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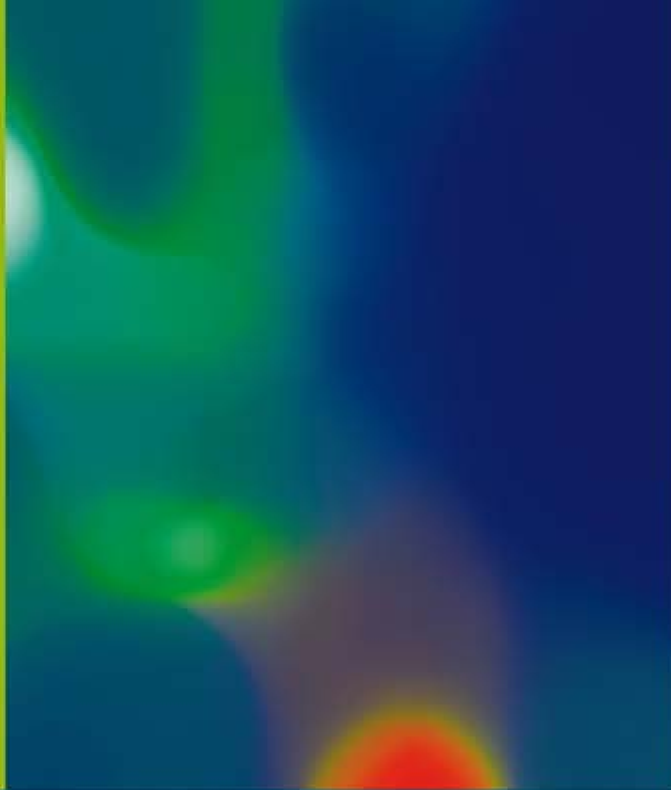

Jan-Peter Homann

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Digital Color Management

Principles and Strategies for the Standardized Print Production

Springer

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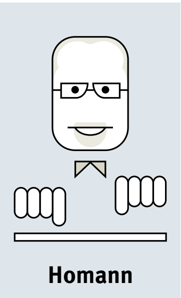
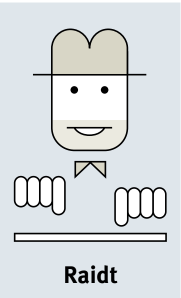
The production team
The close integration of text, translation and graphics in this book called for an equally close collaboration between the author, translator and designer. Only through intensive teamwork, from conception to production, has this book, in its present form, been possible.



Jan-Peter Homann (b. 1964)
studied Communication Science and Technology at the TU Berlin, Germany. Since 1988 he has been working in image editing, color management and pre-press. Since 1991 he has been writing for publications such as PAGE and Publishing Praxis. In 1989 he published his first book: “Digitalisieren mit Amiga” (Digitizing with Amiga).



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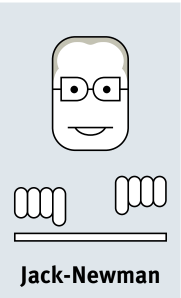
is a skilled typographer, studied Communications Design at the FHTW Berlin and works as a freelance graphic designer, mainly in corporate and editorial design. He is responsible for the design and layout of this book as well as the graphics.



Andy Jack-Newman (b. 1970)
studied Visual Communication at the University of Portsmouth, England. From 1991 he worked in Berlin as both a graphic designer and translator. Since 2007 he has been working as a senior web designer on the south coast of England.

Jan-Peter Homann

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www.colormanagement.de

ISBN 978-3-540-67119-0 e-ISBN 978-3-540-69377-2

DOI 10.1007/978-3-540-69377-2

ISSN 1612-1449

Library of Congress Control Number: 2008932552

Title of the original German edition:
Digitales Colormanagement, 3rd edition
ISBN 978-3-540-20969-0, © Springer-Verlag 1998, 2000, 2007

Translated from the German by Andrew Jack-Newman
Layout and design: Axel Raidt, Berlin
Production: le-tex publishing services oHG, Leipzig
Cover design: KünkelLopka, Heidelberg
Printed on acid-free paper

9 8 7 6 5 4 3 2 1

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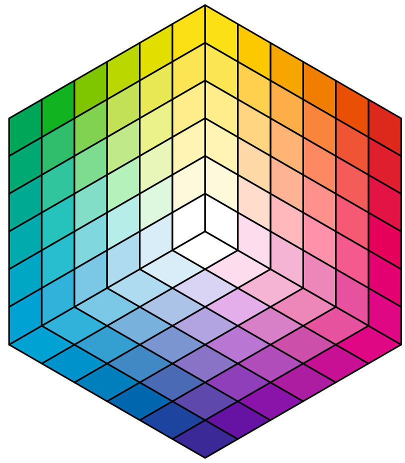
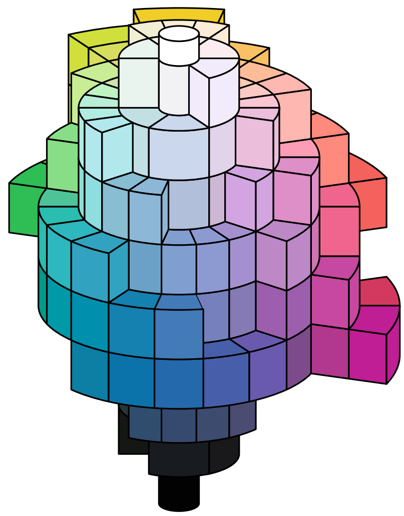
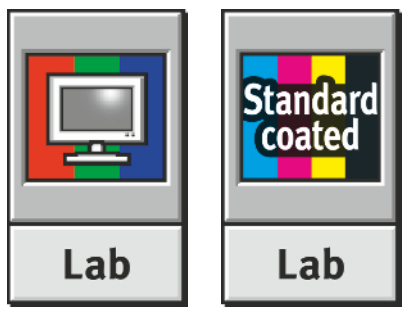
Contents







