The Creative World of Digital Data

Color Management

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Hello and welcome!

Are you interested in the topic of color management?

A couple of pertinent questions to start with:

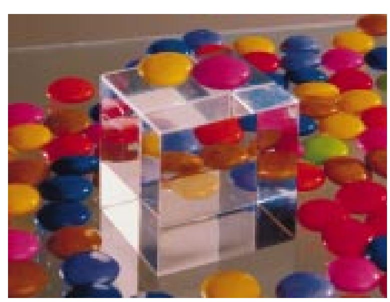
- Do you personally scan all the originals that you use and always with the same scanner?
- Do all your images always look exactly like the originals?
- Do you use all the images only once and for a single purpose?
- Do you always use the same imagesetter to produce print films?
- Is the only printout process you use offset printing?
- Do you always work with the same printing house?

If you've answered all of these questions with a resounding YES, then the topic of color management is only of theoretical interest to you. For most of us, though, it's more likely that a little no slipped in there as an answer to one or more of the questions. This isn't a problem but rather a clear indication that this topic is also of great, practical interest to you.

Please take a look at these three images:

Reproduction which corresponds to the original

Original scanned with scanner A, without color management



Original scanned with scanner B, without color management

Here you see reproductions of a single original produced by different scanners. Without color management The results are visibly distinguishable.

With the help of this book, we'd like to help you do away with such inconsistencies. We would like to explain to you exactly what is hidden behind the concept of color management, what concrete problems can arise in practical work with images, what solutions are available, and how you can put these various solutions to good use.

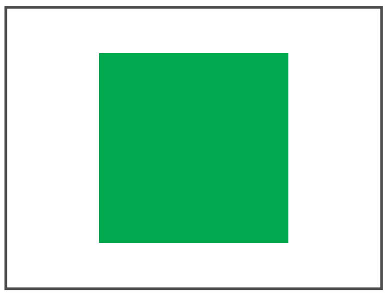
Once again, as in the book about Scanning, we've prepared a few surprises for you.

And here, once again, we would like to wish you:

Loads of Fun While Reading and Playing!

Before we get into the topic of color management, we'd first like to explain how colors come into being at all, and how they're perceived by people.

Take a look at this image:



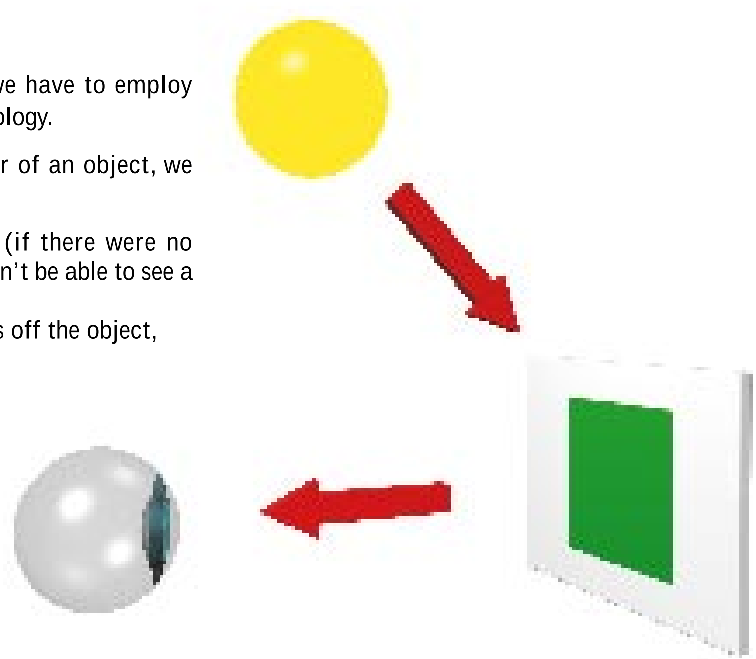
You see a green square.

- How can you see this square?
- Why is the square green?

To answer these questions, we have to employ just a little bit of physics and biology.

In order to perceive the color of an object, we need:

- first of all, the object itself (if there were no square up there, we also wouldn't be able to see a square),
- light which strikes and reflects off the object,
- our eye.



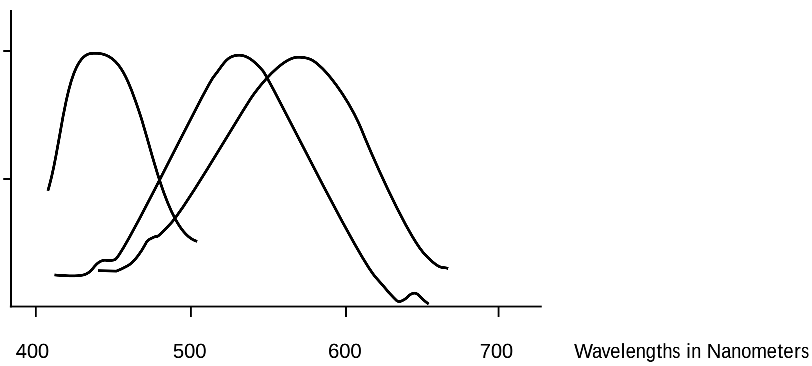
Light strikes our square and is reflected by it.

The reflected light strikes our eye and acts as a stimulus for our vision cells. These vision cells are composed of staves and cones. The staves, however, are only active in the dark and in twilight. In good lighting such as normal daylight, we see exclusively with the help of the cones. And exactly these cones are responsible for distinguishing colors. Three types of cones distinguish the various colors. Our little, green square above calls for only those cones which are responsible for green, and these in turn are the only ones which relay an impulse to our brain. The brain thus registers: square green.

So much for biology, now to a little physics. Don't worry, this'll be just as quick, easy, and simple. We just want to quickly answer these three questions:

- How does the transmission of light signals function?
- What actually stimulates the cones?
- And why only those which are responsible for green?

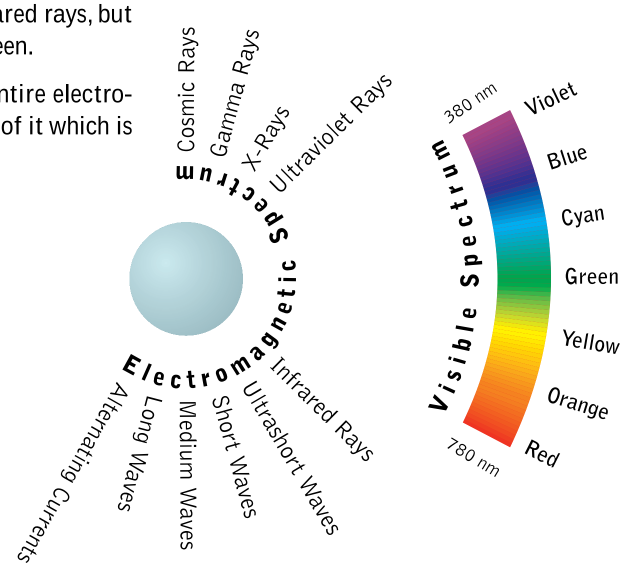
Colored light is transmitted in the form of electromagnetic waves. Different colors have different wavelengths. The various cones respond differentially to these different wavelengths.



Visible Spectrum for the Individual Types of Cones

On the one hand, the limited spectrum perceived by each kind of cone allows us to differentiate colors, but on the other hand it gives rise to the fact that there are waves which we cannot see. For example, we can feel ultraviolet and infrared rays, but neither the one nor the other can be seen.

This graphic shows once again the entire electromagnetic spectrum as well as the area of it which is visible to us:



Colors are perceived very differently by different people. Like smells or sounds, they trigger entirely subjective perceptions.

The spectral sensitivity of the eye varies slightly from person to person, which means that the same color can generate several different impressions. The color turquoise is thus often cause for confusion when it's perceived by one person as being green and by another person as being blue.

Even the mood you are in can influence your perception of color. If you feel tired at the moment, a gray-wallpapered room can seem to be much darker and grayer than would otherwise be the case.

Furthermore, external circumstances have an influence the way a color appears. The kind of light source is a very impoortant factor, for instance. It makes a difference whether you observe something in daylight, by the light of a light bulb, or by candlelight. A sheet of paper which looks white in daylight appears to be rather yellowish by candlelight. But that only lasts for a little while because our eyes adapt very quickly to changing light conditions. After a certain amount of time, the sheet of paper will look as white by candlelight as it did in the first place, although you'd think it would actually have to be more yellowish. This adaptability, or adaption, is a tremendous advantage when we enter a dark room, for instance. But in our judgement of colors it can be something of a hindrance. In this respect, we are actually deceived by our visual perception.

Aside from the lighting, an object's surroundings are also important.

Here, once again, you see the little, green square, but this time half of it lies on a vivid yellow background and half on a dark green one. Each background produces a very particular color impression for its half.

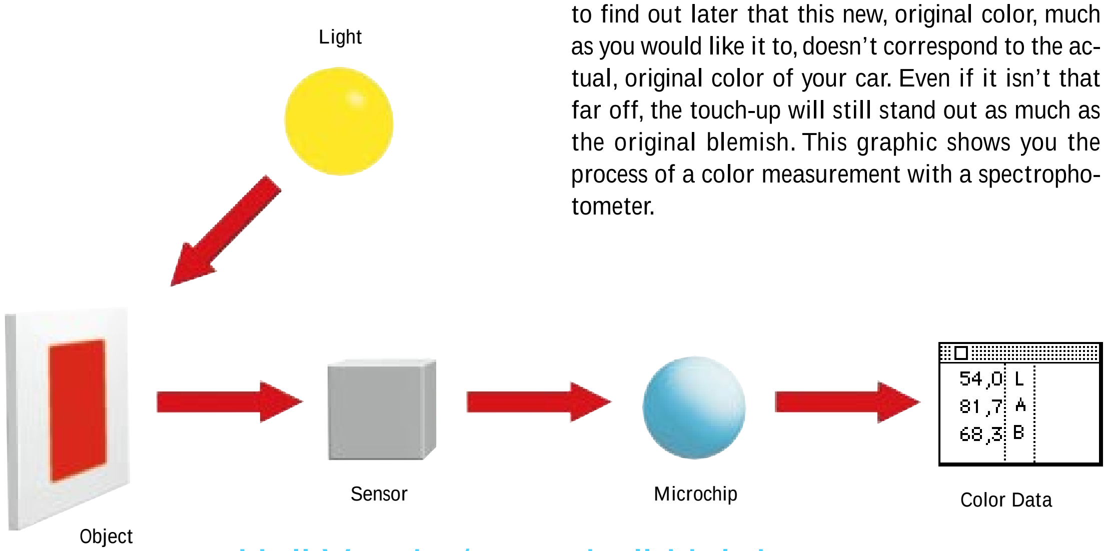
Another important point is the size of the color surface. This text, for example, lies on a background which is the same color as that of our little, green square. Doesn't the color also appear to be much more vivid to you? Even rather loud? So be careful when you select the color for a new carpet with the help of a 4 inch x 4 inch swatch !!!

If, however, color perception is so individually specific and so dependent on external circumstances, how can colors be described so precisely that there will be no mistake when, for instance, you want to design a logo and are supposed print it with a very particular red. The description "bright red" wouldn't exactly be precise.

Despite their subjective nature, colors can still be objectively compared with one another. Yet standardized conditions have to be created for that purpose. To that end, there are light trays and tables (no, these aren' t just nice, large work surfaces ...) on which your originals can be exposed to a standard light. Repro specialists generally use a light source with a temperature of 5000 K (Kelvins). This corresponds to medium sunlight. Photographers often prefer a light source with a color temperature of 6500 K, corresponding to medium daylight. The good thing is that a light tray or table maintains these conditions once they are standardized. Its light doesn't vary from morning to evening or depending one's mood. That means that you have conditions which are independent of external influences, and that you can undertake an objective color comparison.

Colors can even be accurately measured. You can measure whether the white of this page really corresponds exactly to the white of the opposite page. This measurement requires, however, that you have a special device called a spectrophotometer.

