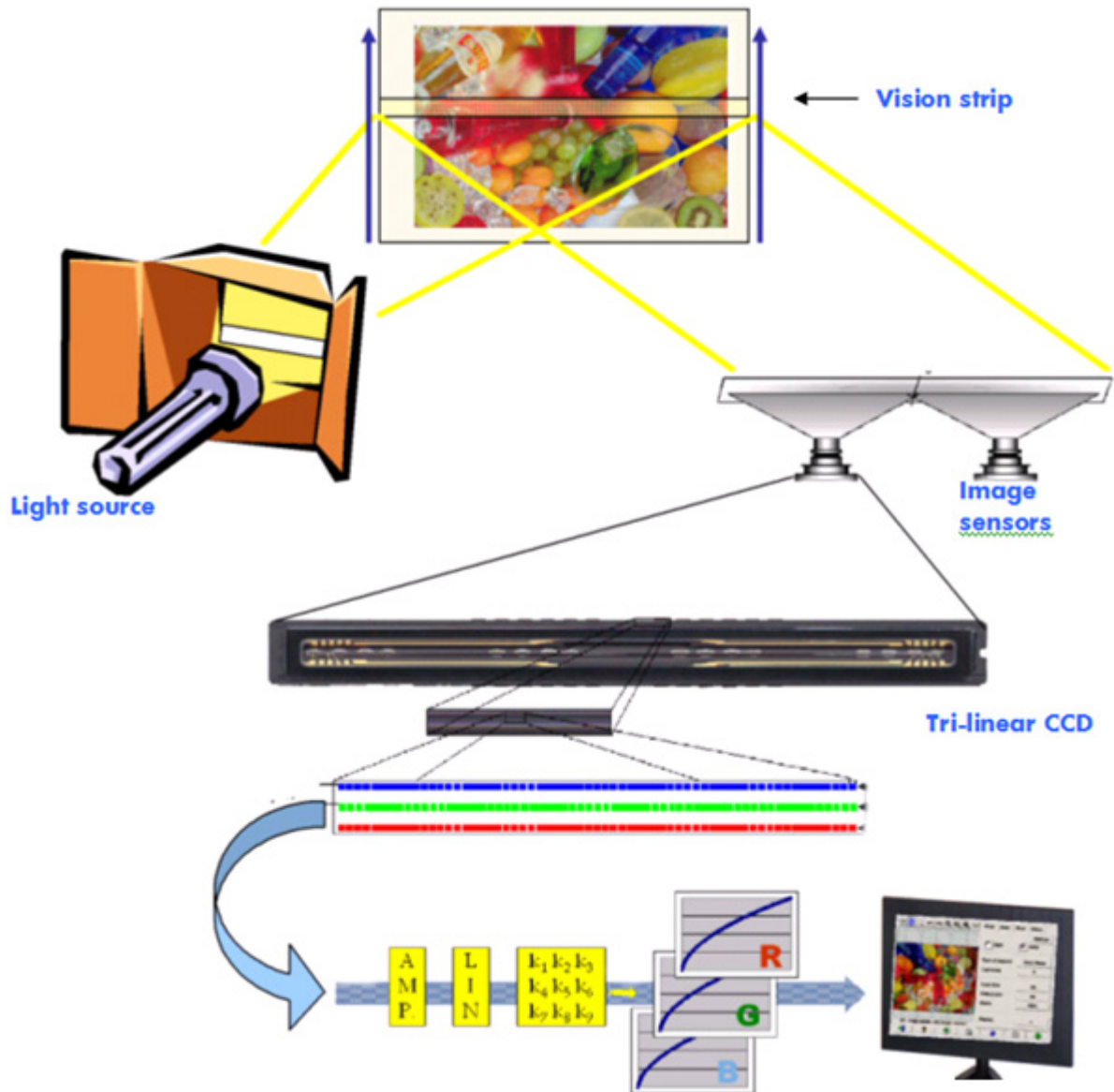
It is important to know what type of original you are handling in order to use the correct reproduction settings.

When using a color reproduction system it is also very important to handle the original with maximum care in order not to damage it and to be able to generate a good copy.

Finally, it is very important to make sure that, if the original has been recently printed, it is completely dry before using it.

3.1.2 Large format scanner

The scanner is the device that digitizes the original and sends it to the processor for further digital treatment. It consists of a light source, a paper movement mechanism, RGB image sensors (two or more cameras) and the electronics required to process the data from the sensors.



3.1.2.1 Light source

The light source provides enough light along the vision strip so that, after being modified by the original image², there is sufficient reflected light to reach the image sensors.

The light source (lamp) stabilizes after the scanner has been on for approximately one hour. Therefore, if the color reproduction is critical and you don't want to see differences from one end of the copy to the other, it is advisable to start scanning one hour after powering on the scanner.

3.1.2.2 Paper movement and glass plate

Since only one strip of the original image at a time is "seen" by the color sensors, either the sensors are moved to scan the original (as in most home/office scanners) or, as in the case of a large format scanner, the original is moved through a looking glass by a roller mechanism.

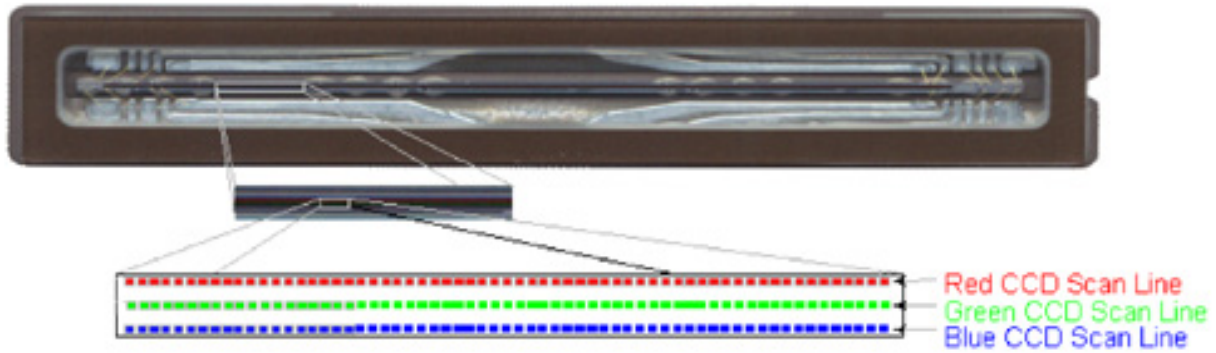
As the paper is moved over, small fragments of the original media or dust stuck onto the glass plate may cause image quality problems, like undesired vertical streaks appearing on the copy. To minimize this problem make sure that your original is completely dry before loading it into the scanner and, as previously mentioned, handle it with care, choosing the proper document height in the loading mechanism. If the original is thicker than 2 mm, refer to guidelines for scanning thick media. Take care to protect the scanner from dust.

3.1.2.3 Cameras

There are four cameras to digitize the full width of the original image. Each of them consists of an optics part³ and a CCD (Charge-Coupled Device), which are similar to the active elements found in digital cameras. The CCD is able to digitize the color of the pixels into four components: Black, Red, Green and Blue. When scanning in Black and White mode a combined signal is produced from the Red, Green and Blue signals (some CCDs can generate it directly).

² Red patches absorb more light in the blue, green and yellow parts of the visible spectrum than in the red part.

³ The optics part of a camera is a series of mirrors and lenses that enable the small CCD to see a wider part of the original.



The cameras must be periodically calibrated in order to avoid undesired geometrical distortions in the final copy, as well as ensure a correct color capture. Calibration can be performed using the scanner maintenance tool provided with the system. It is advisable to run the scanner calibration every time the system warns the user to do so, or when any of the following defects appear: jagged lines, blurry images, modified colors (with respect to previous copies).

3.1.2.4 Electronics

After each strip has been digitized, the electronics compose the whole image and apply several image treatments and linearizations to correct geometrical and color space distortions. The result is a digital image ready to be sent to the touch screen, which in turn will either store the image or send it to the printer.

During the scanner maintenance process, the electronics calibrate all the responses from other elements (light, optics and CCDs) and between the CCDs themselves to obtain an accurate response.