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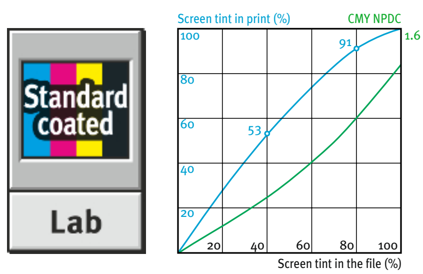

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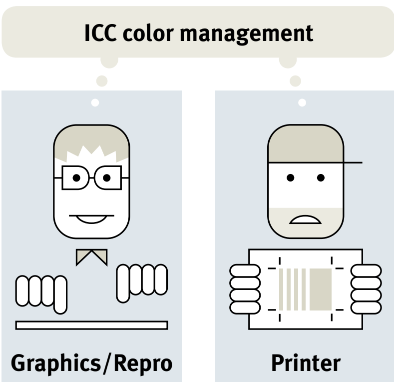
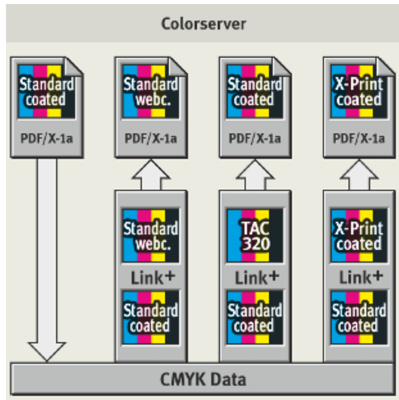

ICC color management
Graphics/Repro
Printer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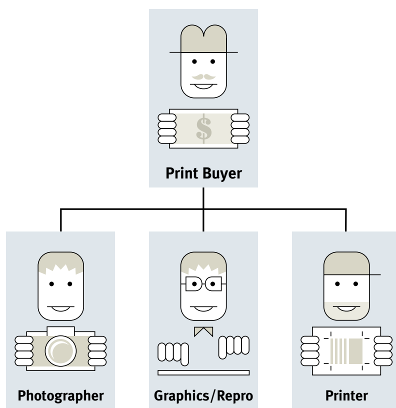

Print Buyer
Photographer
Graphics/Repro
Printer

Acknowledgements for the 1st (German) Edition

I would like to thank everyone who stood by me during the production of this book. I feel particularly obliged to Axel Raidt and Karsten K. Auer for translating calmly my constant new ideas and concepts into graphic form; Gregor Reichle of Springer Publishers for his patience despite all the delays; Joanna, for putting up with all my moods; Florian Süßl of CitySatz for accompanying this project as regards content, as well as Wieben and Frauke Homann for their active support during the final stages.

A number of companies and people have supported the production of this book in many different ways: Medialis with joint projects in the initial stages of the book; Logo and especially Dr. Brües with loans and background information on the ICC-Standard; Optotrade and Linotype-Hell with loans and support as well as Divikom with the loan of extensive equipment.

Acknowledgements for the 2nd (German) Edition

Again, thanks to Axel Raidt for his patience and thoroughness; the companies Epson and BEST, who supported me with the supply of hard and software as well as materials; Franz Herbert, Mr. Fuchs and Dr. Tatari, who always promptly answered by e-mail my technical questions regarding the ICC-Standard, as well as all proofreaders.

Acknowledgements for the 3rd (German) Edition

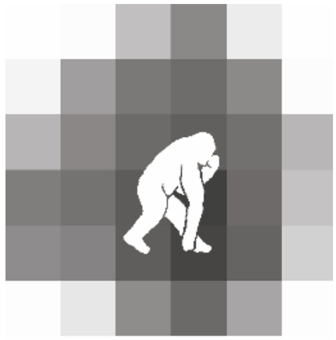
Thanks go to Axel Raidt and Ingo Neumann for their patience during the layout and production of the 3rd edition, as well as Martin Steinröder for the 3-D illustrations. Mr. Engesser of Springer Publishers for his calmness in dealing with the constantly postponed publication, and my wife Joanna who picked me up when I began to despair.

Furthermore, I would like to thank the following companies for their long-term loans of hardware and software: Adobe, Color Solutions, ColorLogic, Epson, GMG, GretagMacbeth (now X-Rite), Heidelberger Druckmaschinen and Meta-Design

Acknowledgements for the English Edition

Thanks to Andy Jack-Newman for the translation and to Paul Sherfield for proofreading the English color-management terminolgy.

1998: Introduction from the first German Edition



A Look Back at PostScript and a Look at Color Management

At first sight it might astonish some readers to begin a book concerning the handling of color with a look back at PostScript. There are many indications though that the technology known as "color management" will have as strong an impact on the organization of work in the graphics industry as PostScript has in the last ten to twelve years.