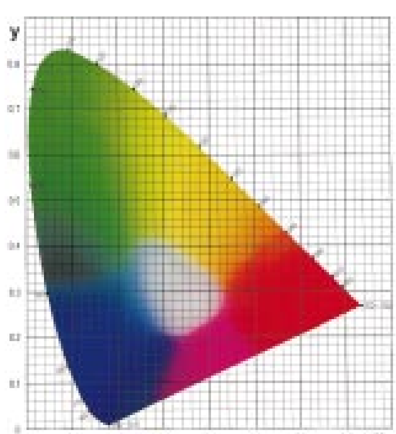
The work with a spectrophotometer means as well that the object is lit by a constant light source. The parameters are standardized as in the case of a light table. This device also detects the tiniest color differences which are not registered by the human eye. In industry this can be very important because of the rigorous demands for color exactitude. It would be terribly aggravating, for example, if you were to buy a touch-up stick in your car's original color in order to touch up a small paint spot, only to find out later that this new, original color, much as you would like it to, doesn't correspond to the actual, original color of your car. Even if it isn't that far off, the touch-up will still stand out as much as the original blemish. This graphic shows you the process of a color measurement with a spectrophotometer.



The measuring device is aligned with its scanning side towards the color which is to be measured. The light reflected by the object then strikes the scanning side. From there the light is focused through a prism and divided into its spectral components. These, in turn, are scanned by a special sensor. With high-end machines, the distances between individual scans are very small. This is important because the red signal on the monitor, for example, has a particularly small band width. If the distances between the individual scans were larger, then the red signal would practically fall out of the measurement, which wouldn't exactly lead to the most reliable measurement results.

The conversion of the measurement values into the real color values follows the scan. Whereas high-end machines conduct these conversions with an integrated microchip, with a simpler machine you'll have to trouble your computer with the task. The individual color values can then be arranged and printed out in vivid color systems.

The CIE, the Commission Internationale de l'Eclairage, plays a leading role in the definition of color systems. In 1931 the CIE developed the XYZ color system, also called the norm color system. This system is often represented as a two-dimensional graphic which more or less corresponds to the shape of a sail or a shoe sole.

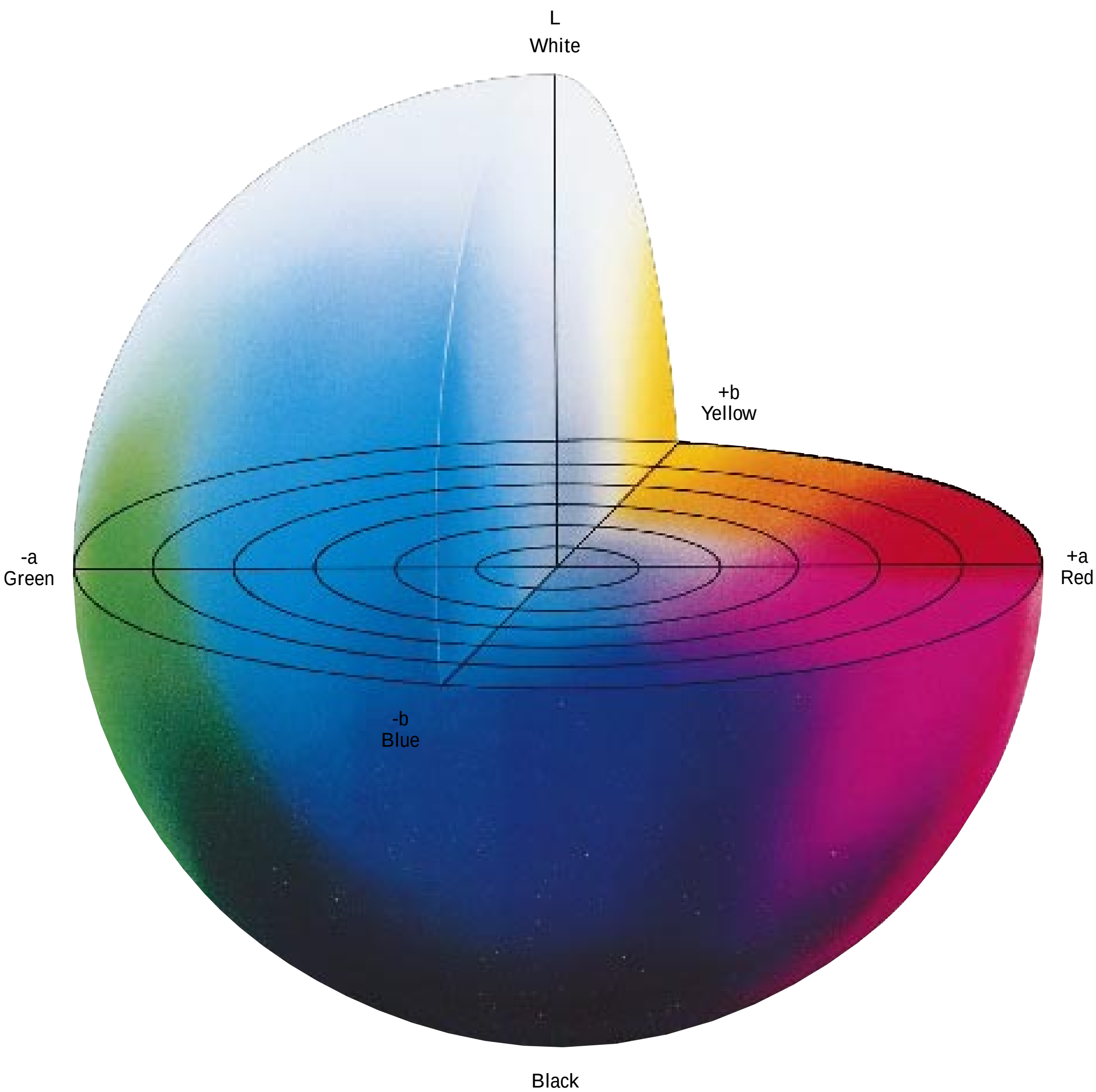


The red components of a color are tallied along the x axis of the coordinate plane and the green components along the y axis. Thus, every color can be assigned a particular point on the coordinate plane. Here you can see that the colors towards the inner side of the shoe sole tend to be gray, which means that their spectral purity decreases towards the inside. But what's not taken into consideration in this model is brightness. If we were to take this element into account as well, we would have a figure which roughly corresponds to a flat sack.

One problem with this color system, however, is that the colorimetric distances between the individual colors don't correspond to the perceived color differences. So, for example, in the figure above, a difference between green and greenish-yellow only is noticeable after some distance, whereas the distance distinguishing blue and red is quite small.

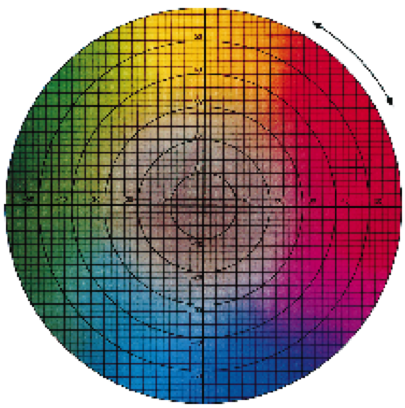
This problem was solved in 1976 by the CIE with the development of the Lab color space. A three-dimensional color space was the result.

In this model, the color differences which people perceive to be equispaced really do correspond to those distances when measured colorimetrically



The a axis extends from green (-a) to red (+a) and the b axis from blue (-b) to yellow (+b). The brightness (L) increases from the bottom to the top of the three-dimensional model.

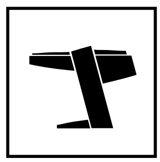
A horizontal cross-section of the model reveals a plane which depicts all values of the same brightness.



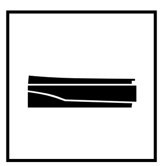
This means that every color can be named exactly using its specific a, b values together with its brightness, L.

The really important aspect of this color space, as with the norm color system, is its device independence and therefore its objectivity. So, completely independent of the weather, of your cheerful or gloomy mood, of the model of your scanner or color copier, the same combination of a, b, and L always refers to the same color.

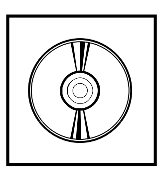
After all that color theory, we now want to get into the practical aspects of color reproduction and thus into the actual subject of color management. To do this, we'd first like to introduce you to the various machines with which we'll be working closely in this context. Naturally, our graphic depicts only a small, representative selection of the multitude of input and output devices available.



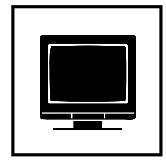
Scanner A



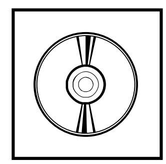
Scanner B



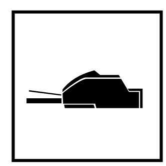
CD



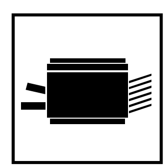
Monitor



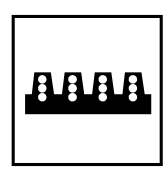
CD



Color printer



Color copier



Printing press

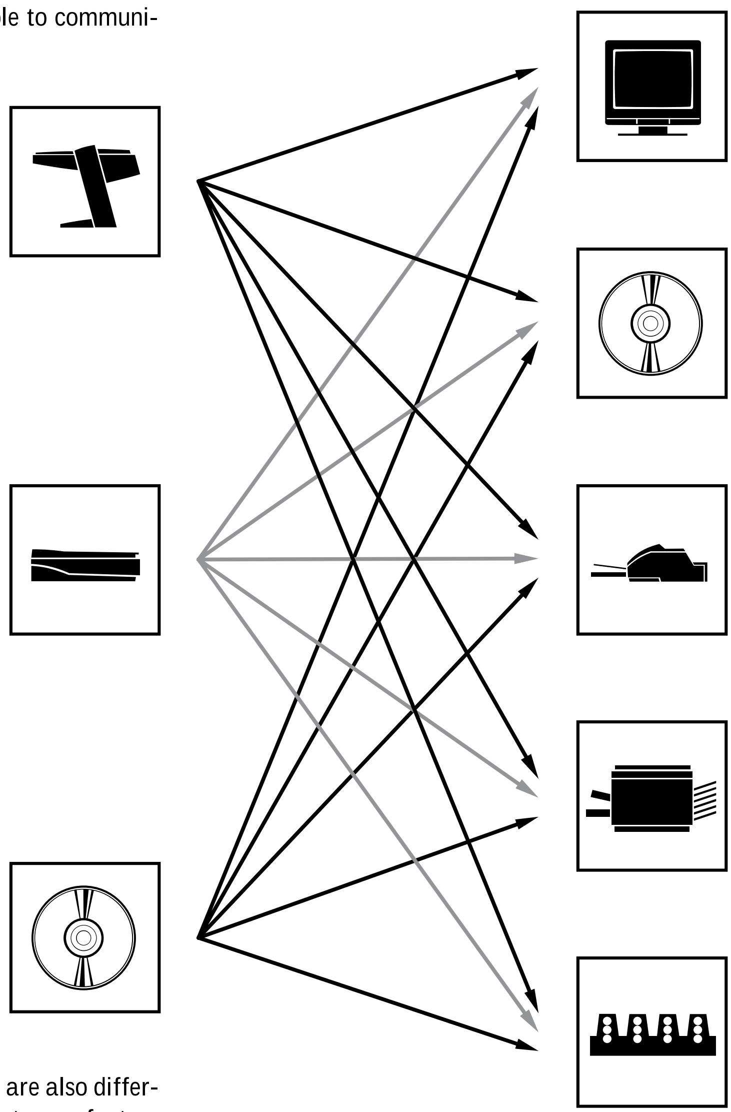
In the last few years, graphic and DTP systems have become increasingly available so that today everyone can easily and inexpensively come up with the prerequisites for producing color graphics or editing images on one's own computer. The desire to print out the results of this work in color is the next logical step, and so too the attempt to match as closely as possible the appearance of the printout and the appearance of the original.

In professional circles nowadays, pre-press work is hardly ever in the hands of one person. Rather, the situation is often one in which the graphic designer develops a concept and then searches for the appropriate documents. He'll either scan the documents himself, or he'll go to a scan service which can scan them for him. Then he'll take the files and use the data to produce a document on his computer based on his concept.

Of course, he might also pass on his data to a reproduction service which produces a document on the basis of his scribbles. Then, with the help of some color printer, a first draft can be printed for an initial check-up of his work. At yet another location, the films for the offset print will be exposed. Finally, these films will be sent to the printers to be printed.