The scanner maintenance should be run whenever you suspect that copies are losing image quality due to the scanner maladjustment or periodically (e.g. once a month), depending on:

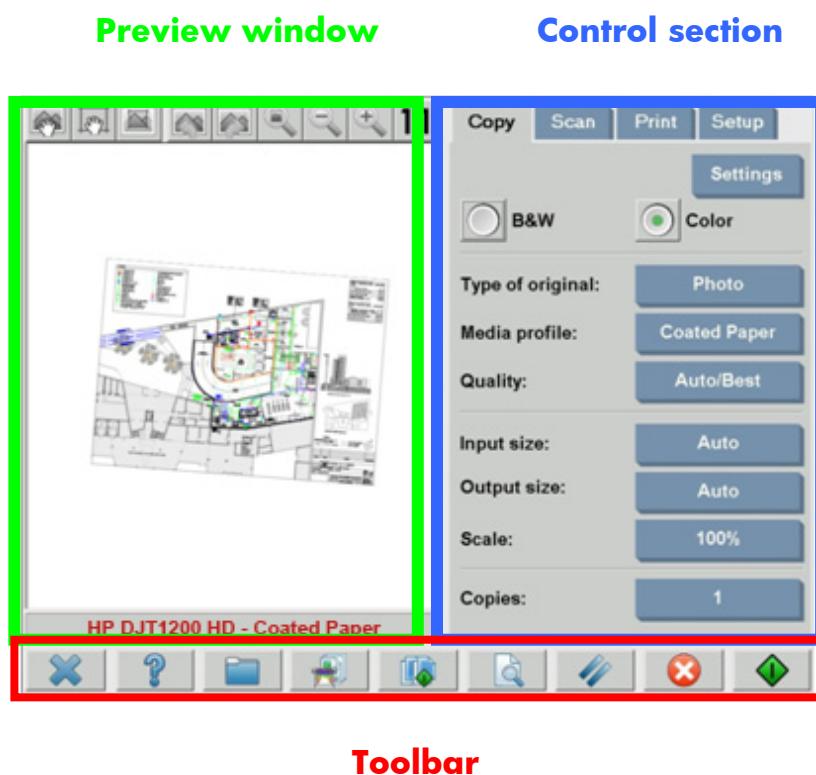
- Number of hours of usage
- Types of original loaded (some originals dirt the glass plate more than others)
- Variations of temperature and humidity

3.1.3 Touch screen

The touch screen provides the user interface to the system and connects the various elements of the system.

The user interface is divided into three parts (see picture below):

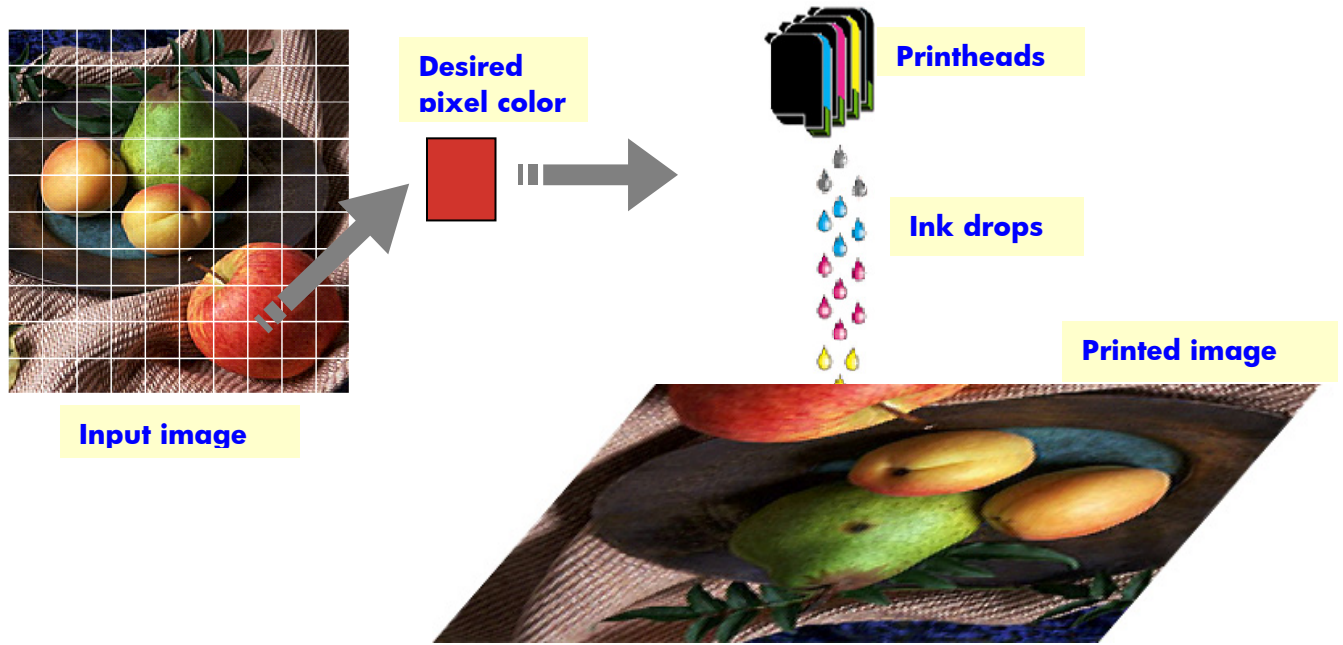
- The control section, with four main control tabs: Copy (from original to final output), Scan (for scanning to a file), Print (for printing from a file) and Setup
- The preview window, where you can see how the image will look when printed
- The toolbar, a set of command buttons at the bottom, used to start or stop various actions (e.g. see a preview image, start copying)



What you see on the screen may vary slightly depending on the printer installed.

3.1.4 Large format printer

The task of the printer is to place tiny drops of ink on the media (paper or other substrate) in order to form an image that corresponds to the data file received.



Your HP Large Format Copier supports the printers defined in the product's data sheet.

Most of them are thermal inkjet printers, which means that little drops of ink are heated up to the boiling point and sent to the media. The amount of ink that reaches the media is controlled by the writing system of the printer (the printer's controller) and depends on the type of media and desired print quality (e.g. coated paper accepts less ink than photo-gloss paper and Best quality mode requires more ink than Fast mode).

This is why it is very important to tell your copier system which type of media you have loaded.

The real amount of ink dropped may be different from the amount requested by the printer's controller, due to unequal performance of the printheads: one printhead may drop 12 pl⁴ while another may drop 14 pl, thus resulting in different final colors. Another nuisance is that different media lots may behave differently: one lot may allow more ink than others to reach the inner part of the substrate, thus resulting in "duller" (washed-out) final colors.

⁴ A picoliter is equal to one millionth of one millionth of a liter. It is similar to a nanogram of ink (one millionth of a milligram).

The HP Large Format printers have a way to compensate for these problems: Closed-Loop Color calibration (CLC). This process consists of calibrating the printer by applying a color value table, which is created by printing a color ramp for each ink and measuring it with an internal color sensor.

Depending on the printer model, there are different ways to access this feature (see your printer's documentation).

Each time a printhead is replaced, a printhead alignment should be run (this is automatically started in most cases) to avoid image quality degradation.

Please refer to the printer's documentation to maintain it in good working order.

3.1.5 Final image

The final image is the output of the printer. It should be handled with care, ensuring that the ink is completely dry before using it.

Please note that the perceived color is a result of the ink, media, light and air physical or chemical interactions, and it can, therefore, change unexpectedly when conditions differ significantly: direct sunlight, temperature, humidity, air contamination, etc. In order to avoid fading, you are recommended to cover the copy with glass or transparent film and not to expose it to direct sunlight.

3.1.6 Overall system

The previous sections have described each of the components of a color reproduction system. This section talks about the interactions between these components.

3.1.6.1 Color management

To obtain a good color reproduction, the color definitions coming from the scanning system have to be adapted to the color definitions needed by the printer. For example, a specific green color may be reported by the scanning system as:

Red: 60%, Green: 70% and Blue: 40%

but can only be reproduced identically by the printer if defined as:

Red: 42%, Green: 81% and Blue: 38%

There is therefore a need to convert the scanning system's RGB colors to RGB values understood by the printer. This conversion is done automatically by the scanning system, using the media profiles.

The media profiles define the relationship between the colors the scanning system sees and the colors the printer is able to print. For some printers there is a set of pre-installed media profiles (High-gloss Photo, Coated, Bright White, etc.). However, if you need to print on other media, or desire a color reproduction system that better matches your media, it is advisable to create new media profiles, as specified in section 0.

A new media profile will ensure that the scanning system and the printer are perceptually better adapted to each other. You are recommended to create a new media profile every time a printhead is replaced (just the printhead, not the cartridge), and every time a new media type, for which no media profile already exists, is loaded into the printer.

In addition to the always-active color conversion provided by the media profile, there are some optional settings in the touch screen that allow the operator to modify the colors of the printed output. Any modification to such settings may produce a copy that is not perceptually similar to the original, but may be desirable for some other reasons (more vivid colors, darker or lighter image).

These settings are:

- **Lightness:** makes the whole image darker or lighter.
- **Saturation:** intensifies or weakens the colors. The final image becomes more vivid or grayer.
- **Color balance:** corrects the red, green and blue of the whole image. For example, if the image has a yellow color cast, increasing the blue color balance may reduce it.
- **Black enhancement:** makes all areas beyond a specified threshold of darkness completely black. This feature should be used when text that should be black appears in the copy as gray.
- **Background cleaning:** makes all areas beyond a specified threshold of lightness completely white. It is useful when copying drawings that have a colored (not white) background, such as blueprints.
- **Black ink only:** forces the printer to use only black ink. It is useful to avoid a color cast in the printed output that is produced by the use of composite black made from mixing colored inks. Note: the **Black ink only** setting is not available with some printers.
- **Enhance gray:** converts pale colors in a color image to gray.

To see these settings in action, please refer to section 3.4.