PostScript is a technology for running output devices and a universal exchange format for text, image and graphic files. Following the introduction of PostScript it was a few years until so-called Desktop Publishing Software made full use of PostScript's possibilities. In this time PostScript was improved in certain areas to make it more practical. After this start, with all its teething troubles, the work organization in the graphic industry began to change radically. However, even twelve years after its introduction, many people who work with PostScript have still not grasped its concept. Whoever has worked in an imaging studio can sing a song about this.

After PostScript, color management is the second wave to break over the graphics industry. The PostScript wave has had a strong impact on two areas of the graphics industry in particular: creation (agencies and publishers) and production (classic photosetting and to an extent repro). The color-management wave clearly covers more areas: along with agencies, publishers and photoset, the repro area will change more drastically than with the introduction of PostScript. In addition to creation and production comes duplication. This is traditional and digital print. Also, photographers will have to rethink their ideas as in the long run color management is a technology for the exchange of digital images between all digital media.

The History of PostScript

PostScript is founded on basic elements that existed before its conception: the depiction of graphics and type by means of vectors as well as the depiction of images and photos by means of pixels. This encoding of text, graphics and imagery existed before the time of PostScript e.g. in some very expensive photosetting and prepress systems. The developers of these photosetting systems were responsible for everything, from the basis software for making text, graphics and imagery available on the computer, to the user software for the design work, to running the imagesetter. Each manufacturer had his own data format and was pleased when he could sell a few thousands of his systems worldwide. As a result, these systems, the peripherals and the software were expensive. In the early 1980s a photosetting work station with a basic furnishing of 100 fonts would have cost $75,000. With PostScript came the crucial turning point.

The basis technology for the depiction of text, graphics and imagery became an integral part of the operating systems for personal computers. Likewise, the control of output devices became standardized along with the exchange of text, graphics and imagery between various applications.

The quality of the basis technology was in keeping with classic photosetting. The first applications based on this, however, had a different aim: instead of highly complicated and specialized photosetting software for a tiny specialized target group, PostScript-based software products were developed for the mass market.

“What you see is what you get” was the slogan at the time. Instead of programming language as with photosetting, the user could lay out his text, graphics and imagery directly on screen. The typographical possibilities were very limited to begin with, but the cost of the work place was only 1/10 to 1/5 that of photosetting. Whoever, as designer, used the machines from the DTP stoneage to the full, could produce simple yet appealingly designed printed matter.

In the realms of software development a completely different picture in comparison to photosetting revealed itself. A young company with a good idea for a clever application software had a better starting point by far than in the classic photosetting area: a much broader market and much lower development costs. The basis technology for the depiction of text, graphics and imagery as well as the control of output devices already existed on the machines of potential customers.

The first DTP software PageMaker 1.0 lacked, for example, the exact numerical access to important layout parameters such as type size, leading, image size and placement, etc. For experienced photosetters PageMaker was wholly out of the question. One year later a group of motivated software developers brought out QuarkXPress 1.0. With this, exact numerical working was possible. Within only a few years the division of labor within the graphic industry began to fundamentally shift. Innovative advertising agencies and publishers who until now had their jobs set externally, bought themselves a Macintosh and QuarkXPress and began to get into production themselves. Photosetting businesses that soon recognized the market trend also acquired DTP equipment and the necessary imagesetter. Not only were their own creations put out on the imager, but they also sold the imaging of PostScript data as a service to advertising agencies and publishers who had no imagesetter of their own.

This restructuring of work divisions was not without its problems though. The traditional ways of working between the designers (agencies and publishers) and the producers (photosetting) were long in place with few uncertainties.

In the early years PostScript-orientated work organization was a real adventure for pioneers: the wrong type on the film, rough pixeled graphics, files that could not be imaged, and, and, and ...

Together, the pioneers among the designers and PostScript service providers learned to master the technology. The experience gained during these pioneering years allow these services to fulfil their complex contracts far more effectively and safer than any competition that has turned to this technology at a later date.

The development can be summarized as follows:

1. Special technology becomes part of the operating system. (Photosetting technology moves to PostScript.)

2. Innovative software companies develop new, efficient and affordable products (DTP software is inconceivable without PostScript).

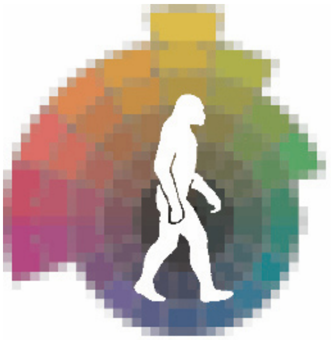
3. The designers to an extent become producers. (Agencies and publishers set smaller jobs themselves rather than contracting a photosetting service.)

4. The old producers extend their services to offer new ones to designers. Although the producers (photosetting services) lose some of the contracts from their customers, they can build on new areas of business, provided they invest in the right technology in time (PostScript imagesetter).

5. The new technology and ways of working are, at the beginning, not without teething troubles.
   This phase continues a few years after the introduction of PostScript. The teething troubles were down to the technology as well as the work organization of all involved with dealing with the technology.

6. The restructuring of workflow organization lasts longer than the initial technical problems.
   Even after the basis technology of PostScript and the DTP software based on it was technically stable, it took a lot longer until those involved could work correctly with it. Many users and service providers today still have not mastered this technology within workflow organization.