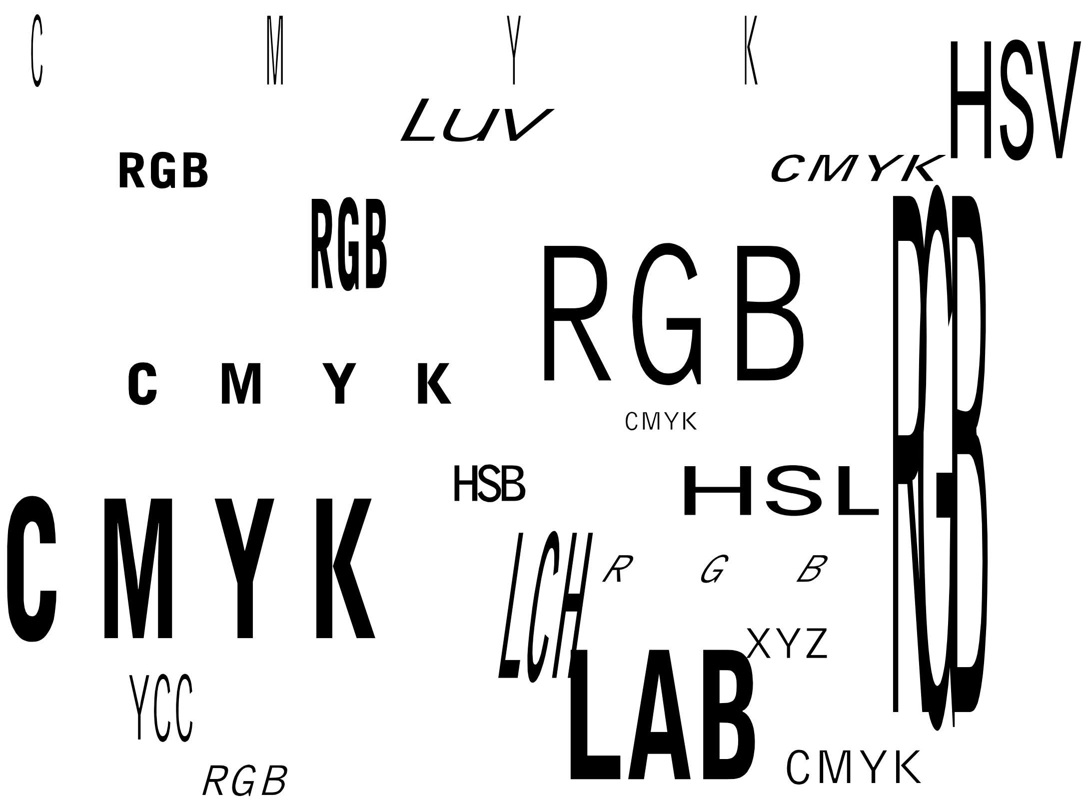
Alone the confusion you felt while reading this paragraph shows you that the data could well pass through any number of different hands. Work is no longer produced in closed systems as it was with traditional reproduction technology. Instead, we now have to work with open systems.

So that working in open systems functions well enough to support reliable color reproductions, all input devices involved have to be able to communicate with all the output devices.

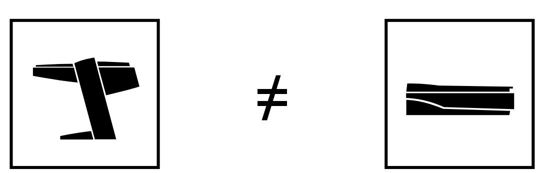


If you now also imagine that there are also differences among machines from different manufacturers, and if you consider how many different scanners there are already, you get a vague idea of the extent of the problem.

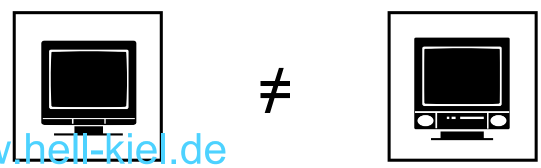
Working in open systems brings with it a few new problems and demands. You're working within a production line involving not only completely different machines, but machines that are all working within their own color spaces. The maze of all these color spaces can more or less be imagined as follows:



Monitors represent all colors on an RGB basis. They construct all colors from red, green, and blue. Four color printing and a lot of color printers work on a CMYK basis. The four process colors are cyan, magenta, yellow, and black. Neither the RGB color space nor the CMYK color space is defined by a uniform standard. Thus, different scanners will "see" the same color in more than one way, depending on the particular features of their scan systems.

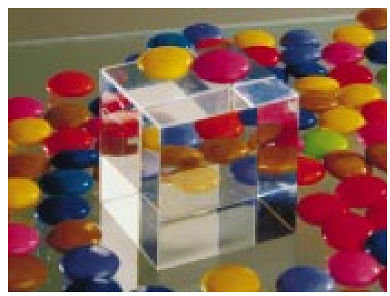


Two different monitors using the same image data will depict different images even though each works on an RGB basis.



The differences become especially noticeable when you print out the same image data with different output media. If, for instance, you send your data to the press, without color management you have no guarantee that the finished image will have the same coloration as the image of the same data on the monitor. The printed image often ends up darker and less colorful.

Original

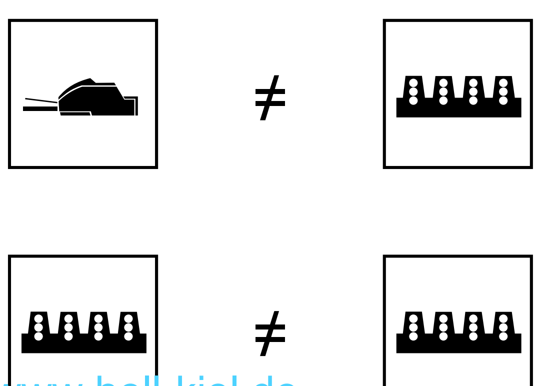


Color impression of the monitor image without color management

Color impression of the printed image without color management

Also, if you're thinking of printing up your data, and believe that a print is just a print, you're making a mistake. For example, color printers generally produce completely different results than offset presses do.

And if you're thinking of keeping to a single printing process so that that way nothing goes wrong, you're standing on shaky ground. Unfortunately, even offset printing isn't just offset printing. For example, the data can look completely different if you print the image on a different kind of paper or at a different press.

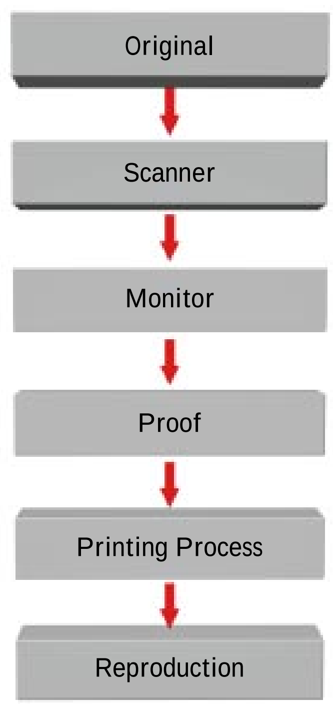


Next, consider that each machine practically speaks its own language and that now they're all supposed to work together on one task. A translator will have to be found for this communal effort. This translator is named color management.

The goal of color management is to coordinate the color spaces of all the machines involved to allow a data interchange which will guarantee a true-color reproduction of images and graphics. It should be possible to ensure repeatable and above all predictable color reproductions. Colors should be as reliable as is now taken for granted with print fonts. The Helvetica font looks the same all over the world, regardless of whether you have something printed in Italy, the United States, or Hong Kong. Color information should be just as transportable.

One further aim of a color management system is to make it possible for you to simulate one output process on another output device. That means that it should be possible for you to produce a soft proof of an image on your monitor whose color impression doesn't differ in the slightest from the image printed later. And with the help of a printout, it should be possible to create a proof which depicts the exact same image as the later print. In this case, the color printer has to be able to act as though it were a printing press.

In order to ensure this, standards have to be defined which cover the entire production process, regardless of which or how many machines are employed. This graphic shows us as an example the production line for offset printing which would have to be standardized in this case.



This standardization gives you the certainty that the monitor image of a scanned photo looks exactly like the original. The printout on your color printer would also look just like the monitor image. What's more, that means that you don't have to worry about whether or not the offset print will look just like your color printout. And above and beyond that, you would have the same certainty of reliable color reproduction a couple weeks later when you run the entire production line again with completely different machines. The goal, therefore, is to achieve the same harmony of color reproduction with the common, open systems of today as has long been the case with closed systems.

Our goal thus looks like this:

Original

Monitor image

Printed image

However, it doesn't do any good if these facilities are available but, because of the prerequisites, are once again only of use to specialists. So now we come to the requirements of a color management system:

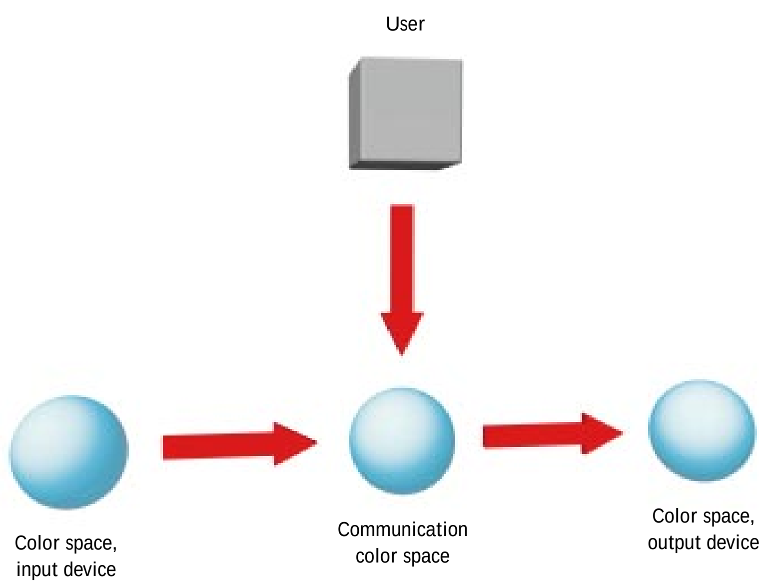
- Color management systems should be simple and applicable without prior experience !!!
- The system cannot be too slow. Actually, it has to be pretty fast in order to allow rapid work.
- Because you generally use a number of programs for the production of color graphics and the preparation of images, a color management system has to be compatible with a variety of different programs. Simultaneously, flexible application in the widest variety of computer environments has to be possible, because sooner or later you're going to want to replace individual components of your system.
- That, however, means that the user himself has to be able to enter the necessary data of the color management system.

Now, that sounds terribly complex, but it'll become clearer as we get into topics like device characterization and profile production in more detail. So don't lose heart !!!

Next we'd like to explain to you how color management actually functions.

Once again: every machine in the system operates within its own color space. If you scan an image, you're moving within the color space of the scanner, which is generally RGB. If you see the image on the monitor, then RGB data are still in play, but these already deviate from the data of the scanner. If you print out the image on the color printer, then you're working in the CMYK space of the printer. So how do you get from scanner RGB to monitor RGB to printer CMYK data without losing the color impression of the original?

Roughly this way:



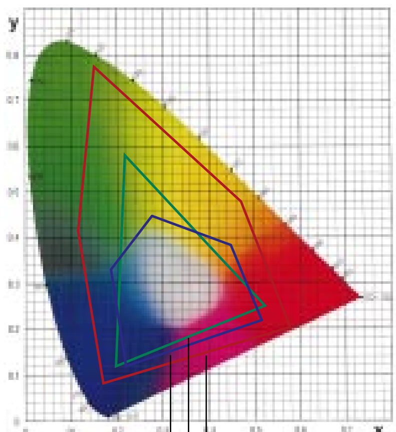
The specific data of the input medium are transformed into a device-independent, communication color space and subsequently converted into the color space of the output device.

Don't get dismayed by this very technical sentence. Said simply, it breaks down like this:

The colors of the input device are measured. These colors are then described in the color coordinates of a standardized and device-independent color space like Lab or XYZ. For example, a very particular red from your original might be measured and then coordinated with the corresponding red in the Lab space. Subsequently, the Lab red would be converted into the red belonging to your output device.

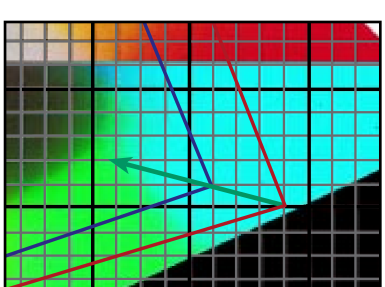
In the context of color space transformation, there will never be a problem with the conversion of the color space of the input device to the communication color space. The communication color space is comprehensive, and thus in every case broader than that of the input medium.

The transformation from the communication color space to the color space of the output device, however, will be difficult. For example, whereas monitors can't represent all the colors that a person can see, printers can't even represent all the colors that monitors can.



So what can you do with the colors that the scanner can read but that the printer can't print? Simply setting all these colors to black in one fell swoop would probably not contribute to the reproduction of the original's color impression.