3.1.6.2 Image enhancement

Image enhancement is used to improve the original image or a portion of it. The final image will not be an exact copy of the original but, rather, a re-interpretation of it that corrects some of the original's shortcomings (e.g. stains, fuzziness).

There are two types of image enhancement available in the touch screen:

- **Blur:** smoothes the image. It is used, for example, when the original is worn out and has spikes or stains that you don't want appearing in the copy.
- **Sharpen:** enhances edges in the image. It is used, for example, when a drawing has smudged text or lines.

Blur and sharpen are not mutually exclusive, and good results are sometimes obtained by combining them: an application example is provided in section 3.4.

Image enhancement is optional and should be selected only if necessary, as the final image will look somewhat different from the original.

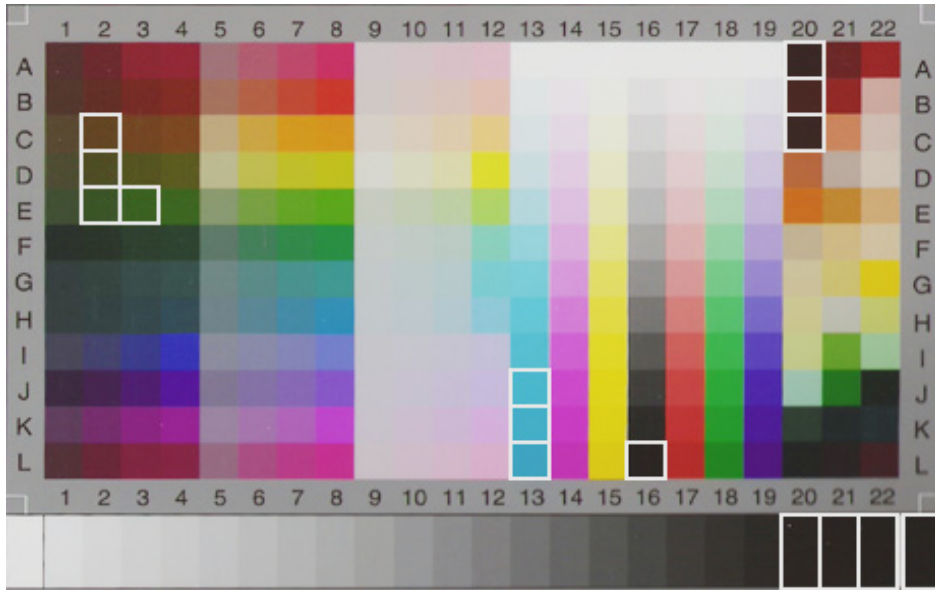
3.2 Which colors can be reproduced?

The colors that can be reproduced vary between different printers and different printing media. At HP, we analyzed various environments and reached the following conclusions:

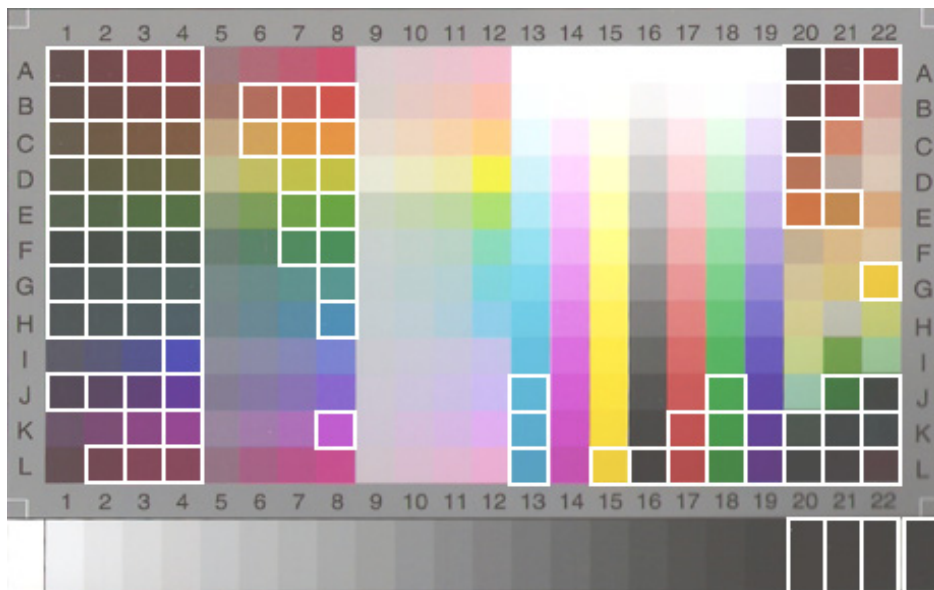
- Glossy paper (such as HP Universal High-gloss Photo Paper) has a much wider “gamut” (amount of reproducible colors) than matte paper, such as HP Heavyweight Coated Paper. Typically, the main difference resides in the darkest tones (those found in shadow areas of pictorial images) and in the most saturated colors (vibrant red or blue).
- The cyan ink is not as saturated as the cyan found in traditional silver-halide pictures. This may lead to problems when reproducing saturated cyan (sky blue) or dark blue (navy blue).
- The darkest blacks are difficult to reproduce, especially on coated paper. Sometimes, the problem is to achieve the desired darkness; in other cases, the darkness is correct but has a color cast (green or pink tint).

In any case, the fact that an original image shows colors that cannot be matched exactly does not mean that the copy will be unacceptable. It will depend on the relation of these colors to the surrounding ones and their “criticality”. If the affected colors are not well reproduced, but the surrounding ones are, the result is normally acceptable (the difference may be barely noticeable). On the other hand, when a color must be reproduced as accurately as possible (such as colors in a company logo) even a small deviation may cause the job to be rejected.

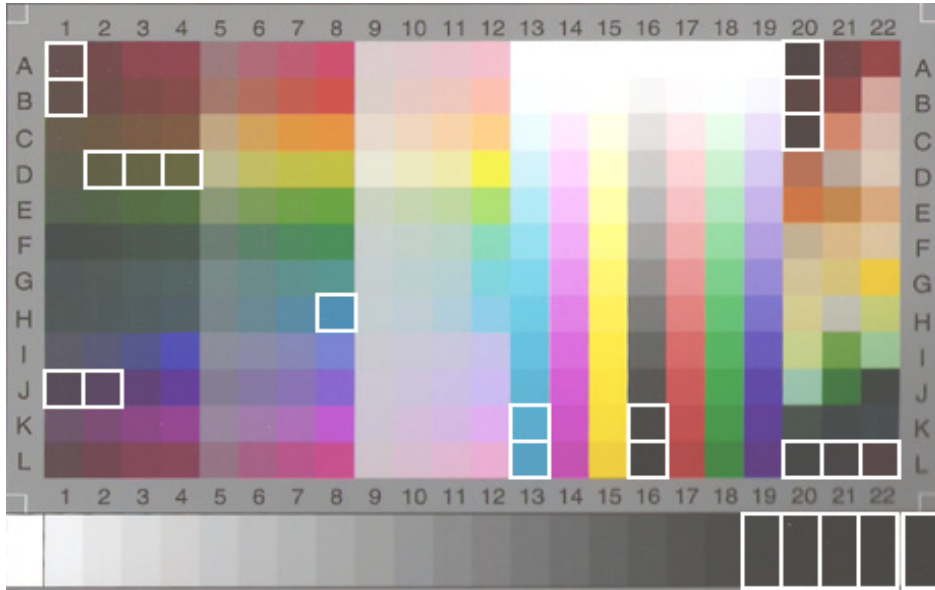
For example, the following images show the non-reproducible colors for some copier systems and paper types as patches surrounded by a white square. This test has been based on the IT8.7/2 target provided with the scanner maintenance tool, which is a silver-halide picture and has been scanned and reproduced with the following HP Designjet printer series: 500/800, 105x, 4000/4500, 5500, T1200, Z2100, Z3200 and Z6100. We show the results obtained for two paper types: HP Universal High-gloss Photo Paper and HP Heavyweight Coated Paper. Please note that the result may vary if a different original, a different paper type or an uncalibrated printer is used.