7. The pioneers create their own market.
   The pioneers of the early years develop a work organization to suit PostScript. Consequently they are able to work more efficiently, safer and can take on more complex jobs.



Parallels and Differences Between the Introduction of PostScript and the Introduction of Color Management

1. Special technology becomes a part of the operating system.
   Also, the basis technology color management is already an integral part of specialized high-end systems. Whether it be the color processor in a drum-scanner or the color adjustment in a digital proof system.

2. Innovative software companies are developing new, effective and affordable products.
   This phase is just beginning. Compared with the introduction of PostScript, color-management products are at the level of PageMaker 1.0. It is worth while then to watch the effectiveness of new software that touches on color-management technology.

3. The designers, to an extent, become producers.
   This development begins with flatbed scanners that, with integrated color management and an automatic image analysis, offer even the beginner an increased quality in the face of an uncalibrated system.

4. The old producers extend their services to offer new ones to designers.
   In comparison to the introduction of PostScript, this process is running much more smoothly. Alongside the introduction of color-management technology, PostScript is developing further and alternative output devices such as digital printing systems, slide imaging, CD-ROM, digital video production or internet are becoming important. Color-management technology serves as a base technology to ensure a consistency in color when transferring between these media.

5. The new technology and ways of working are, at the beginning, not without teething troubles.
   This is unfortunately more the case than with the introduction of PostScript. Color management develops parallel to PostScript-based systems and creates one of many interfaces to other digital media. So not only are there the internal teething troubles of color-management technology, but also the problems that occur when integrating color management into other technologies.
   For example, there is at present a number of areas of application where PostScript and color management conflict with each other, although each technology functions correctly in itself.

6. The restructuring of the work organization lasts longer than technical teething troubles.
   As mentioned in the previous section, color management is a basis technology among others, which all grow together in digital media technology. So the demands on individual services and their workers will constantly change. One central theme for innovative services will be the development of tools and workflows for the assurance of quality.

7. Pioneers create their own market advantages.
   The introduction of color management provides on the one hand a chance to conquer new niches in the market. On the other hand, there is the danger of investing in the wrong technology – and more important: without further training for workers and management – to be superseded by the young, fresh competition.
   Color management will not become a plug-and-play solution by growing together with different digital media. Pioneers will not get around having to try out much for themselves. This testing must be systemized and planned into everyday production.

2000: Amendment to the 2nd German Edition
Even two and a half years after the publication of the first edition, the situation is still sketchy. On the one hand, ICC-based color management together with high-quality inkjet printers have created lower costs for digital proofing systems.
On the other hand, there is still no consistent integration of ICC profiles in the operating system, application programs, printer driver and PostScript RIP. Many problems with regards to color management do not arise if one concentrates, from the start, on optimizing the traditional CMYK-based working method in the graphics industry.

2007: Amendment to the 3rd German Edition
The graphics industry has changed dramatically in the 7 years since the 2nd edition. Just like with the introduction of PostScript and DTP programs, the cost of repro equipment has sunk dramatically thanks to color-management technology. In many cases application software like Photoshop also take on this role. Many agencies and publishers are currently setting up their own repro departments and the number of classic prepress businesses has greatly decreased.

However, even 9 years after the publication of the first edition, we still cannot speak of a stable technology. Herein lies the reason why the 3rd edition was finished a number of years later than planned. The standards on which the whole of color-management technology is based, are still deficient when it comes to integration in operating systems, application software, printer drivers and the data formats PostScript and PDF. The ICC standard for the use of color profiles remains, in many areas, insufficient for the color management of CMYK print data.

Whoever wants to use color management purposefully and safely needs to know where this technology delivers predictable results and how potential problems can be avoided right from the start. For me, as an author, it was much more difficult to explain strategies for avoiding problems, than it was to describe the functionality of color management. Work on this subject has led to me redesigning and rewriting the 3rd edition many times. It has now a focus on strategy for color-management implementation. Some central points of this strategy depart from recommendations that many “color-management gurus" have preached over the last 10 to 15 years. For example, I recommend that printers only accept PDF/X-1a files as print ready instead of PDF/X-3 files. The varied color-management options should only be used with great caution and control in layout programs and when producing PDF data. Whoever wants to prepare print data for different printing standards, I recommend pure CMYK-PDF/X-1a data as the base format and color transformation with carefully checked DeviceLink profiles.

The necessary theoretical basic knowledge for this is given in this book.

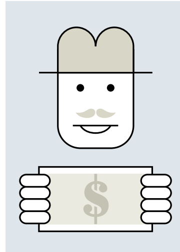
2008: Amendment to the English Edition

The English Edition is based on the 3rd German Edition but also takes a closer look at the developments of SWOP, GRACoL and G7 in the US market.

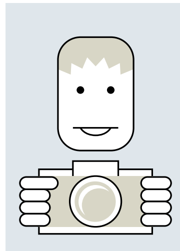
Digital Color Management – a Didactic Play in 7 Chapters

The first two editions of this book concentrated mainly on technological aspects of color management. In this third edition, particular value has been placed on the communication among those involved in a print production. Here is a short introduction to the different protagonists who appear time and again in the following 7 chapters:

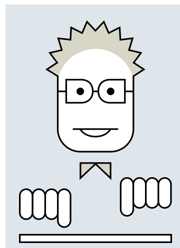
The print buyer
The print buyer depicted in this book is concerned professionally with the purchasing of photography, graphic design and repro services as well as the production of printed matter. In the agency environment and publishing houses he is called the production manager and in large industrial companies he works in the marketing department. If the print buyer observes certain basic color management rules when allocating contracts, he can provide for a possible trouble-free production cycle.