Instead, an extremely clever color space adjustment has to be carried out. This process is known as gamut mapping. In it, all steps in the color spaces from the input to the final output have to be coordinated with one another in such a way that the non-reproducible colors are replaced by reproducible ones. The larger, input color space is thus reduced so that it matches the smaller, output space.


Gamut Mapping

So in case the red from our example can't be printed by your printer, gamut mapping will ensure that, from those reds which the printer can reproduce, that tone is selected which comes closest to the red of the original. Maintaining the overall color impression, that is, the relation of the colors to one another, is important in this process.

Just where is all this supposed to take place?

One good approach is to connect the color management system to the operating system of the computer. Then, all the colors of the entire computer can be handled neutrally and independently of any particular input or output device. All the hardware and software components connected to the system can access color management, because they all already work with the computer's operating system.

On the initiative of FOGRA, the print research association, a few manufacturers of color graphic hardware and software agreed in April, 1993 to the formation of a committee. The goal of this committee was to determine and standardize various platform-independent device profiles for color space transformation. This committee is known as the ICC, or International Color Consortium. The original members were the Adobe, Agfa, Apple, Kodak, Microsoft, Silicon Graphics, Sun, and Taligent companies. ColorSync 2.0, first launched by Apple in the spring of 1995, was the first operating system enhancement working with these ICC profiles.

The generation of one of these device profiles as well as the calibration of the system are both prerequisites for all of the transformation processes described here. These are very complicated words for what are basically simple processes. So just keep reading. The next chapter won't be too technical, either. Furthermore, with every page you're getting closer and closer to the second surprise !!!

The most important conditions for the functioning of a color management system are that the color spaces of all the system components be known and that these components be calibrated with one another.

A computer system is a little like an expensive stereo system. It does no good simply to buy the most expensive components and place them next to one another. Rather, you have to ensure that all the components are optimally suited for one another. The same is true for the coordination of the scanner, monitor, and printer.

Prerequisite for the calibration of a device is its color characterization. This characterization provides us with the so-called device profile.

Often, the device profile is already provided by the manufacturer. However, you have to consider that it corresponds to an average value. Furthermore, the device's portrayals of color can change in the course of time.

The colors produced by a few older color copiers can shift within as little as a day's time. That means that they reproduce the same colors differently in the evening than they did on the morning of the same day. Even scanners and printers change their color characteristics over longer periods of time.

Thus it is very important that the user, with the help of a calibration tool, can personally undertake the calibration of his machine to compensate for these fluctuations. To do this he has to be able to assess the current color characteristics of the machine by producing a device profile.

We would now like to explain this process to you using the example of scanner calibration. Profile generation requires the determination of individual color points throughout the entire color space of the scanner. This measurement should maintain reasonably small, optically equivalent distances between neighboring points. Should it become necessary, intermediate values can then be easily calculated. Don't worry: you don't have to seek out the color points yourself. They are provided by your calibration tool.

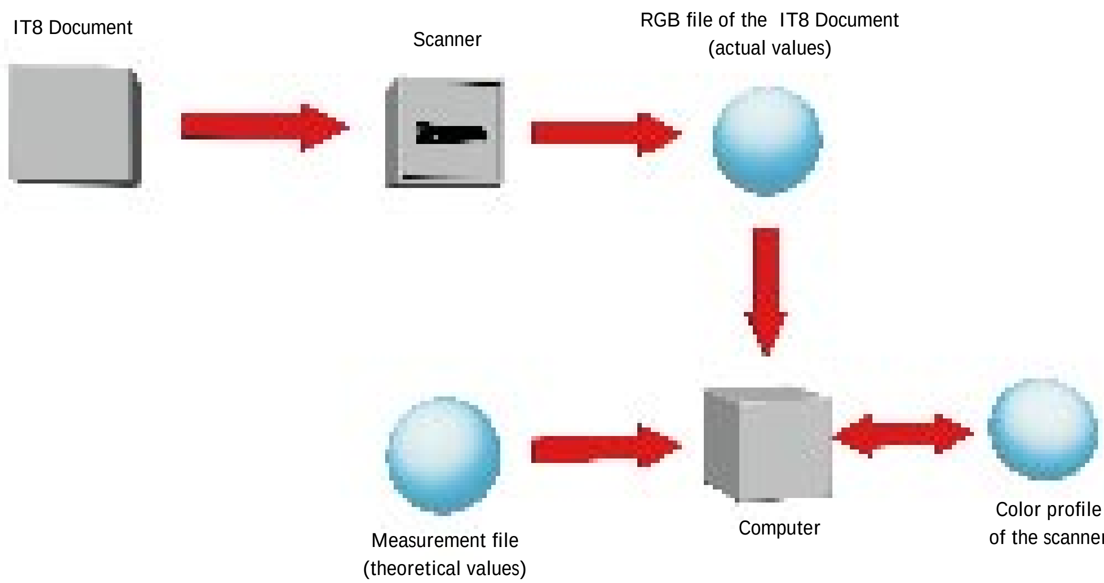
The number of color points determines the accuracy of the later profile. It is possible to produce a simple profile on the basis of a 3x3 matrix. That means that work for the entire color space is based on nine reference points. Such an instance would naturally generate only approximate values and leave quite a lot of room for interpretation. This isn't necessarily always bad, though. If you are working in a system with simple components, then the production of a profile in this manner can be entirely sufficient. Other profiles, generated on the basis of a 32x32x32 matrix, are much more exact as a result of their 32,768 reference points.

There are standard documents for color characterization which were defined by an ANSI committee. ANSI stands for American National Standardization Institute, the national institute for norms in the United States. The relevant subcommittee which concerns us is called IT8. IT8 determines standards for use in color graphic applications. There are two documents for scanner calibration: the ANSI IT8.7/1-1993 for transparent documents and the ANSI IT8.7/2-1993 for reflective documents. An IT8 document from Kodak, for example, looks like this:

The color values of the individual fields of this document are established. The portrait photo is not generally taken into consideration in calibration. It is, however, useful for the assessment of skin tones which are particularly difficult to reproduce.

If you scan the IT8 document, you get the device-specific color values of the individual fields (actual values). At the same time, the original color values are once again presented as device-independent values (such as Lab values) on a diskette (theoretical values). The actual values delivered by the scanner are then compared to the digitally composed theoretical values.

The deviations between actual and theoretical values provide us with exactly the information we need about the color space and character of the scanner.



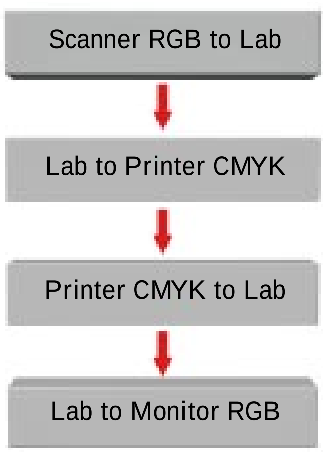
By comparing the actual values and the theoretical a conversion table (Color Look-up Table) is produced during the course of device calibration. By itself, however, this table for the color fields of the document will not suffice. We should be able to assume that our machine can produce more colors than are actually present on the document. That's why an interpolation occurs in the second part of the calibration. The mathematical logarithms that come into play in this part are responsible for the calculation of intermediate hues which are not displayed on the document.

With the help of the Color Look-up Table and the logarithms, the transformation from color space A to color space B can be performed for all processes involving color. Clearly, the quality of a color management system is highly dependent on the quality of the logarithms. They have to work quickly and reliably.

The resultant device profile can be saved directly onto the computer so that you can always access it directly from the program at hand. Storing the profile in a TIFF folder (and thus with the image data) is also possible. This is an obvious choice if you have to pass along the data but don't yet know which output medium will be used.

Work involving many individual profiles often results in a large number of individual color transformations.

For example, the soft proof on the monitor depicts data which is first transformed from input data to the CMYK data of the final output device before it is converted to the RGB data of the monitor. The monitor is only then able to represent the image as it would appear in print. If you were to carry out all the transformations necessary for this work with individual profiles one by one, they would look like this:



That would be not only labor-intensive, but certainly imprecise since with every additional transformation, the data deviate a little bit more.

Fortunately, though, it's possible to link several profiles to a single transformation table. In this process, the individual profiles of the relevant devices are selected and compiled together to form one overall profile. By virtue of this new, comprehensive profile, the process described above can be reduced to a single transformation. This course of action naturally involves some adaptation of data and thus some deviation. Nonetheless, this sort of gamut mapping is much more precise than four individual transformations (and best of all, much faster).

Now the only question which remains is when and how often you should calibrate a device.

Generally you can say that a device should be newly calibrated when changes in the colors displayed become clearly visible (these changes could be measured much earlier). These changes might express themselves by an image suddenly becoming much brighter or darker, or by color casts appearing in gray tones.

And one thing should always be kept in mind:

Optimal work can only be done on a completely calibrated system. This small effort will be worth it every time!

Now that we've introduced to you the goals of a color management system as well as the relevant prerequisites, we would like to explain to you the advantages behind this standardization although this is really very obvious.

Critics often comment that standardization is tantamount to removing any traces of individualism.

Forfeiting the individual achievements of your own products naturally hurts, but in the final analysis, the standard will be a boon to all.

One very important point is that a real standardization means that color reproduction is no longer something limited to specialists. Positively everyone is in a position to operate his or her machines, to coordinate the machines, and to produce results otherwise only attainable by trained specialists – all without the need for exhaustive knowledge.

The next advantage is of interest to specialists as well. Actually, there are two advantages, namely the tremendous time and cost savings. Finally no more stabs in the dark!!! No one has to produce five, separate color prints to only achieve the desired result after trying umpteen changes of the widest variety of settings. No one has to make 20 color copies anymore, just to find one which is acceptable.

The time you save is a plus for the final product every time, because now this saved time can be spent on work which once had to be omitted. If you know from the beginning that the final output of a product will involve a lot of time you'll naturally end up breaking off work on the image earlier than you would actually like to.

Another advantage is the regional independence which wide distribution of a standard brings with it. Even today, data transferal through telecommunications instruments no longer represents a problem. So why not work with graphic designers in Japan or Europe, who can add data to a document in their own countries, and then ship off the whole lot to Taiwan for printing?

The most important advantage, however, is that consistent color management delivers quality results that are no longer dependent on chance or luck.

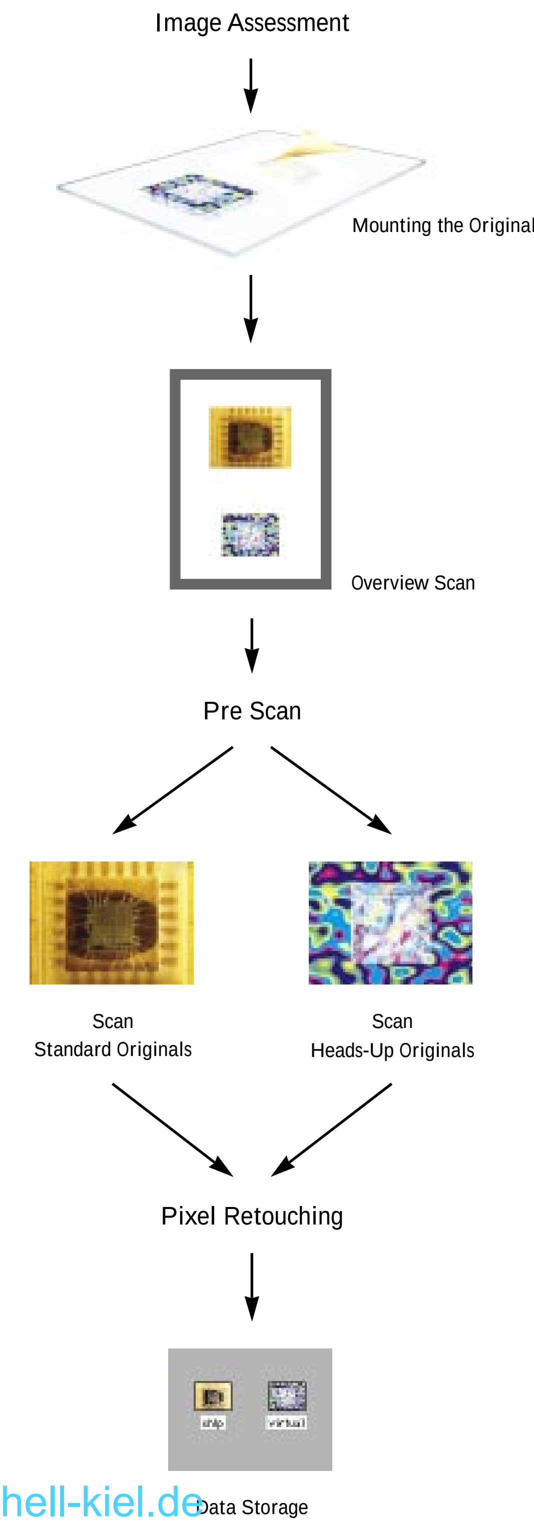
Image data can be reliably reproduced at any time, with any machine, by any user.