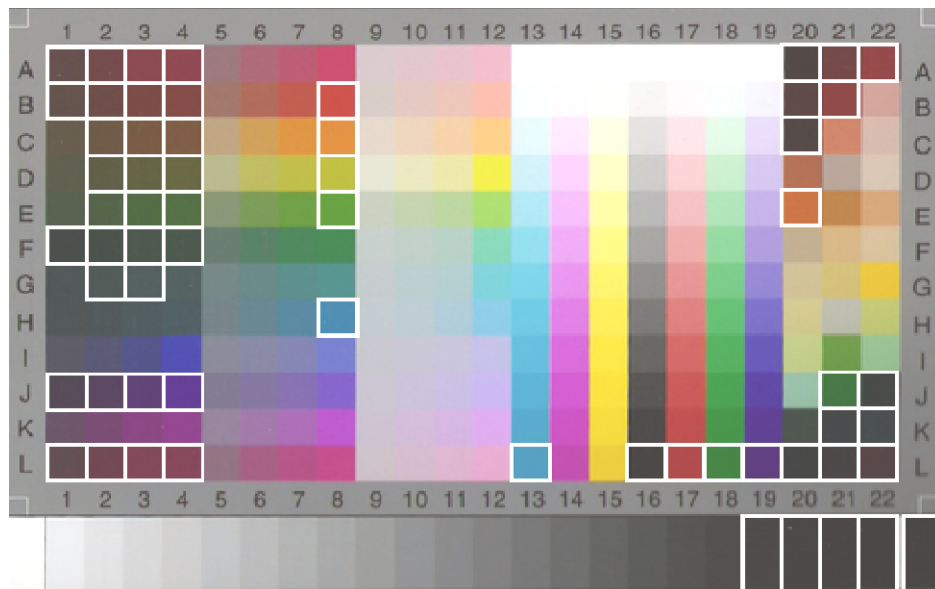
HP Designjet 500/800 with HP Universal High-gloss Photo Paper (Q1427A)



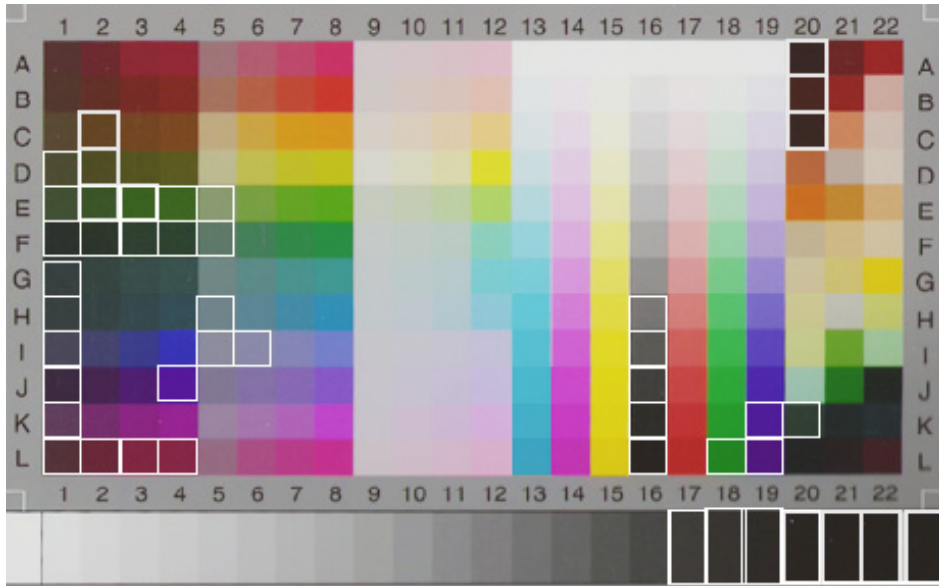
HP Designjet 500/800 with HP Heavyweight Coated Paper (C6030C)



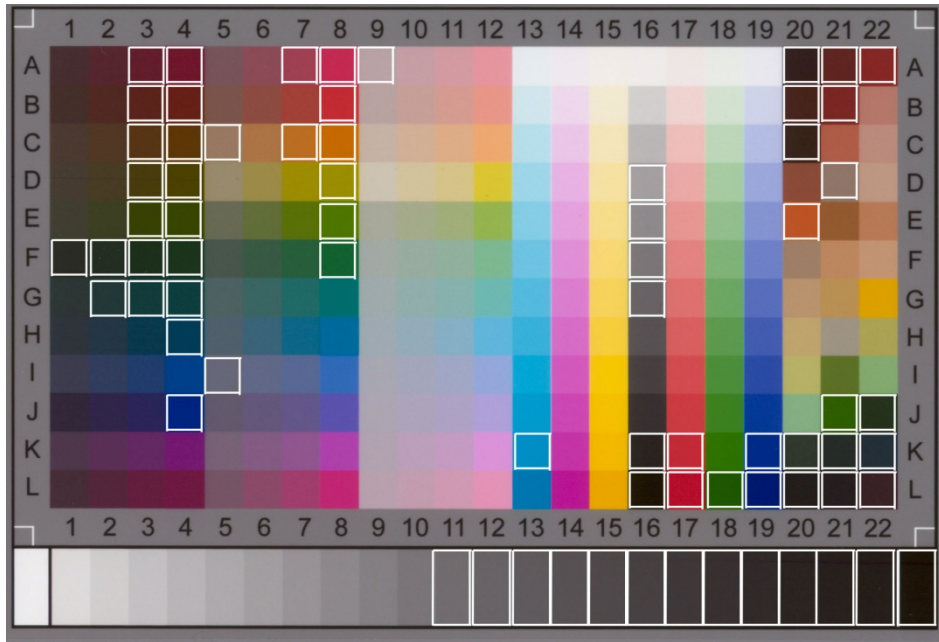
HP Designjet 105x with HP Universal High-gloss Photo Paper (Q1427A)



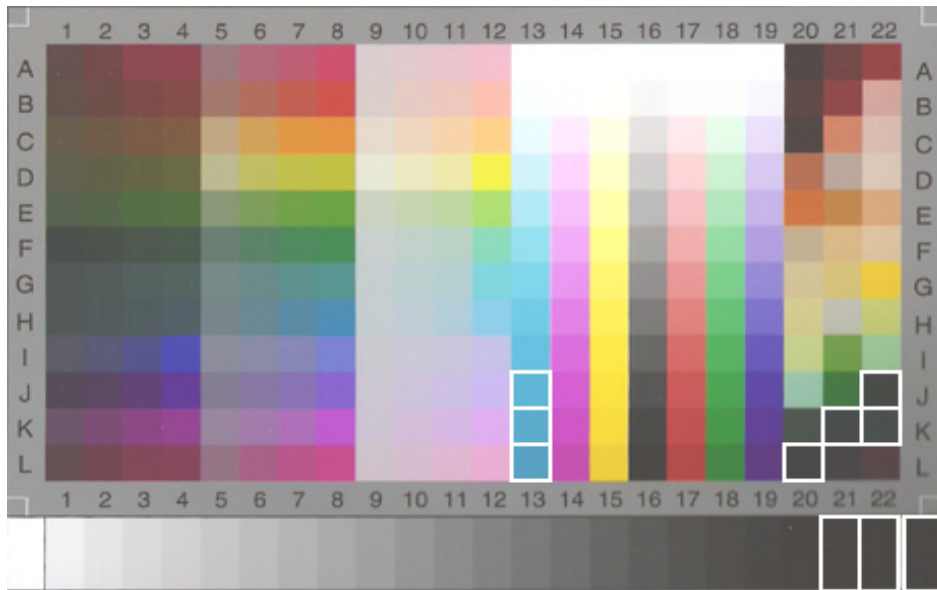
HP Designjet 105x with HP Heavyweight Coated Paper (C6030C)



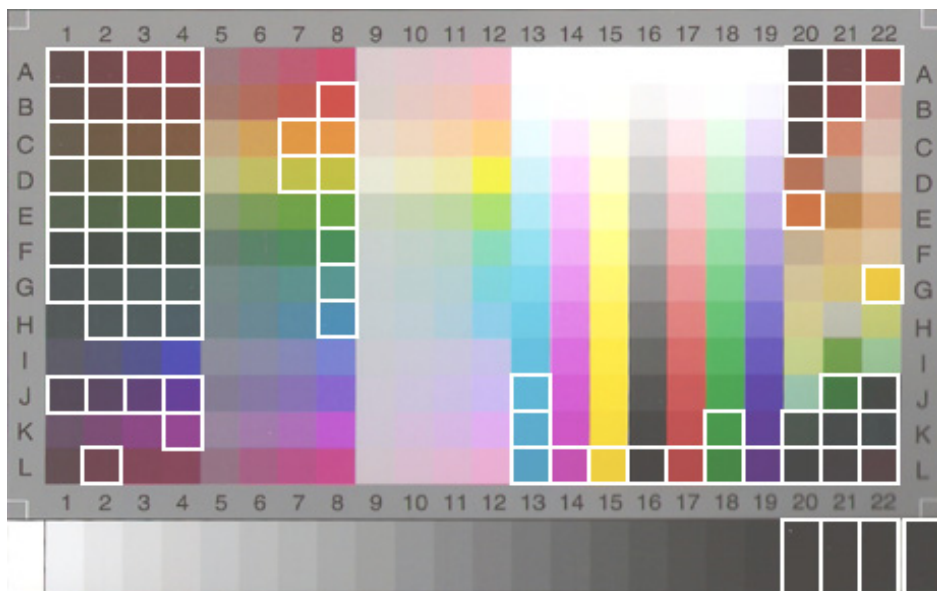
HP Designjet 4500 series with HP Universal High-gloss Photo Paper (Q1427A)