Print Buyer

The photographer
After changing to a digital method of production he must increasingly consider how he can reliably communicate the color of his images to the print buyer and prepress.


Photographer

Prepress (graphics and repro)
While in the past the work was clearly divided between the graphic designer and repro specialists, today there are more and more graphic designers who edit photographers' digital image data for print and send their layout artwork as PDF print data to the printing house. And so they take on classic prepress tasks. However, despite color management, there are still tasks that are best left for the repro specialists. For this reason the aforementioned appear separately in this book as well as in union.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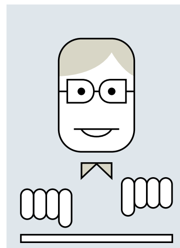
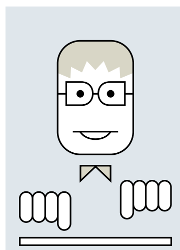
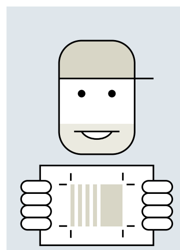
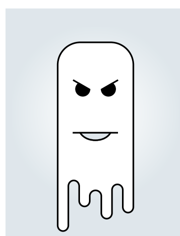

Repro

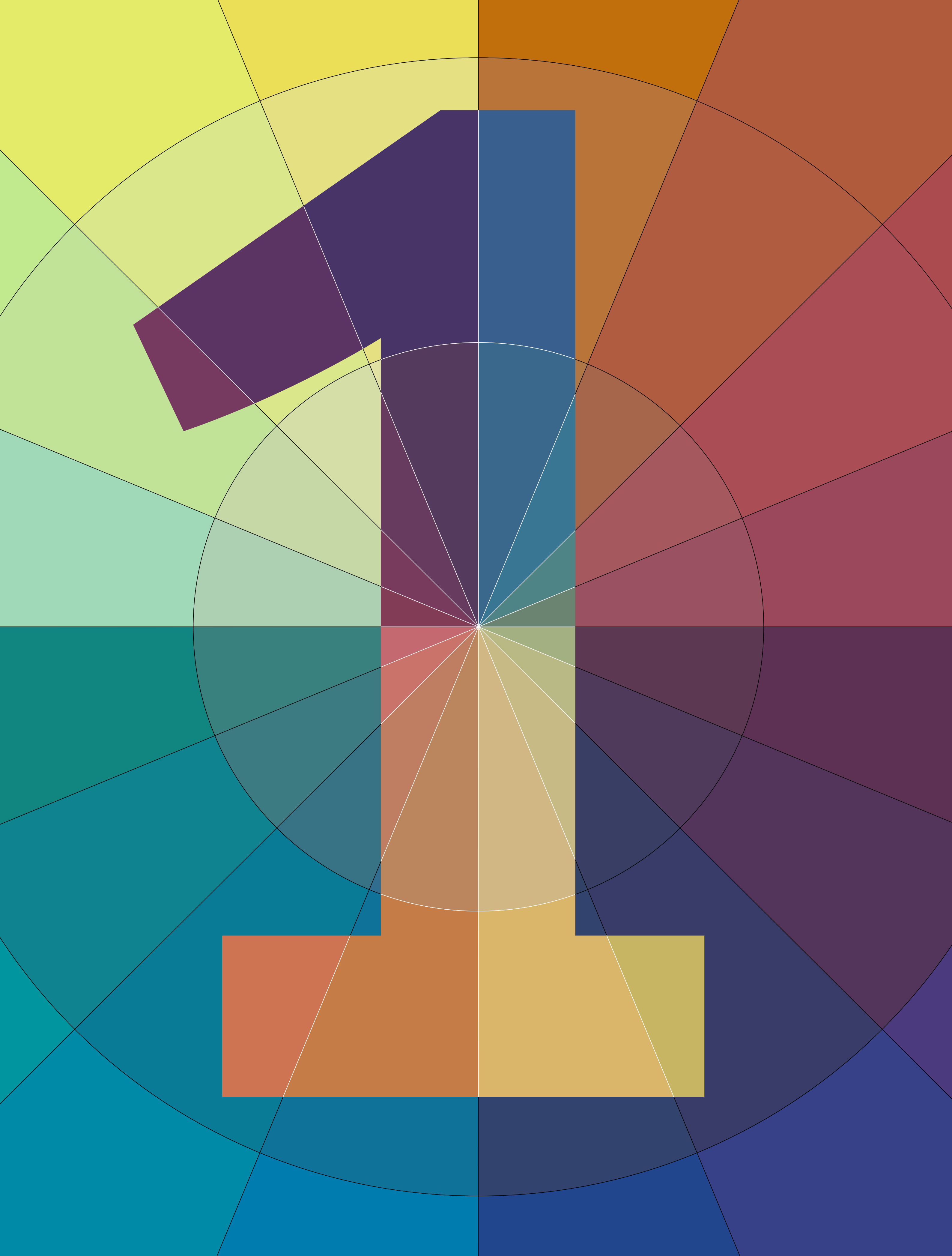

Graphics/Repro

The printer
He is responsible for producing printed matter from the data provided by graphic designers or repro services, which meet the print buyer's expectations. The clearer the printer can communicate how the print-ready documents should be composed, the more trouble-free the production.