You achieve greater quality in production that will be there for you every day, even on Monday mornings, even between Christmas and New Year !!!

Now we come to the description of a few work processes used together with color management, image input, and image output. First to scanning.

Scanning represents the most important form of image input, regardless of whether you're compiling an archive of images on CD or preparing documents with bound illustrations for print. We start out by digitizing the image. This lets us revise images later or use them in other contexts.

Regardless of whether you would like to scan a photograph or a slide, the scan process generally is as follows:



After both the image assessment and the mounting of the original comes the overview scan, which shows you the entire tray with the individually mounted originals. From this you select the area that you'd actually like to scan. Next follows the pre scan, which shows you a preview image. This preview image will allow you to judge whether you would like to keep all the settings as they are or opt for changes which will alter the final product. Once you have found those settings which are optimal for you, activate the scan.

We would like to take this opportunity to briefly explain to you what happens technically during a scan as well as to explain to you some of the fundamental considerations for achieving good results.

Your original is read pixel for pixel in the course of a scan. From this reading, a record of digital data is produced. You thus have a digital copy of your original. This digital image is called a bitmap. Every bitmap is composed of many, individual pixels.

Here we come to the first point that you have to bear in mind when scanning: the scan resolution. It is fundamentally responsible for the quality of the results (along with the quality of the scanner, of course). In general, you can say the higher the scan resolution, the higher the quality. If you would like to print out an enlarged copy of your original, you have to take this into account, because the individual pixels can become visible as small squares in the image if you have selected too low a resolution for too great an enlargement.

User-friendly scanner software makes calculation of the optimal resolution very easy for you. All you have to do is enter the size of the original document, the desired printout size and the screen ruling for the subsequent print. The rest takes care of itself.

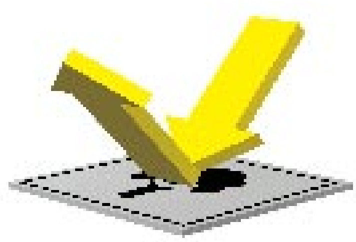
Image with visible pixels

The next thing to consider is what would you like to scan. We're not going to discuss here whether it's smart to lay a unwrapped chocolate bar on the document tray and then shut the lid on it. Instead we would like to introduce the various types of originals as well as their particular features.

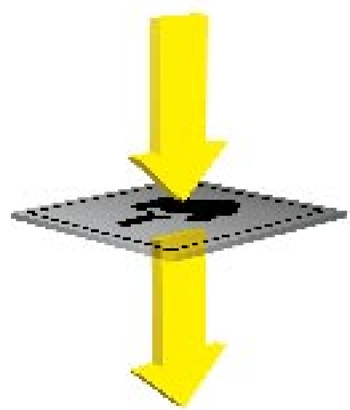
First, the simplest subdivision:

Transparent original or reflective original:

Reflective originals are those originals which reflect incident light, for example a photograph or newspaper clipping. In contrast, transparent originals let a certain amount of light through, which also means that you can look through them. The classic example is a slide.



Reflective original
with reflected light

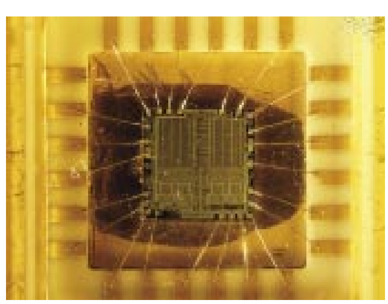


Transparent original
with transmitted light

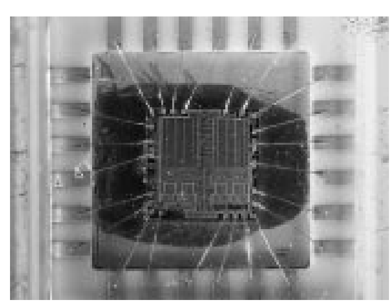
Now for the something that requires a little more explanation:

Standard Original or Heads-up Original:

Strictly speaking, Standard Originals are originals which do not display any particular features and are correspondingly easy to scan. These can be grayscale images, color images, as well as bilevel images.

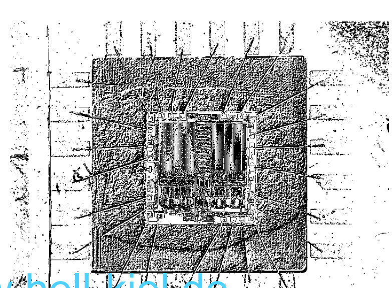


Color image



Grayscale image

Bilevel image



In this case all you actually have to do is enter the above-mentioned parameters for the calculation of the scan resolution, activate the scan, and lean back. You can be sure that you'll end up with a high-quality product. It's really as simple as it sounds !!!

Scanning Heads-Up Originals is in principle no more difficult, so long as you pay attention to their particular features and are supported by your software. From the point of view of color management, interesting Heads-Up Originals can include artistic originals, computer generated originals, or even negative originals.

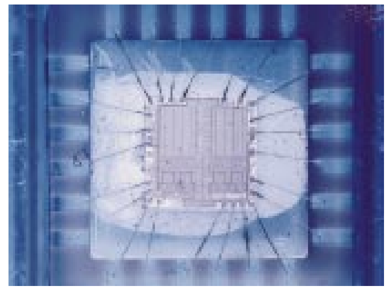
Other Heads-Up Originals are high key images (depicting very bright subjects), low key images (depicting very dark subjects), catchlight images overexposed or underexposed originals or even unfocused originals.

As mentioned, the right software can make work with these originals just as simple.

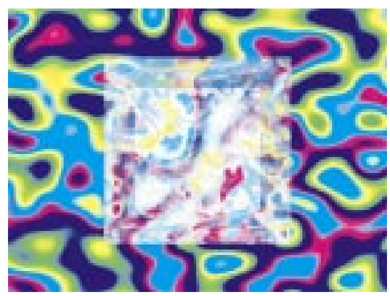
Naturally, though, everything can function optimally only if your scanner is correctly calibrated. As you have already learned, this is very simple.

Scanning is no longer a job just for specialists!

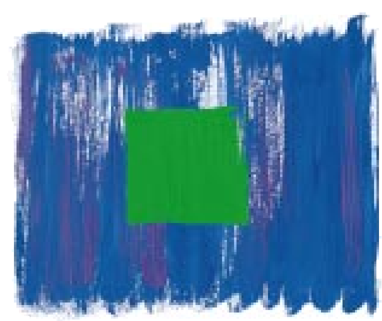
The scanner is easy to operate. Together with the right software, even inexperienced users can attain results which meet high expectations !!!



Negative original



Computer generated original



Artistic original

A little tip for the question of how often you have to calibrate your scanner:

Scan a document that you already scanned and saved some time ago. Call up both images onto the monitor next to one another. The grayscale of your IT8 document is well suited for this test scan if you scan it in the color mode. If you see a color cast, it's time to calibrate.

The scanner is once again the link between the original and the monitor.

The workflow looks like this:

Assuming that our scanner is calibrated, we should now tend to the proper setting for our monitor.

The scanned image becomes visible for the first time on the monitor.

In image editing, all adjustments and corrections will generally proceed on the basis of the monitor image. A printout will first be produced when you are pleased with the monitor image. That clearly demonstrates how important it is that the monitor displays a reliable test image. It would be pretty bad if, on the basis of the monitor image, you assumed that a distinct tint of red was present in the document, then went ahead and corrected it, and finally printed out the data, only to discover that, aside from the green tint that resulted from the correction of the non-existent red tint, you have a pretty nice image. You have to calibrate your monitor if you are to avoid situations such as this one and produce truly reliable scans.

In principle, calibration proceeds exactly like that of a scanner or printer. If the manufacturer wasn't that nice to include a monitor profile, or if you suspect that your monitor has become misaligned over time, start this calibration with the generation of a profile as well. For this, first you'll need a special device which is very similar to a spectrophotometer, but which doesn't have an integrated light source. It doesn't even need one, either, because the light is provided by the monitor itself.

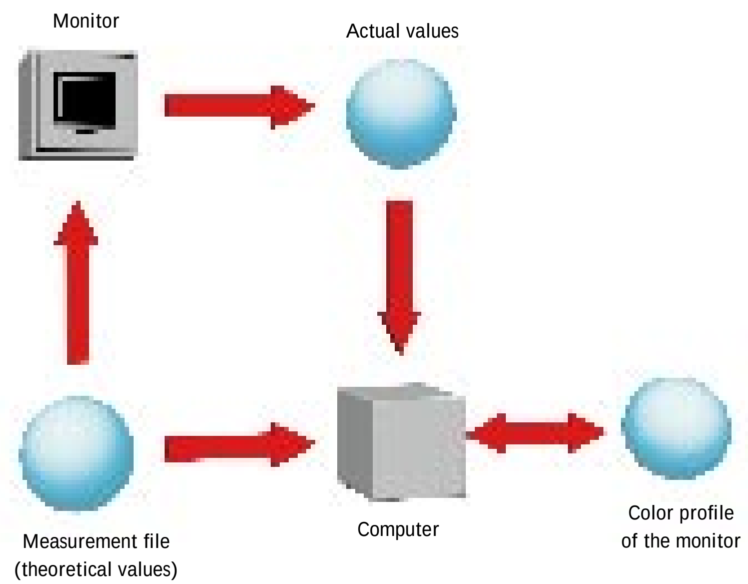
This device can be attached to the monitor with a small suction cup. But please don't attach the cup and head out for lunch!!! The suction is not so great that the measuring device would wait very long for you on the monitor. Instead, it would fall down, which can be pretty aggravating when it's an expensive and sensitive measuring device.

Calibration software will generate a series of different colors for measurement purposes on the monitor. These color fields all appear at the same spot so that you don't have the inconvenience of removing and re-attaching the device for each new color.

Exactly as was the case with the scanner, the measured values here are compared with the ready-made theoretical values. And just like with the scanner, the device profile is determined from the differences between the actual and theoretical values. The quality of the profile depends, as with all other profiles, on the number of the color points and the quality of the measuring device.

The generation of a profile of acceptable quality is easier for the monitor than it is for a scanner, though, because here far fewer color points are needed. A simple monitor profile often involves scanning only the three primary colors green, red, and blue as well as a gray scale. Total, that's only 6-8 color points. Naturally that leaves a lot of room for deviation, but to get by on it should be enough. Even high-precision monitor profiles are produced with comparatively few reference points.

The resultant profile can then once again be used by color management system software to address the color transformation (for example, from Lab to monitor RGB).

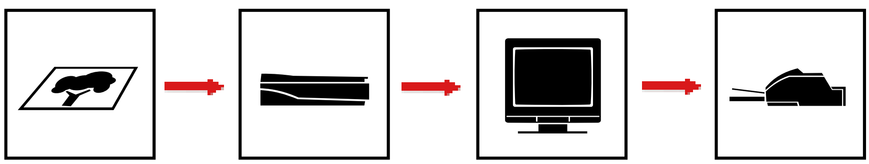


On the whole, the color space of a monitor is larger than that of a printer or offset press. Thus, it is capable of representing a wider variety of colors. However, there are color ranges for which a fairly simple color printer is better suited than a monitor. We're referring to the cyan and yellow ranges. These ranges represent the primary colors of all printers, as printers work on the CMYK basis. For the RGB-based monitor, however, these ranges are considered to be secondary colors. The monitor has to put them together from red, green, and blue. So naturally, printers have home field advantage when it comes to these ranges. The representation of a really nice, intense cyan on the monitor can be pretty tough.

This fact has to be taken into account for the soft proof on the monitor, as it is there that the color impression of the printout or printed image is to be simulated. In such an instance, gamut mapping and, consequently, the accuracy of your soft proof both depend on the quality of your monitor and on the quality of your color management application.

Now, after we've calibrated our scanner as an input medium and our monitor as a control and output medium, we'll want to take care of the coordination of the printout on paper, and thus the calibration of our printer.

The workflow from the original to the printout is as follows:



Those readers who only want to calibrate their printers because the printers never print anything which in the least resembles that which is depicted on the monitor screen, and who have just opened the book at precisely this chapter, should first take the time to start reading a bit further back.