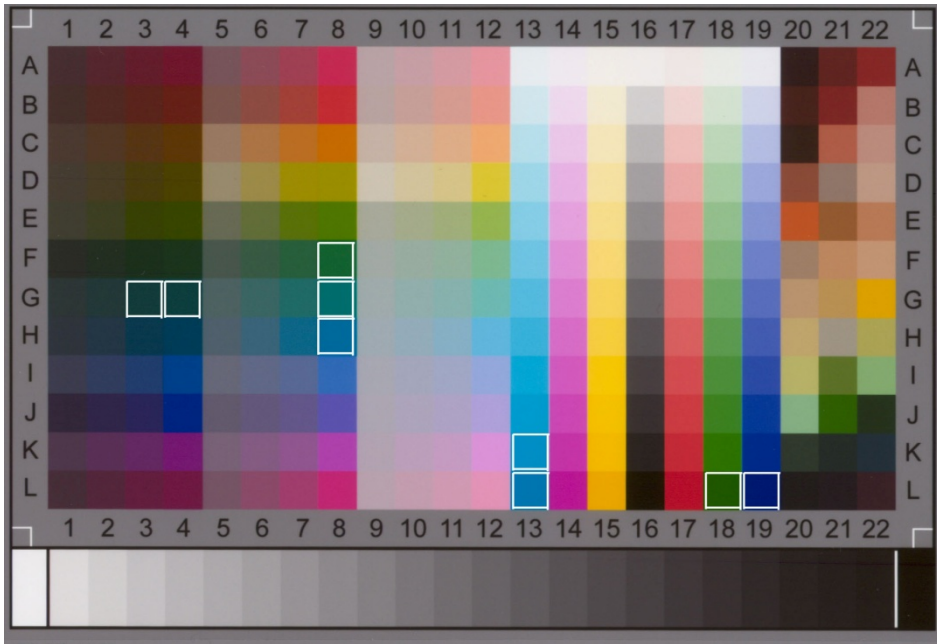
HP Designjet 4500 series with HP Heavyweight Coated Paper



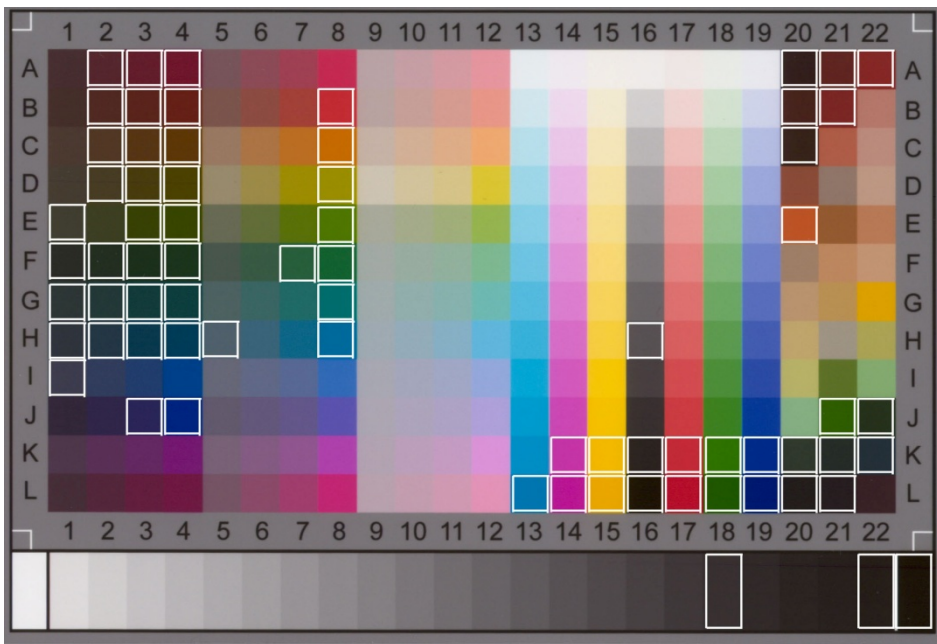
HP Designjet 5500 with HP Universal High-gloss Photo Paper (Q1427A)



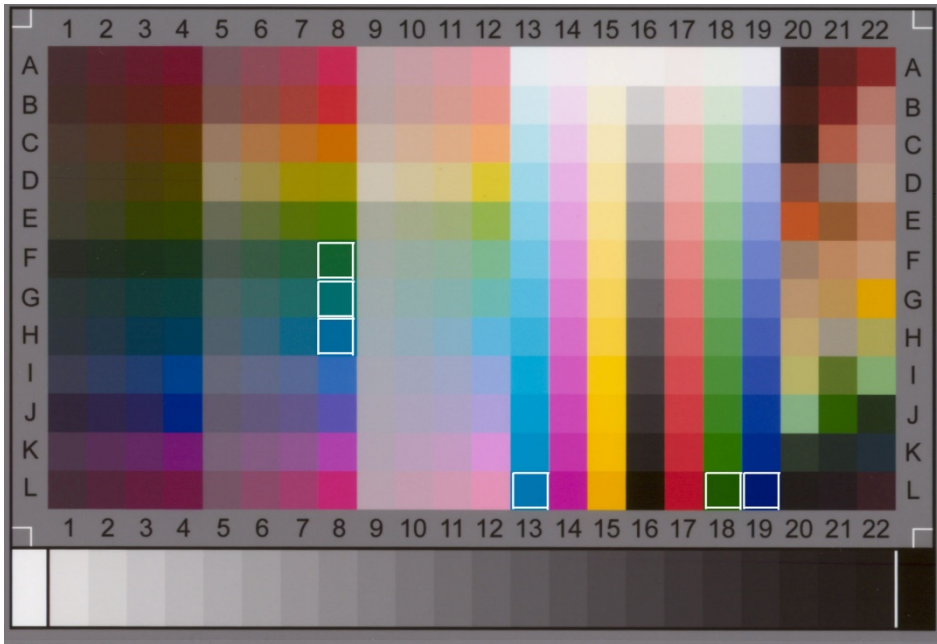
HP Designjet 5500 with HP Heavyweight Coated Paper (C6030C)



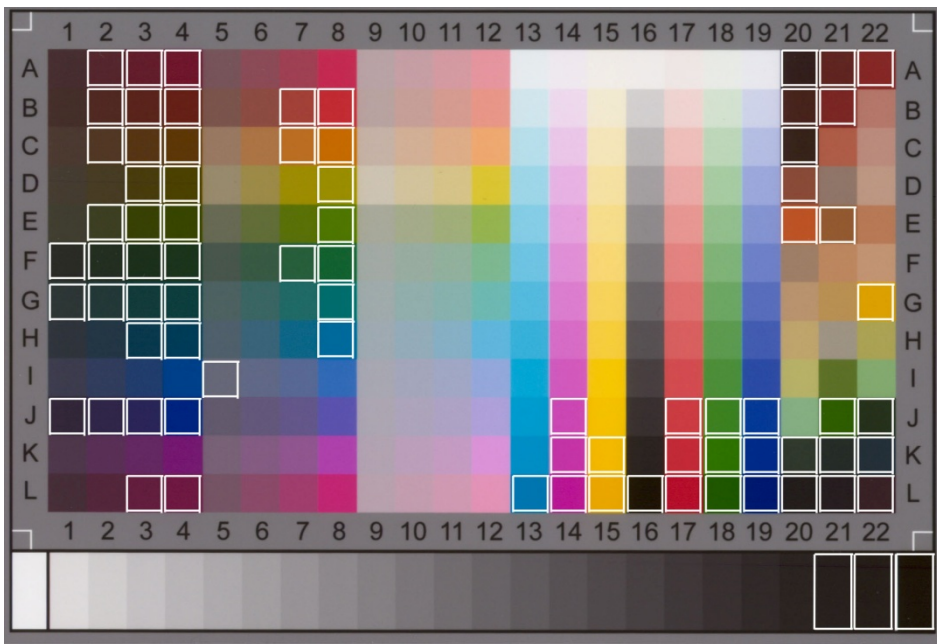
HP Designjet T1200 with HP Universal High-gloss Photo Paper



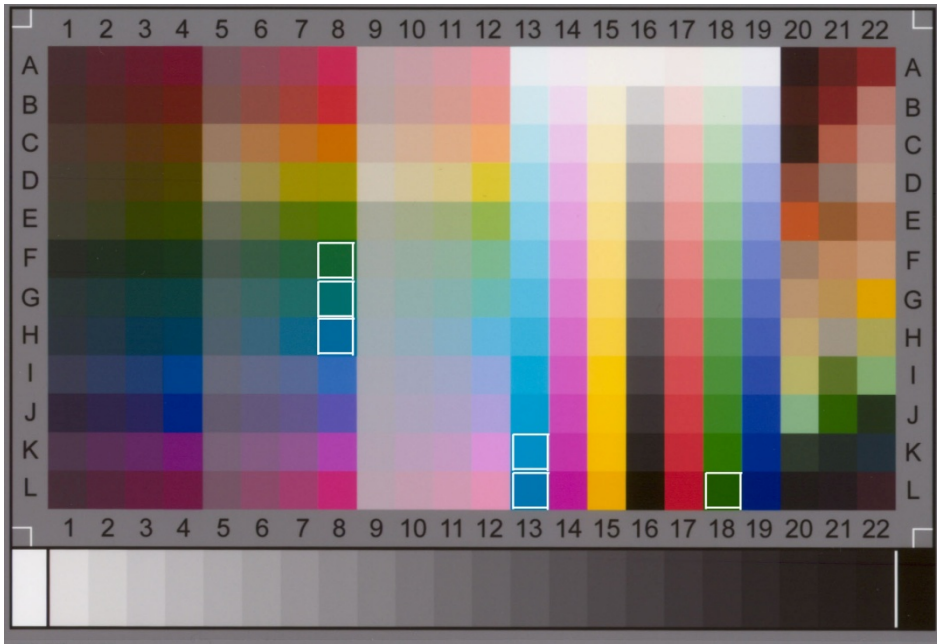
HP Designjet T1200 with HP Heavyweight Coated Paper