Printer

The banes of color management
Those of the above protagonists who are seriously concerned with color management quickly become familiar with some unpleasant banes: the optical brighteners, that help make some papers a gleaming white. They are a main reason why color management is more problematic in practice than the theory suggests. Whoever wants to use color-management tools professionally must come to terms with these banes.


Optical Brighteners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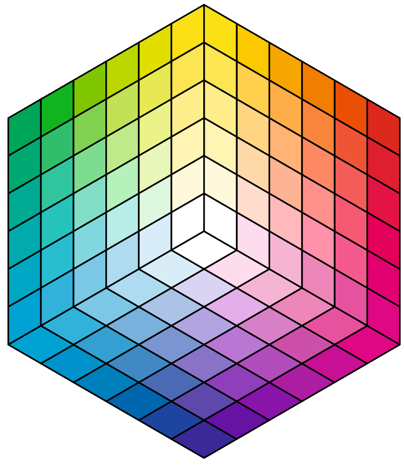
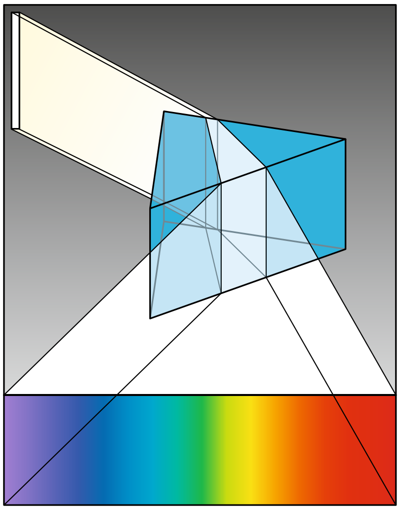
Color Theory with Ideal Colors

The term color management means exactly what it says. Whoever, as manager, does something without knowing why, must constantly be prepared for nasty surprises. To utilize color management, a basic knowledge of color perception and color models is invaluable. For an easier lead-in, this chapter is based on ideal colors that do not occur in practice. But for this, the basic laws of chromatics take greater shape.



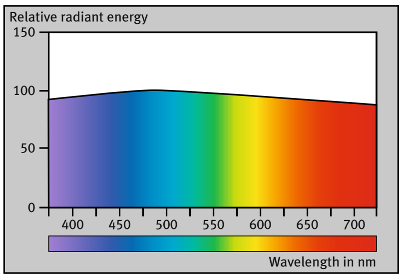
The Spectrum and the Eye



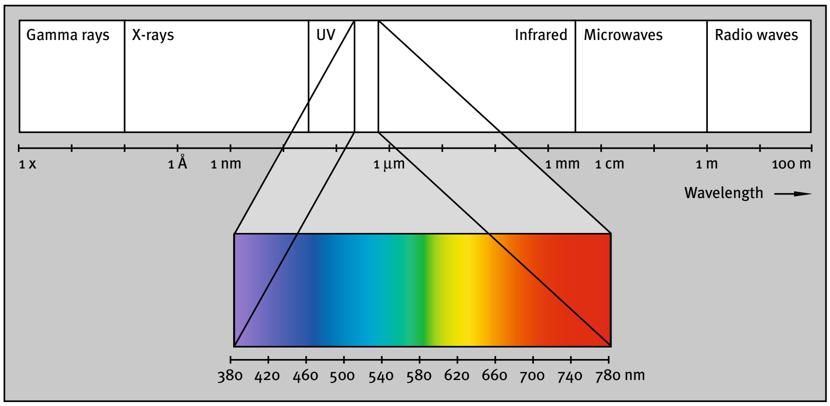
Refraction through a prism

Without light we see nothing. This simple truth becomes more complex upon closer inspection, because light is not just light. Colloquially one talks of cold and warm light. The photographer differentiates between daylight and artificial light. In reprography there is standardized lighting for color matching artwork, print proofs and final runs. As light sets the basic conditions for the perception of color, this book begins with light.

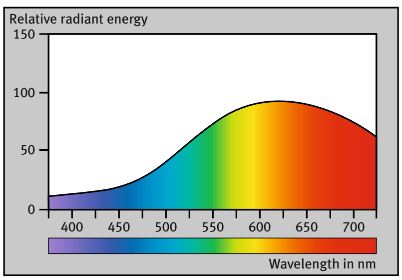
Light is an electromagnetic wave, and so finds itself in the company of radio or television waves or X-ray apparatus. Like a radio, which converts radio frequencies into audible tones, the eye and brain convert the rays of light into color images. Every electromagnetic wave can be described by its wavelength. The waves perceived by man as color have a wavelength of 380 to 780 nanometers.