Why ??? It's simple! The process described above makes it clear that a calibration of the printer without a calibration of both the scanner and the monitor is pointless. So align the other two first and then get started on the printer !!!

There are various ways of making a color print: inkjet, color laser, and dye sublimation processes are a few examples. These processes are characterized by individual technologies, different qualities, and above all, by the various purchase prices of the machines as well as by the costs of expendable materials.

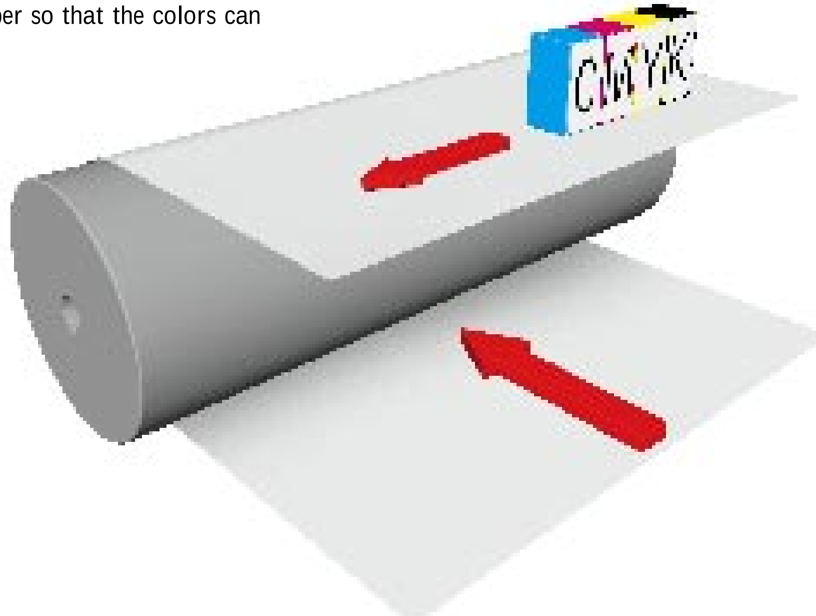
Before anything else, we want to go into inkjet printers here, and specifically the bubble jet process. One reason is that, for now, this is the most common kind of color printer. Another reason is that we're going to go into color laser printers in the chapter on color copies.

First comes a brief introduction to the technology of inkjet printers. Not so that you'll get bored, but because a little knowledge on the subject can be very helpful for your understanding of the problems and solutions associated with color reproduction.

Inkjet printers function either on a CMY basis or CMYK basis. CMY machines produce black by way of a 100% overprint of the other three process colors. The only problem with this is that the resultant black often doesn't look black but rather looks greenish-brown. The investment in a CMYK printer is worth your money every time, just so that you can use black as an extra, primary color.

How does an inkjet printer work?

There is a print head for each of the primary colors. The four print heads are attached in a row on a carriage. When printing, the carriage slides over the individual lines of the paper so that the colors can be applied to them.



The colors reside in the cartridge in the form of fluid inks.

The inks for the print are heated in the inkjet nozzle. The heat causes a small bubble to form which creates high pressure in the jet. At some point the pressure becomes too high. The ink can no longer withstand the pressure and sees ejecting a drop of ink from the jet as the only way to create more space for the rest. The catapulted drop can reach a speed of 700 km/h. In this way, as many as 5,000 drops are ejected every second to be applied to the paper as print dots. The individual print dot represents the smallest unit of print. It's our image dot. Once an entire line has been printed, the paper is pushed further along and the process starts again from the beginning.

After this brief digression into inkjet technology we can now return to color management. We want to explain here how color management systems have to perform when preparing a color printout and what sorts of problems can arise.

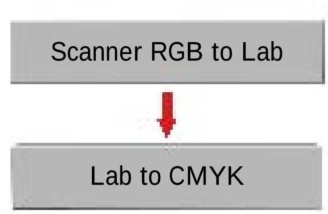
What annoys you about your printouts?

- Are they too dark?
- Are the colors no longer brilliant?
- Do the colors appear to be in any way pale, as though they were covered by a gray fog?

These points represent the most common problems in the production of color printouts. Furthermore, they can come up not only with inkjet printers, but also with color laser printers and even with dye sublimation printers.

So what is the cause, and how can we do something about it?

The color management workflow from the original to the printout can be portrayed as follows:



As you see, two transformations are necessary. This is exactly the point at which the problem previously described occurs. The output medium's color gamut is very likely to be smaller than that of your original. What that means is that the quality of the transformation of the input color space to the output color space depends greatly on gamut mapping.

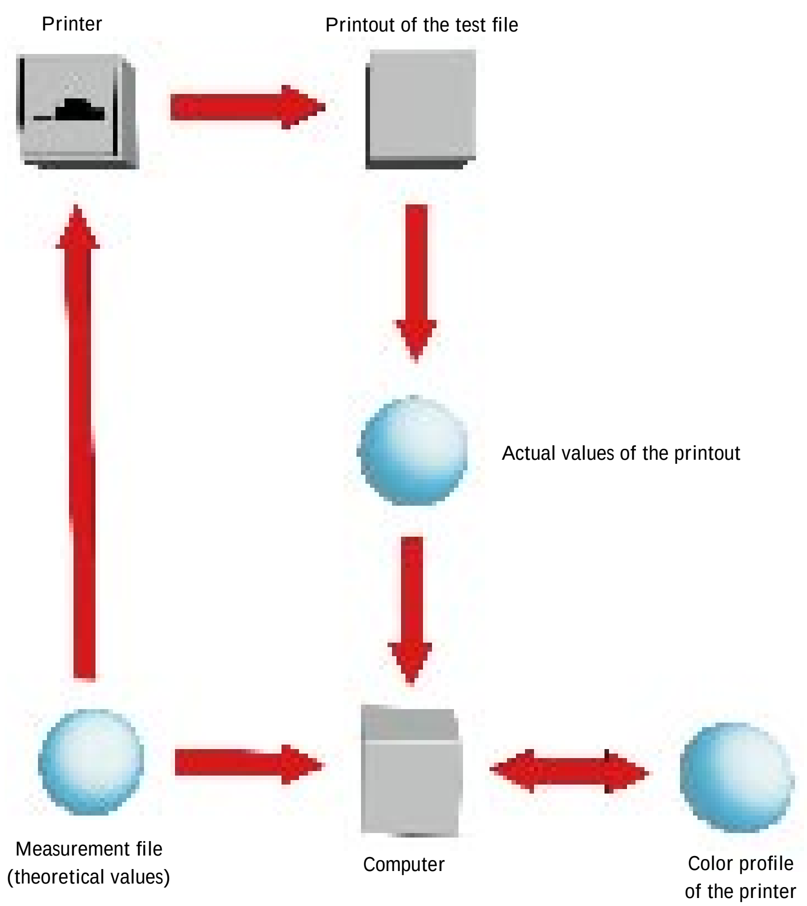
For this, however, you first have to calibrate your printer as you have done for your scanner and monitor.

This process has its own special tools as well. The tools consist first of all of a test document. This time, however, the test document is stored from the start in the form of a digital data record rather than an image. In addition, you once again have calibration software which later compiles the actual and theoretical values.

The data record of the test document is transmitted to the printer as a print file and printed out. Afterwards, the individual color fields of this printout are measured using a spectrophotometer. The data deviating from the test data again represent the device profile, which will be at our disposal for all further transformations.

A tip for calibration

The inks of a set have been mixed so that they match each other, but inks can differ slightly from one set to another. For that reason, you should check your printer every time you change your inks and, if necessary, calibrate your device again. With inkjet printers, this means when you put in a new print head cartridge, with dye sublimation printers, when you put in a new color cassette.

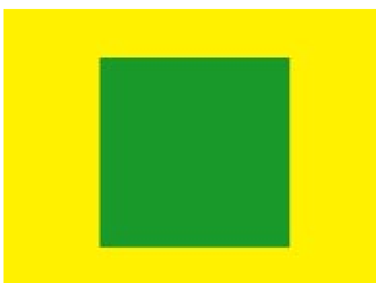


By no means does everything related to inkjet printers depend on color management. Inks and paper play a large role.

Let's first take a look at the colors.

The individual colors are liquid. Technically, the printer reacts to this in its attempt not to print the colors over one another until the previous layer is dry. This doesn't always entirely succeed, so that a slight overlapping of colors can't really be prevented. You can see this most clearly along the image's sharp edges.

When two completely different color areas come into contact with one another, what you often see is unfortunately not this:



But rather this:

Thus you see that in this case the color produced does not depend solely on the quality of your color management system. It is also influenced by the technology of your printer. The extent to which inks run into one another depends primarily on the paper you use.

Let's say you're an environmentally conscious person and use only recycled paper. This should be viewed positively, but when you're producing color printouts with an inkjet printer, it can be a real hindrance. The standard, recycled paper possesses a high absorption capacity. Deposited inks are absorbed as though by blotting paper (not so strongly, of course, but still noticeably). In the process, it becomes more difficult to distinguish colors. The colors become paler on the whole. Much of the original's color intensity is lost.

Mid-range quality printouts can be achieved with normal, white, coated, typewriter paper.

However, the best quality only can be achieved with special paper !!!

For calibration, this points to a dependency on the carrier. You will have to produce an individual printer profile for every sort of paper that you use. That means that you'll have to carry out the process of printing out and measuring the test document individually for each and every sort. You'll no doubt notice differences in the data.

In case you don't believe all that, go ahead and test it out:

Take a sheet of recycled paper, a sheet of very white, smooth, typewriter paper and a sheet of special paper. Print out the same file on each without any type of calibration. You'll see that the printout on the special paper distinguishes itself through greater color intensity and better distinction of colors along the edges. A suitable calibration of the printer can make a printout with special paper much more like the original than ever could be achieved with other carriers.

So pay attention: producing a printout is not dependent solely on the quality of your color management system. The carrier material plays a big role. You should not try to save money on it !!!

A few more tips for handling printouts …

With inkjet printers, it's sometimes the case that the ink is not completely dry when the paper leaves the printer. So don't immediately touch the image.

Because the inks are water-based, they're also water-soluble. For that reason you should protect the printouts from coming into contact with liquids.

If you should happen to be working with a dye sublimation printer, pay attention that you use the special foil protectors to protect the printouts. Standard protectors dissolve the surface of the printout and destroy the image !!!

What happens inside a color copier?

Basically, a color copier is nothing more than a scanner and a color laser printer in one. Since we've already gone into scanners, we'd like to spare you that review at this point and deal straight away with the printout unit, or (as announced) the color laser printer.

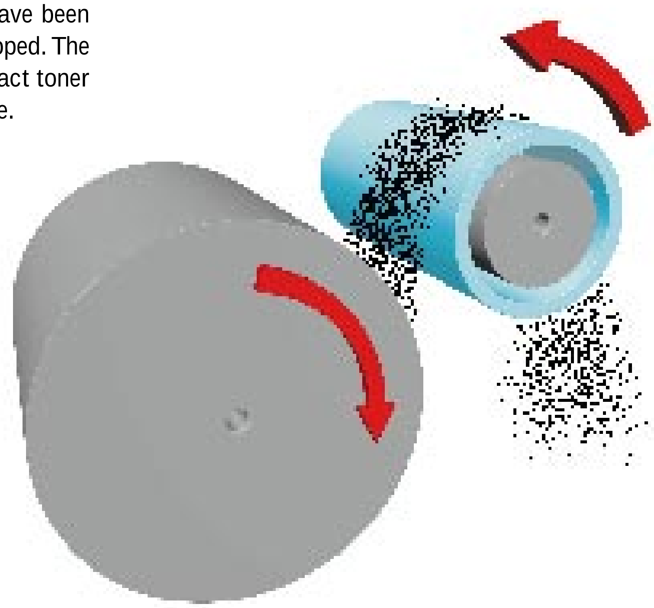
Here, too, we'd first like to explain the technology of color laser printers. Since this technology really is pretty technical, though, we want to limit ourselves to a simplified portrayal.

The color laser print is an indirect print technology. That means that the color isn't applied directly to the paper as is the case with an inkjet printer, but rather by way of a detour.