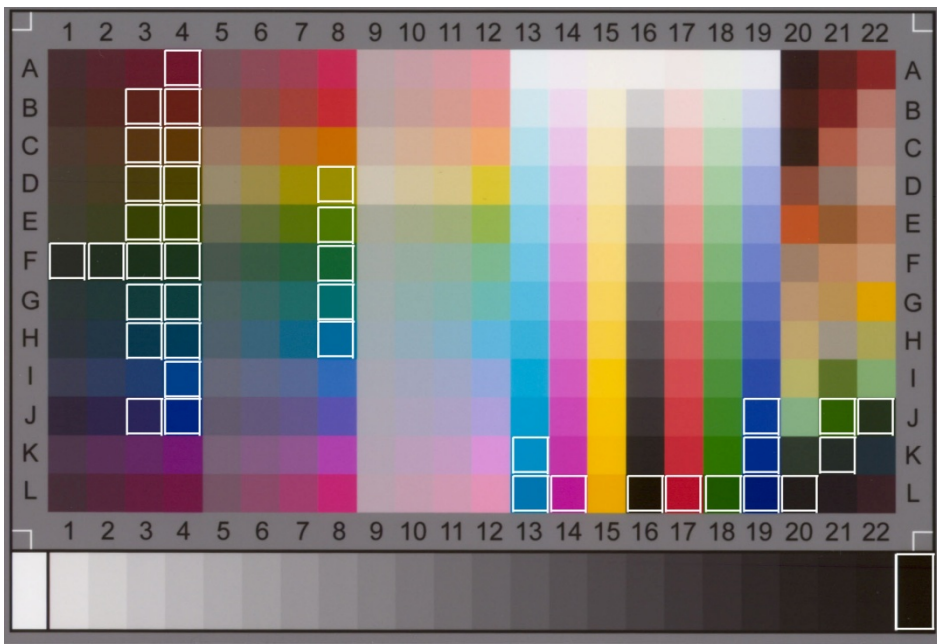
HP Designjet Z2100/Z6100 with HP Universal High-gloss Photo Paper



HP Designjet Z2100/Z6100 with HP Heavyweight Coated Paper



HP Designjet Z3200 with HP Universal High-gloss Photo Paper



HP Designjet Z3200 with HP Heavyweight Coated Paper

3.3 Guidelines to create or validate a media profile

Many of the color problems appearing in the HP Large Format Color Copiers products are related to the mismatch between the media's color characteristics set up in the touch screen and those of the real media that is loaded into the printer. If there is such a mismatch, colors may be reproduced incorrectly, grays may have some color cast or some colors may be lost.


The characteristics of the media are defined in the media profile and are selected (for some printers) by the Media Profile setting under the Setup tab. In some printers, there are a number of predefined media profiles (e.g. High-gloss Photo, Bright White, Heavyweight Coated); however, if you are using a media type that is not included in the list, or using a printer without predefined media profiles, a new media profile has to be created. By using a media profile that does not correspond to the characteristics of the interaction between the printer, the media and the ink, you risk having color copies that do not correspond to the original.

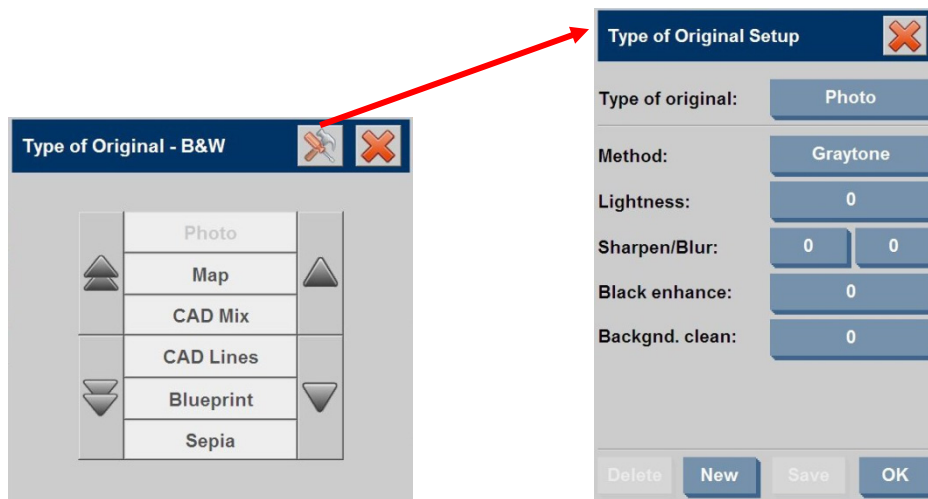
It is recommended to check the media profile in use from time to time; for example, once a month or when you suspect the overall system has changed its "behavior" (e.g. you see colors that are consistently substituted with other colors). This is done through media profile validation. Please see your scanning system's documentation to see how to create and validate media profiles.

Note: Before creating or validating a media profile, ensure that you have color-calibrated the Scanner.

3.4 Effects of changing default media profile settings (color)

This section describes how the media profile settings act upon the image.

To create or modify⁵ a type of original you need to select an existing one (Photo in this example) and press the Tool button .



In the preview pane you will see two copies of the image: the bottom one is the original and the top one is the image modified by the settings of the selected type of original. Therefore, when modifying the settings you can immediately see the effect on the image. You will also see an asterisk (*) on the upper right side of the type of original name (as in the picture above), to show that some settings have been modified.


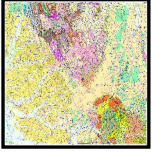
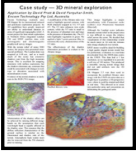
If you plan to scan many originals of the same type, it is advisable to store the newly created type of original under a meaningful name.

The following sections describe the settings that can be modified and their possible values. Please also refer to the values defined in paragraph 1.3 of section 2.2.

⁵ Please note that when creating or modifying a type of original, the color accuracy between original and copy can be compromised.

3.4.1 Method

Method defines the basic image enhancement to apply to the scanned image. It depends on the printer installed, but may have one of the following values:

Continuous tone: used when the image has many colors and transitions among them. This method is used in the "Color Photo" type of original.	
Graphics: used for images where lines and edges should be sharp. Used in "Map" and "CAD" types of original.	
Mixed: used when the original contains both text and pictures. Used in the "Brochure" type of original.	

3.4.2 Lightness

This setting is used to increase or decrease the lightness of the image. It can be used to compensate for dull or faded originals.

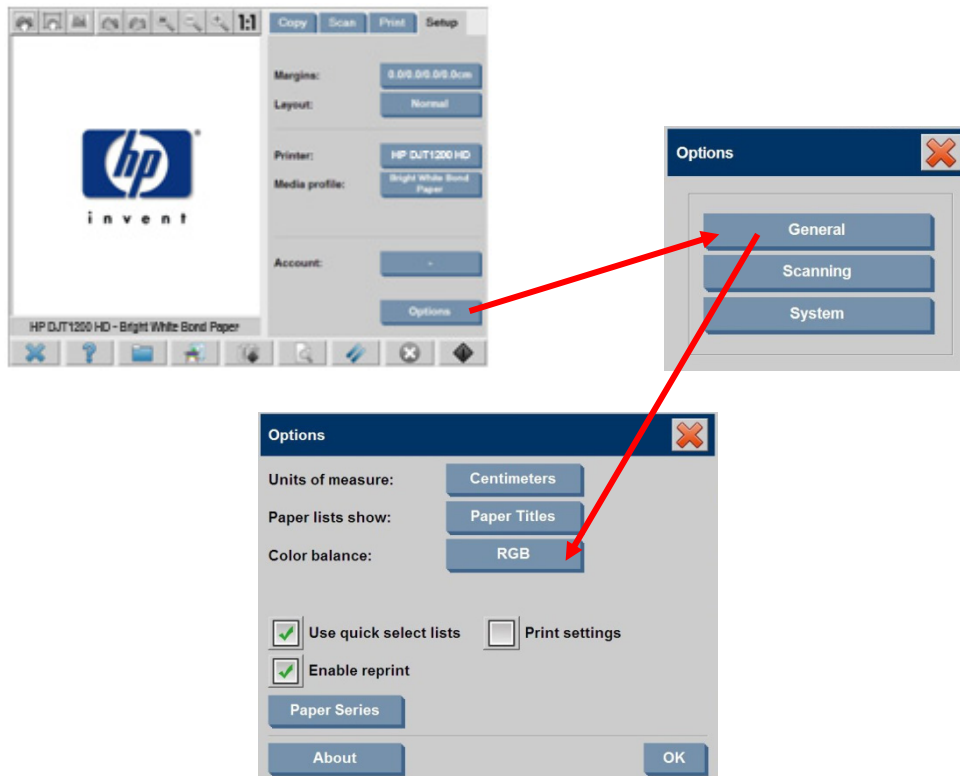
3.4.3 Saturation

When positive, this setting increases the colors' saturation (i.e. colors become more vivid); when negative, it makes the image duller (grayer). It can be used to compensate for faded originals.