Daylight's spectrum



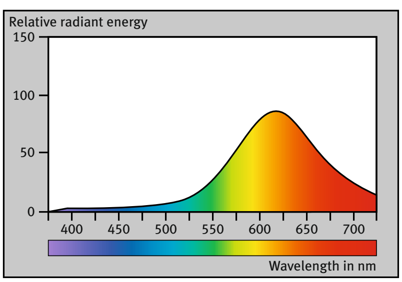
The area of visible light in the scale of electromagnetic waves



A light bulb's spectrum

Normal daylight or artificial light is always a mixture of all wavelengths. If one refracts this light with a prism, one sees the colors of the rainbow instead of white light. The mixture of different wavelengths is now broken down in order. Each wavelength has its specific color. At 380 nm it starts with violet, then through blue, cyan, green and yellow to red at 780 nm.

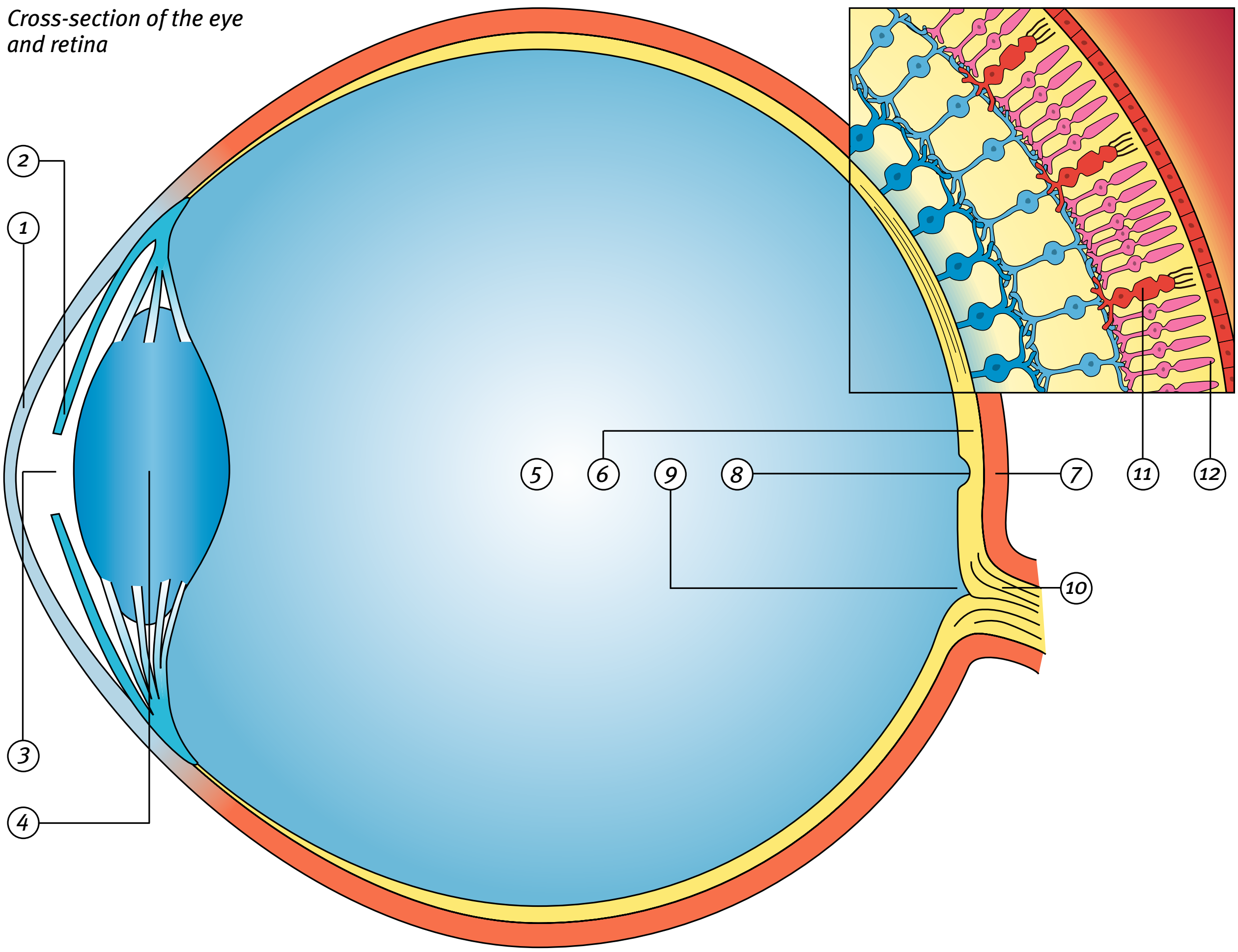
So the whole spectrum of all colors is present in light. The term warm or cold light, or artificial or daylight describes how strongly each wavelength is present in the light.



The spectrum of a red traffic light

To characterize a type of light, the proportions of each wavelength are recorded in a diagram. This diagram is called a spectrum. Sunlight, for example, has a balanced spectrum, all wavelengths are equally represented. In the light from a light bulb, the red areas of the spectrum are predominant. For this reason the light appears to be warmer. In colored light, parts of the spectrum are missing. In the light of a red traffic light, the area from violet to yellow is absent. So our perception of color is very dependent on the spectra.