The process can be roughly divided into four steps:

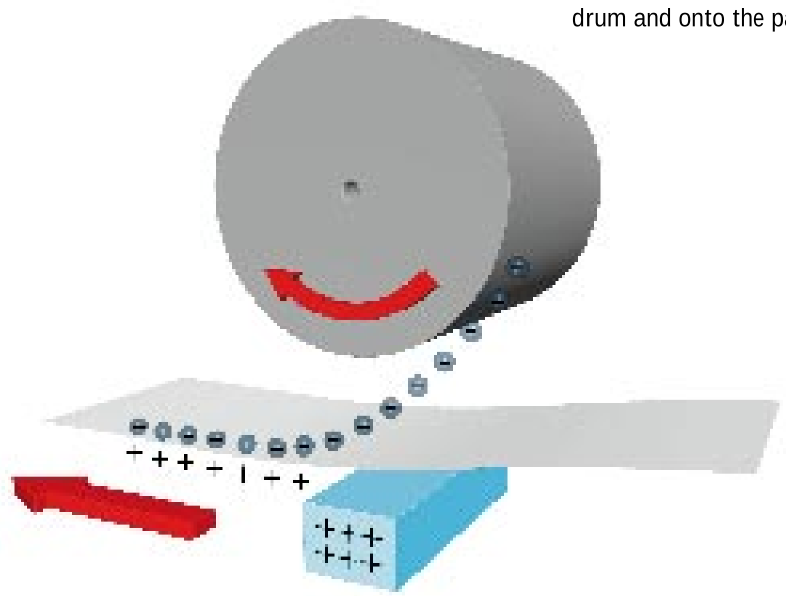
- exposure
- development
- transfer
- fixing.

We'd like to shed some light on these terms on the basis of this breakdown. During the image exposure, an image is created on a drum with the help of electrical fields. This image can present a problem, though, in that it is invisible. This can't have been our goal. Thus, the image has to be developed. The way this works is that electric charges attract toner powder and thereby make the image visible.



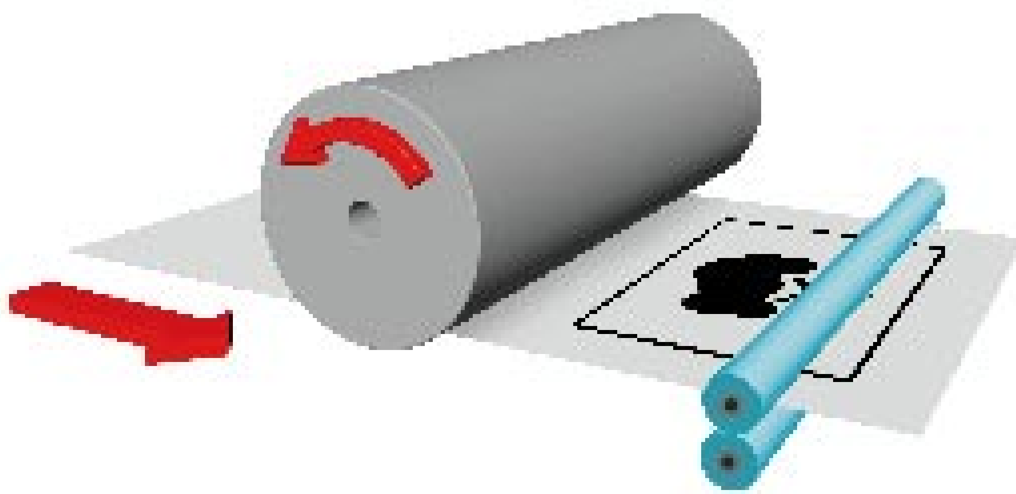
With color printers, this process is carried out once for every color channel. As a result, you have four different kinds of toner (cyan, magenta, yellow, and black). At this point we have the finished image as a cloud of toner on the drum but not yet on paper. It gets there (we're now at the transfer step) when the toner is pulled from the drum to the paper.

It’s just as well that it’s only because of an electric field that the powder is resting on the drum: so it’s not stuck there. What that means for us is that if we apply another electric field to this first electric field, we can quickly bring the toner powder onto our page. To achieve that, an antipolar electric charge is generated behind the paper. The paper is then passed closely over the drum. The charges behind the paper pull the toner powder away from the drum and onto the paper.



So now the toner powder is lying loosely on the paper. This image won't make us happy for too long. Which brings us to the last point: fixing.

In this step, the image is heated and fed between two cylinders. The heat briefly liquefies the toner and the cylinders press the image right onto the paper.



After these explanations for all the technology and theory freaks, we can get back to practical issues.

What does the practical world of color copiers look like nowadays?

- Larger color areas aren't even, but show stripes in the direction of the scan.
- Natural skin tones aren't reproduced.
- Strong color casts appear.
- Many a color copier proves to be more sensitive to influences like air humidity and temperature variances than a person would be. It doesn't catch a cold but does alter the rerpoduction of color.

So how can calibration help you in tackling these unpleasant occurrences?

First the bad news:

There is no calibration in the basic copier mode. So if your only color copier is standing alone in the corner of a copy shop, you're only going to be able to try to match the original as closely as possible by changing the settings.

If you hook up your color copier to a computer, however, calibration becomes possible. At this point you no longer have a color copier in the real sense, but technically a separate scanner and printer. And just like every other scanner and printer, these can be calibrated one after the other, too – the scanner with a completely normal scanner calibration tool, and the printer with a (what else?) printer calibration tool.

For the printer calibration, you send the test file to the printer unit of the color copier. That's right, the printer of your color copier can be addressed directly from the computer. In this way, you can also print directly from your computer. This is just what color copiers are used for in the first place. They give you the chance to make a very inexpensive proof (even if it's not comparable to a Chromalin proof when it comes to a true-color portrayal of the colors).

When the test file is output, this printout is measured (of course, measuring once again concerns the color values and not the length of the edges). A profile is generated from that, and calibration begins.

It is extremely important that the printout of the test file be undertaken with maximal resolution. Otherwise, differences might arise as a result of interpolation. This would falsify the results.

The practical advantage of this type of machine is that you don't need special paper for the printout. That means that your costs per printout are very low. But in case you use several sorts of paper, keep in mind that, strictly speaking, a separate profile has to be generated for every sort.

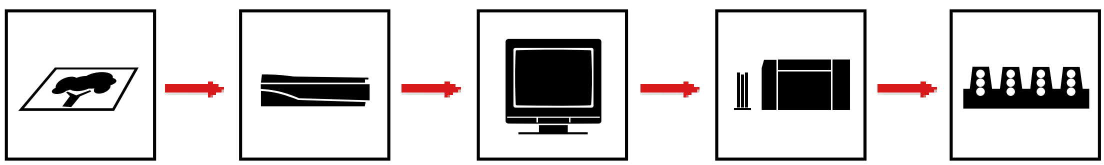
Now, you don't have to go through this process every day. Nowadays, even color copiers can achieve an enduring color stability. For example, it should suffice if you have calibration performed by a technician every time the toner is changed. For day-to-day use you can rely on a much simpler process.

And hey, don't worry if you change something on the settings of your copier. That'll have absolutely no effect on the scanner/printer workings. You won't have lost your calibration.

Tip:

Color stability will first be had after a few printouts. This has to do with the operating temperature. You can count on the best results if you use your machine constently in the course of the day. So don't save it, use it!!

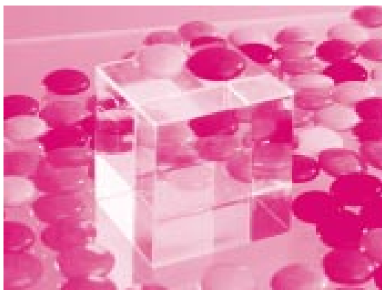
The most important process in color reproduction today is at the same time the most difficult one. We're referring to the process from the original to the printed image. Above all else at this point we'd like to go into offset printing, because from the point of view of volume, this is the most important kind of printing. Below you can see the order of the devices involved in producing the printed image:

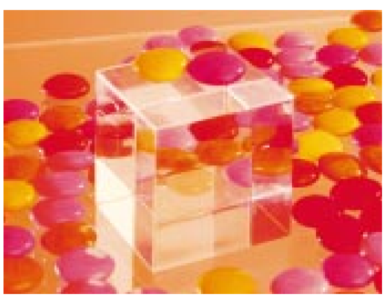


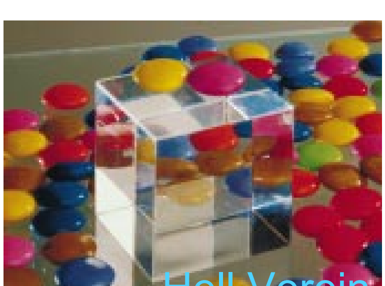
Here, too, we don't want to deprive you of a brief introduction to offset technology. As you can see from the process diagram above, the process does not lead directly from the computer to the print, but first passes through the imagesetter. A film is created for every process color at the imagesetter. If you'd like to print an image, you're going to need four films. Equipped with these films, you can go to your printers' and have a printed image produced for you on an offset printing press. A diagram of this machine looks like this:

You can see that there is a printing unit for each of the process colors: cyan, magenta, yellow, and black. Three cylinders are located in each printing unit. The top cylinder is the plate cylinder. The film is transferred onto the print plate. This is where the ink is applied. From the plate cylinder, the color then shifts to the next cylinder which is covered by a rubber blanket. This rubber blanket picks up the color and passes it on to the paper in the third step. So if the paper has run through the first stage, all the areas affected by magenta have been printed. The sheet is then transported to the next stage, where the same process resumes from the start, only with a different color.

So the image is printed color by color. If you were able to take a look at it along the way, you'd see something like this:







The principle is similar to that of a color printer.

The inks that are used here, however, are of a much higher quality and, above all, dry very quickly. So there's no danger of inks running into one another during the printing process. If the colors had to dry first, the production rate of 15,000 copies an hour could never be achieved.

So in printing where do the problems specific to color reproduction lie? There are a lot of them !!!

One problem that comes up a lot has already been mentioned with reference to color printouts. The colors often look much darker and less chromatic on the print than they do on the monitor. The image loses much of its strength.

Once again, that can be a result of the smaller color space of the printing process to that of the original. The final result is thus again dependent on the quality of the color management system which carries out the individual color space transformations.

Reproduction is often difficult if the images come directly from the computer, as with our computer generated image, or if the graphic designer has let off steam by thoroughly indulging in colors. Colors are often used which either can't be mixed using the four process colors, or can only be mixed with considerable difficulty.

Many of the rich blues and greens that you can still see on the monitor can hardly be represented in print on a CMYK basis. In this respect, because monitors are based on RGB, they have a home field advantage when compared to printed matter as green and blue are primary colors for them. For yellow tones, exactly the opposite is true.

This turquoise, for example, has been printed as a special color. If you tried to produce it using the normal, four-color printing process, you'd never come up with precisely this color. Instead you'd have a choice between a vivid green or a dull pigeon-blue. You wouldn't be able to change this situation even with the best color management system offering the best color space transformations. So either you avoid such colors from the start, or if that doesn't suit you, you pay the costs of printing this special color. If you don't do that, you'll probably be disappointed by the results.

The number of different components that have an influence on the printed result but which aren't in any way standardized represents a pretty large problem in terms of the repeatability of the results. There is no uniform standard for the CMYK color space, and this naturally affects the inks. In Japan, the Toyo inks defined by the JIS are mainly used. In the United States, the Swop standard is predominant. In Europe, there's more or less a standard based on the European ink set.

But even within one individual region, the inks aren't really standardized. If a printer changes his supplier of inks, this might lead to a change in the results. If your work is printed one month with the usual inks, and you'd like to have another issue printed next month but new inks will be used, inconsistencies might become apparent.

These changes are minimal, however, when compared to the influence a change in the sort of paper can have on the printed results. It's similar to the case with color printers. If paper isn't taken into account, you're going to be faced with an unpleasant surprise !!!

If you've carried out the scans under the assumption that the print will end up on beautiful, white, smooth, wood-free paper, but the paper used turns out to be recycled then the colors are only going to be half as intense as you'd assumed. Recycled paper not only absorbs the color intensity but also causes a larger dot gain. The individual print dot will be larger than on less absorptive paper. If you don't consider this point, your colors will appear to bleed. Clearly-defined borders will no longer be possible. Especially if you're printing text, the results can be very unpleasant.