3.4.4 Color balance

This setting is used to adjust the color balance for the whole image. If you find that the overall image has a color cast (e.g. it is too green) then you may correct it by modifying the color balance. You may set the Color balance value to RGB (Red, Green and Blue) or CMY (Cyan, Magenta and Yellow), depending on the selection made in the “Setup tab > Options button > General button > Color Balance”.



Please note that same results can be obtained using either RGB or CMY. The following table explains the relationship between the variations of such colors:

Setting	positive value results in a ... image	negative value results in a ... image
Red	Redder	“Cyaner”, turquoise
Green	Greener	“Magenta”, pinker
Blue	Bluer	Yellower
Cyan	“Cyaner”, turquoise	Redder
Magenta	“Magenta”, pinker	Greener
Yellow	Yellower	Bluer

As you can see, the same effect (e.g. having a redder image) may be achieved by increasing the Red value (in RGB mode) or by decreasing the Cyan value (in CMY mode). In addition, increasing (or decreasing) the value of one color has the same

effect as decreasing (or increasing) the values of the two remaining colors of the same set. For example, to make the image bluer you may increase the Blue value or decrease both the Red and Green values.

The entity of the color change differs depending on the direction you are heading. In other words, when moving towards positive values in RGB mode the appearance of the image changes slightly, whilst when moving towards negative values, the image exhibits a much bigger change. In CMY mode, it is the opposite: moving towards positive values produces greater changes than moving towards negative values.

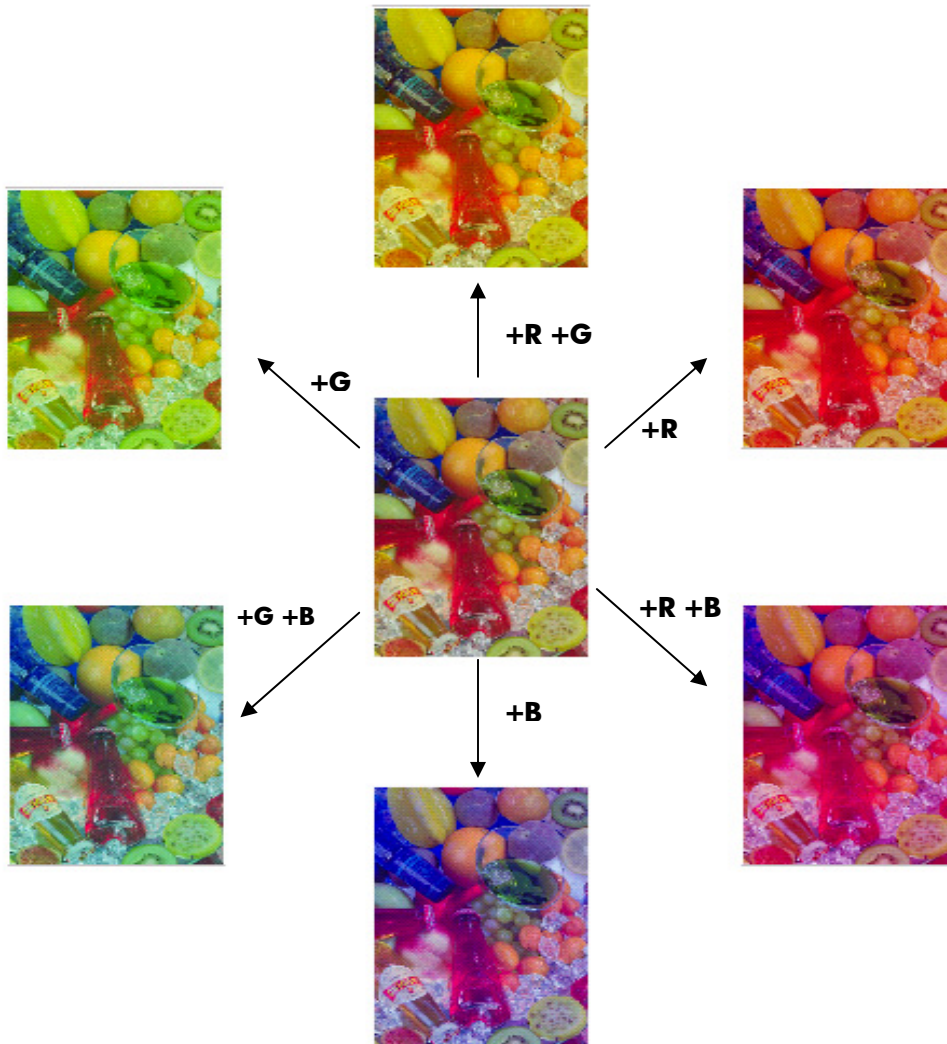
This behavior is shown in the table above where the Cyan, Magenta and Yellow boxes are more saturated (i.e. stronger) than the Red, Green and Blue boxes. This does not exclude the possibility of having slight increases in the amount of Cyan, Magenta and Yellow. These are achieved through the usage of the complementary colors: for example to produce a slight increase of Yellow, you will need to modify Red and Green (in RGB) or Cyan and Magenta (in CMY).

It is advisable to use only one system (either RGB or CMY) and not to mix them. If in doubt about which system to choose, you should consider that RGB is, in most cases, more intuitive. The following table is a guideline to the correct actions required to obtain the desired color balance:

Color Balance Needs:		Should move to ... values			Should move to ... values		
Increase in	Strength in change	Red	Green	Blue	Cyan	Magenta	Yellow
Red	Hard		-	-		+	+
	Soft	+			-		
Yellow	Hard			-			+
	Soft	+	+		-	-	
Green	Hard	-		-	+		+
	Soft		+			-	
Cyan	Hard	-			+		
	Soft		+	+		-	-
Blue	Hard	-	-		+	+	
	Soft			+			-
Magenta	Hard		-			+	
	Soft	+		+	-		-

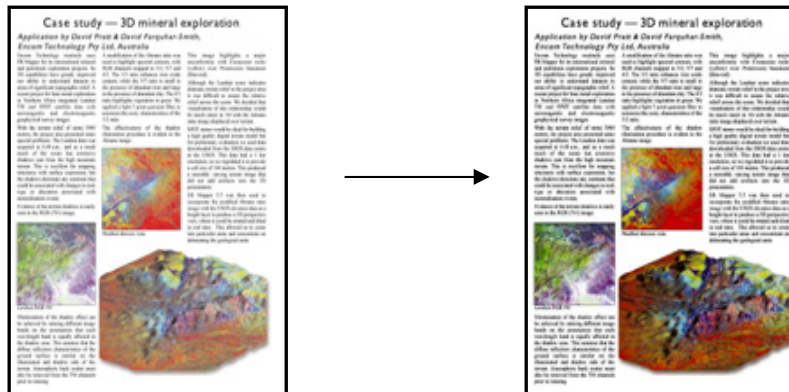
Please remember that Orange and Brown lie between Red and Yellow, and Violet is between Magenta and Blue.

The following picture shows the effects of increasing the RGB values of an image:



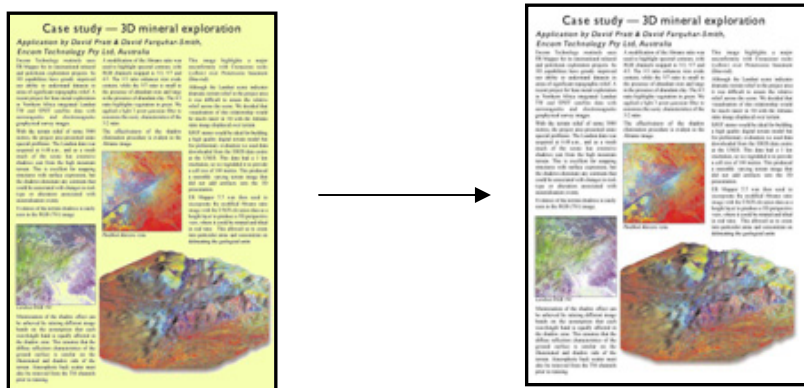
3.4.5 Black enhancement

This setting is used to blacken all areas below the defined lightness level. It is employed to enhance the text parts of a document, when black text is copied as gray. Valid values range from 0 to 255. If 0 is selected, the image is not modified; if 255 is selected the whole image will be black.



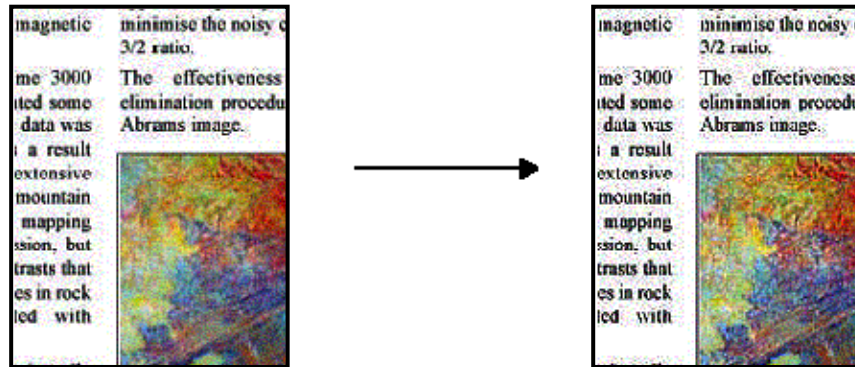
3.4.6 Background cleaning

This setting is used to whiten all areas above the defined lightness level. Valid values range from 0 to 255. If 0 is selected the image is not modified; if 255 is selected the whole image will be white.



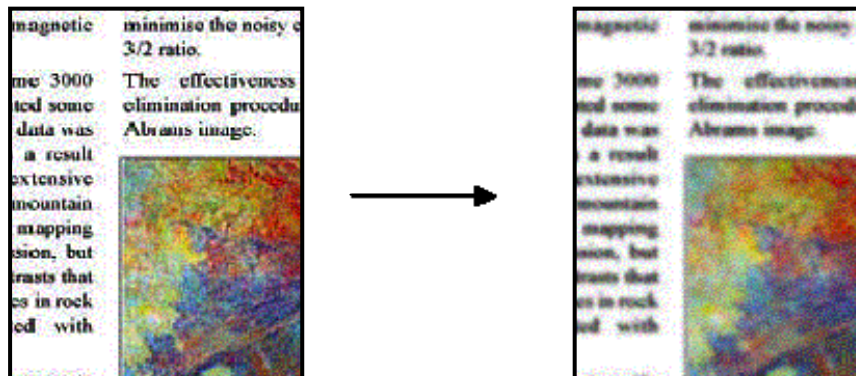
3.4.7 Sharpen

This setting is used to sharpen the image. It enhances the edges between areas of different colors, thus resulting in better-defined text and edges. The strength of the sharpening is controlled by its value.

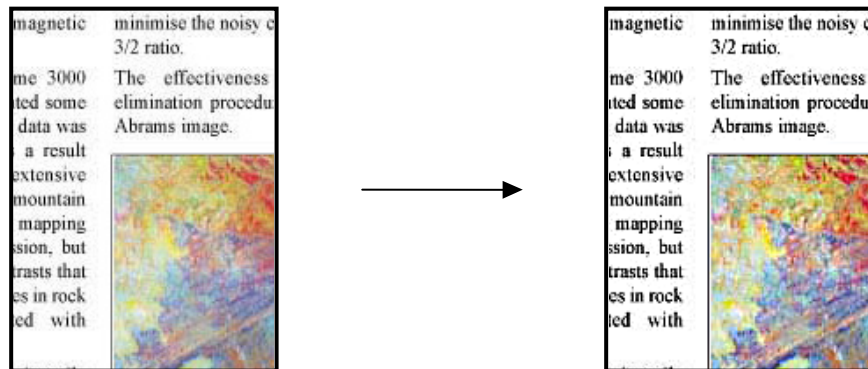


3.4.8 Blur

This setting is used to smooth the image. It is useful when the scanned original is "noisy" (i.e. color disturbance, graininess and non-area uniformity).



Although blurring is the opposite of sharpening, they do not cancel each other out. In fact, the two options can be usefully combined to blur away noise in the image first and then sharpen the result. Observe below the same example as before, with blur and sharpening applied. Note that now there is no “augmented noise” in the text area, compared with the result when only sharpening was applied.


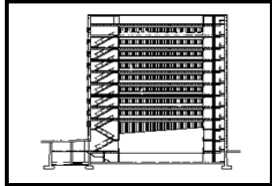


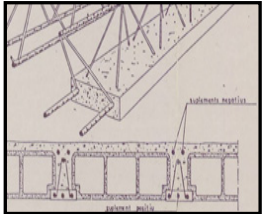


3.5 Effects of changing default media profile settings (b&w)

The settings that can be modified and their possible values are described in the following sections.

3.5.1 Method

Method defines the basic image enhancement to apply to the scanned image. It depends on the printer installed, but may have one of the following values:

<p>Graytone: used for pictorial images (pictures with many gray shades).</p>	
<p>B&W Threshold: used for pure B&W clear CAD drawings and/or text only documents, where the background is pure white and the text or lines are well defined. It only distinguishes two elements, black and white, and they are defined depending on a threshold value (which is the user-specified lightness value described in section 3.5.2). There will be no gray levels in the output.</p>	
<p>Normal: used when the original contains both text/CAD lines and pictures/graphics.</p>	
<p>Photo: this method exists for historical reasons and was designed for pictures; however, better results are obtained with Graytone and there is no predefined type of original that uses this method.</p>	
<p>Adaptive: used for CAD or text documents where the background is barely distinguishable from the lines or characters, where, for example, the original is a blueprint or an old and worn out document. This method is similar to Normal but extracts the background gray level from the input image.</p>	

3.5.2 Lightness

This setting increases or decreases the lightness of the image. It can be used to compensate for dull or faded originals.

3.5.3 Sharpen

This setting is used to sharpen the image; it enhances the edges between areas of different colors (see the explanation in section 3.4.7).

3.5.4 Blur

This setting is used to smooth the image. It is useful when the scanned original is “noisy” (see the explanation in section 3.4.8).

All comments made in section 3.4.8 regarding the combined use of sharpening and blurring apply here as well.

4. GLOSSARY

Background cleaning	Image enhancement feature that whitens all areas above a defined lightness level. Typically used to avoid noise, stains or wear marks.
Black enhancement	Image enhancement feature that blackens all areas below a defined lightness level. Typically used to enhance text.
Black ink only	A print settings option that forces the printer to use only black ink. It is useful to avoid a color cast in the printed output which is produced by the use of composite black made from mixing colored inks.
Blueprint	A white print on a blue background, especially used for copying maps, mechanical drawings and architects' plans.
Blur	Image enhancement feature that makes the image softer and less sharp.
CAD drawing	Computed Aided Design technical drawing: mechanical, electrical/electronic, architectural.
Color balance	Adjustment of the ratio of Red, Green and Blue (or Cyan, Magenta and Yellow) components, which aims at producing a copy free from any unwanted color cast or color bias.
Color calibration (CLC)	Closed-Loop Color. The process of bringing the color printer system to standard operating conditions.
Color management	The process of controlling colors to obtain what is expected from a color reproduction device.
Copying	Reproducing an original image onto a substrate.
Enhance gray	Converts pale colors in a color image to gray.
Gray balance ramp	Sequence of gray patches, ranging from very light (white) to very dark (black) shades, in a constant decrease of lightness.
Hue	Attribute of color that determines whether it is red, yellow, green, blue, or some combination of pairs of these (e.g. an orange can be 30% red and 70% yellow).
Image enhancement	Any process which aims at improving the appearance of an image. This can be done using filtering, transformation or "threshold" techniques, such as edge enhancement, blurring, sharpening or blunt masking.
Inkjet printer	A type of printer that shoots fast-drying drops of ink through tiny nozzles to create an image on paper or other material.
Lightness	The attribute of visual perception in accordance with which an area appears to emit or reflect more or less light.

LUT file	<p>It distinguishes light from dark areas.</p> <p>A Look-Up Table (LUT) file. It correlates n-dimensional entries with m-dimensional outputs. In this instance, it correlates a 1-dimensional entry (the lightness) with a 3-dimensional output (the corresponding Red, Green and Blue values).</p>
Media	The physical material on which an image is formed (printed).
Media profile	A description of the media and printing system's behavior, including which colors can be reproduced on the media and how to reproduce them.
Non-reproducible color	A color that cannot be reproduced by the system either because the color is not correctly "seen" by the scanner (which detects it as a different color) or because it cannot be printed by the printer (ink/media limitation).
Original	The printed media that has the original image formed on it.
Printhead alignment	The process of setting printer parameters to minimize ink drops placement errors when printing. It is performed automatically each time a printhead is replaced or may be started manually.
Printing	The transfer of ink onto paper or other media to reproduce text and images.
Saturation	The purity of a color's hue, moving from gray to the pure color. A high saturation corresponds to a strong color. Conceptually equivalent to a scale from pale/weak (low saturation) to pure/strong (high saturation).
Scan resolution	The resolution at which the scanner digitizes the original image. It is reported in dpi (dots per inch).
Scanning	The digitizing of the original image.
Sharpen	To enhance the contrast at the edges of light and dark areas, with the effect of making an image appear better defined, more in focus.
Stitching	The process of aligning the two cameras of the scanner so that when the two images are composed the differences along the overlapping area are minimized. It is executed every time the operator performs scanner maintenance.
Touch screen	The interface between the user, the scanner and the printer.
Type of original	A template that describes the characteristics of an original image and the color management and image enhancements it requires.

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Edition: October 2009

Hewlett-Packard Company
Large Format Printing division
Camí de Can Graells, 1-21
08174 Sant Cugat del Vallès
Spain