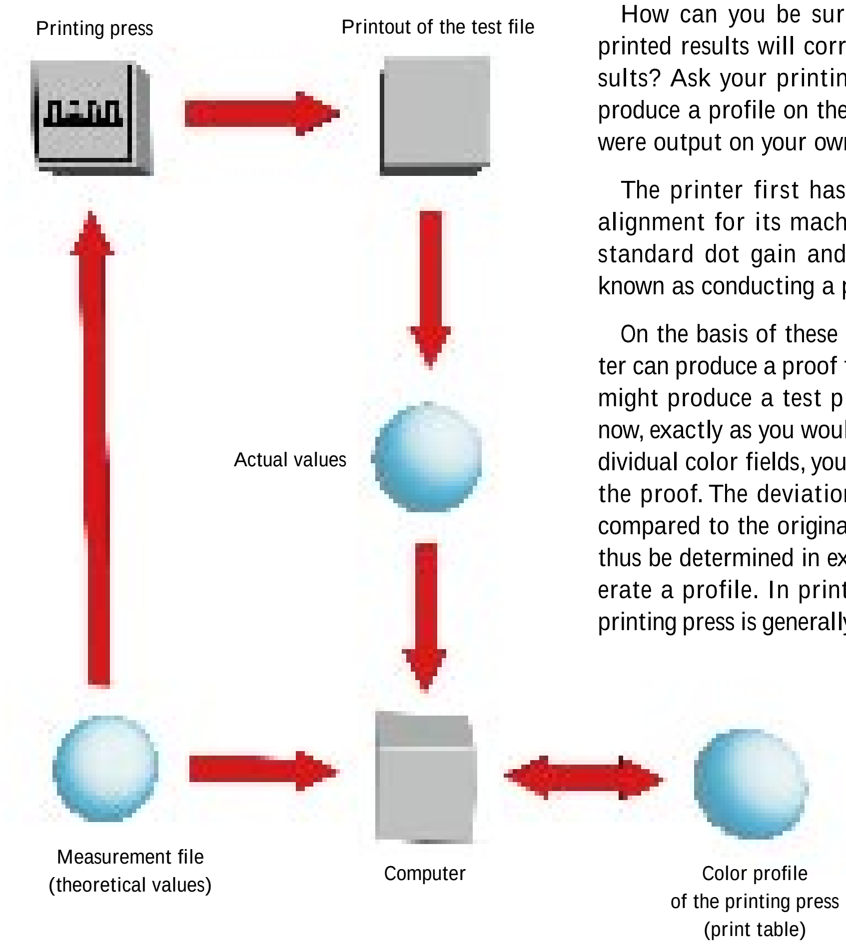
It's not just the quality of the paper that's important, though. Even the smallest color changes lead to different results. One of them you might have already discovered yourself: When two people talk about white paper, they're only very rarely describing the same white !!!

Surprise

Our surprise fits in perfectly at this point. You should be able to put everything into practise by using three pretty, color foils. Take a magenta foil, for instance, and place different colored paper slips beneath it. They can be green, red or blue slips. You'll already see differences in the magenta when you lay both a very white and a yellowish-white slip under the foil. Play around a little bit. Prove to yourself that red comes from magenta and yellow, that the yellow and cyan foils on top of one another really produce green, and that all three one on the other really nearly produce black. Have fun playing !!!

Naturally, different kinds and colors of paper do not make it very easy to produce a proof. If the proof really is supposed to be true to color, it at least has to be produced on the same type of paper or at least a very similar one. But even then, other inks or different print processes can have an influence which would produce a difference in the final result. Only proofs printed by the final machine on the final paper in the final inks are really reliable. Yet this isn't exactly cheap, and above all it's a pretty late point to discover that you still have to change some part of the data.

For that reason, you should at least make a proof of the color images of a document in advance if you're not completely sure how they're going to look printed out. For the reasons described above, the proof won't give you exactly the results which you'll have in the end, but you'll have a rough impression of the printed image. If this doesn't appeal to you, you shouldn't send it to the printers' without changing it.



After all these gloomy descriptions of problems, we'll now get to the solutions that'll cheer you up a bit.

How can you be sure from the start that the printed results will correspond to the expected results? Ask your printing house for help. You can produce a profile on their machines exactly as if it were output on your own color printer.

The printer first has to carry out a standard-alignment for its machines, so that you have the standard dot gain and standard density. This is known as conducting a printing characteristic.

On the basis of these standard settings, the printer can produce a proof for the test file, just like you might produce a test printout on your printer. So now, exactly as you would normally measure the individual color fields, you measure the color fields of the proof. The deviations of the measured values compared to the original values of the test file can thus be determined in exactly the same way to generate a profile. In printing circles, a profile for a printing press is generally referred to as a print table.

This profile isn't universally valid, however. It is specific to the one print process on the one printing press and, above all, to the one kind of paper with which the proof was produced. With another kind of paper you might arrive at completely different values and thus a different profile as well. Here, too, an individual profile has to be prepared for every kind of paper as well as in cases when you're working with a different printing press.

In conclusion, it should be remembered: the print only reproduces that which you've prepared. If the data were prepared specifically for the final print process, for the screen ruling of that process and for the paper selected with the help of the accompanying profile, then absolutely nothing can go wrong.

If one of the above-mentioned components has not been taken into account, however, then in all likelihood the images will look different than you imagined it!

Tip:

When using the print profile, remember that you've specially prepared the images for a very specific process. Above and beyond the final storage of your image, you should always save the image data in a "raw-version" which is independent of the printout process. That'll save you time when you want to print out the data at another printers' or on another machine at some later date.

So where do we put all of our image data?

You'll learn that large amounts of data accumulate very quickly.

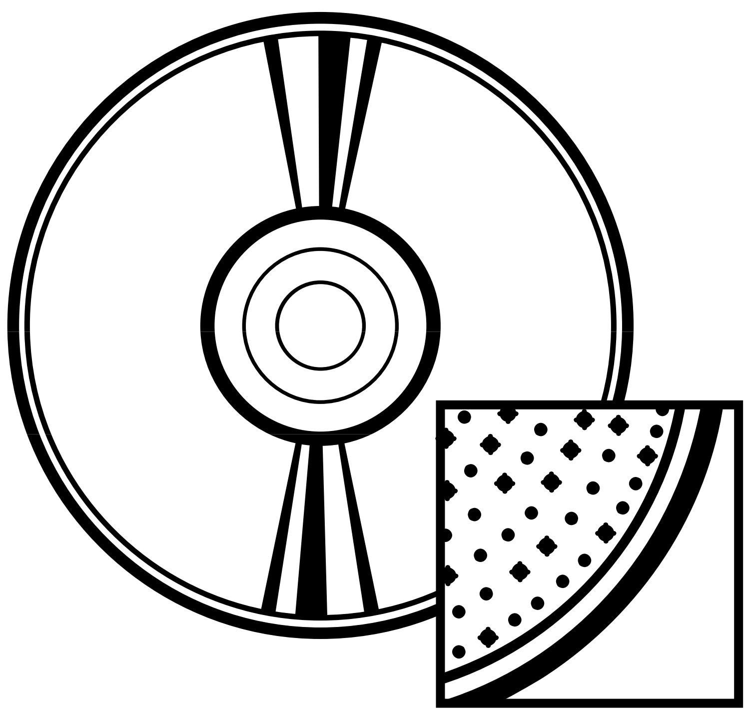
The Photo-CD represents one practical form of storage. It's small and not overly sensitive.

BE CAREFUL

You should remember this: don't think that storage is for ever. After five years' time, it may well be that the data are no longer retrievable. But that's just something to consider in passing. Fundamentally there is nothing wrong with storing data, or for that matter, image data, on CD.

How does a CD writer actually work?

This is quickly explained. The digital data are burned into a round plastic disc. Yet you won't see any branded combinations of 0 and 1 if you hold your CD up to a magnifying glass. Instead you'll see combinations of notches of two different shapes. It looks more or less like this:

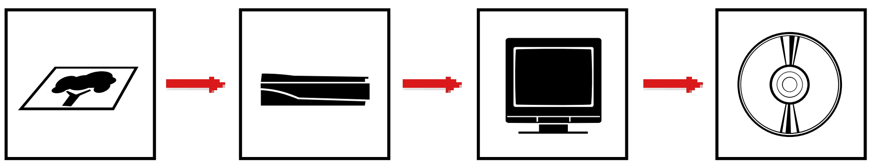


Leaving the notches to lie exposed on the CD would be a bad idea. Even a little grain of dust might lead to peculiar data. For that reason, the CD is sealed with a protective layer.

The data to be read from the small Photo-CD notches are scanned by a laser beam, just like the data of audio CDs. The computer then forms visible images from the various combinations of notches.

But what do you have to watch out for so that these images really correspond to the original documents?

If you yourself should own a CD writer with which you want to record your data, you will use the relevant system components in this order:



The documents first have to be scanned, because the images first have to be available as digital data. Afterwards, these data records are burned into the CDs as just described.

It's easy to recognize that reliable color reproduction is dependent first of all on the calibration of the scanner. If this first link of the chain isn't properly calibrated, then the end result will probably not come out to your satisfaction.

In the final step, your prepared data have to be transformed into the color space of the Photo-CD. This color space is known as YCC and represents an industrial standard. If you carry out the color space transformation with the help of your scanner profile, then you can rest assured that nothing will go wrong here.

But what do you do when you don't have a scanner or a CD writer but do have a totally fantastic CD-ROM processor, and would like to have all your photos available on a CD? Very simple: you contract someone to scan your images and record them onto a CD.

So what do you have to pay attention to in color space transformation? With the help of a scanner calibration tool, you can be sure that you will be able to create a profile for the data on the CD.

For that task, you'll have to scan the scanner's test document in addition to all your photos.

You'll be able to call up these image data as though you had just scanned them. And this is exactly the little swindle that you'll pull, too. The values of the color fields will be measured by your calibration software and then compared with the theoretical values. In this way, you can prepare a profile for a completely foreign scanner and use it when recalling any other photo on the CD.

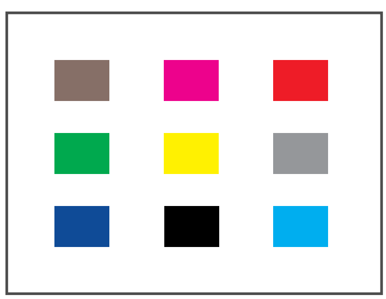
As you see, this process brings you one step closer to your goal mobility of color information.

After all the descriptions of the various calibration processes, we now want to cast a quick glance towards the future of color management.

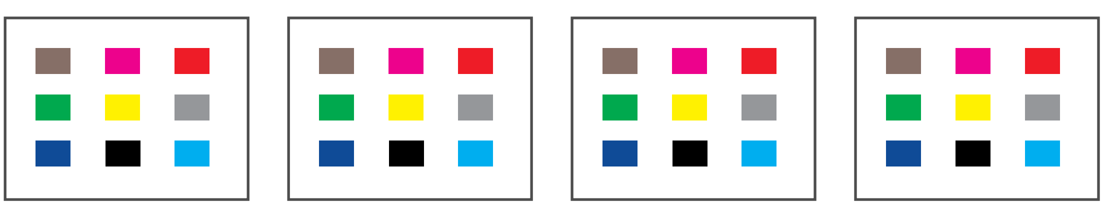
There’s one thing the future of color management will definitely become: colorful !!!

And yet not chaotically colorful,

but systematically colorful



and all of that regardless of time or place !!!



We have high hopes that reliability in the reproduction of colors will not remain an illusion.

The present color management systems will be improved further, both in terms of the quality of color space transformation as well as its ease of use. Color management will finally be clear to everyone and applicable by anyone.

These improvements will, of course, be accompanied by changes on the hardware side. Even today we have the first color copier which is sensitive to shifts in relative humidity and temperature and can adjust itself in order to achieve consistently optimal results. Other machines like scanners or imagesetters are becoming more stable, so that they don't have to be calibrated as often.

Standards will continue to gain ground. Many more applications will become available which are capable of producing or using ICC profiles. At some time we'll actually reach the point when color information will be as reliable and simple to transmit as fonts are today.

There will be no more obstacles to worldwide cooperation in the reproduction of color.

Wait and see! Its development will definitely remain exciting!!

For the grand finale, once again, the essentials of this book briefly:

Take advantage of the color management systems that are already available today.

Do you remember our introductory images? After the calibration of your machines, and with the help of a color management system, you can have the following, clearly different result:

Reproduction which corresponds to the original

Original scanned with scanner A, with color management

Original scanned with scanner B, with color management

Because calibration is so simple, as you saw for yourself, you should really make the effort every time. It's truly worth it !!!

After reading this small book, you're still not going to have the knowledge of a trained repro specialist. But you have all the knowledge you need to achieve good results in the reproduction of color images and to keep ahead of a variety of nasty surprises.

The results of your future work do not depend on chance. With that in mind, we don't want to wish you "good luck" in your future work with color graphics and reproductions but:

All the best !!!

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Color Management