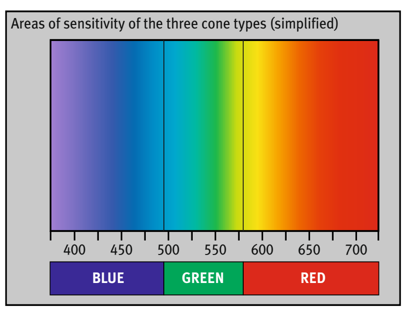
Cross-section of the eye and retina



1 *cornea*	6 *retina*	11 *cones*
2 *iris*	7 *sclera*	12 *rods*
3 *pupil*	8 *fovea*	
4 *lens*	9 *blind spot*	
5 *vitreous chamber*	10 *optic nerve*	

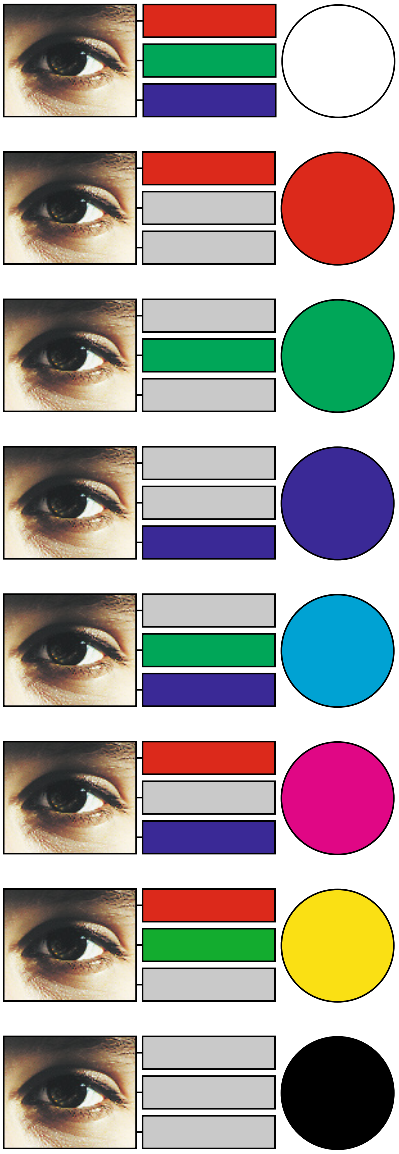
Receptor cells in the eye's retina convert the entering light into electrical impulses. One differentiates between rods and cones, although the light-sensitive rods are "color blind" and it is the cones alone that are responsible for the perception of color. There are three different types of cone. Each is especially sensitive to a particular area of the spectrum.

Each cone type is assigned a primary or base color that we term as red, green and blue. In color vision, the distribution of the various wavelengths in the spectrum is reduced to the large areas red, green and blue. From the combination of these primary colors, the impression of color results in the brain.



Three types of cone are sensitive to different areas of the spectrum

Ideal Colors and Ideal Cones



The model of color perception shown here and on the following pages is based on ideal cones and results in ideal colors that do not occur in practice. In this way though, the basic laws of color perception can be demonstrated better. Practical models will follow later.

The three cone types absorb the light energy of their respective ranges from the spectrum taken in by the eye. The eight maximum color sensations of the primary colors result when, at any time, one or two cones are stimulated to the full while the other cones receive no light energy. With white all cones are stimulated, with black none. With red, green and blue, one cone is stimulated and with cyan, magenta and yellow, two (see illustration, left).

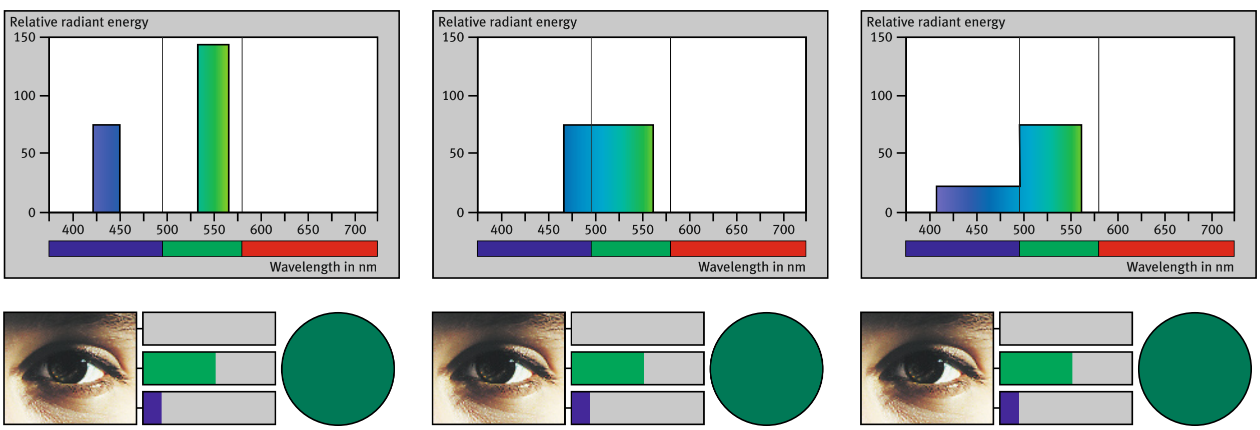
Because the cones take in energy for a broad area of the spectrum, it is possible for different spectra to create the same impression of color. For the cone it is unimportant whether it absorbs a narrow section of a spectrum with a high maximum energy, or a broader one with a low maximum energy. If the sum of the photons is identical then the cone relays the same energy input to the brain (illustration, below).

The terms hue, lightness and saturation, used for distinguishing colors, can also be applied to the spectrum (illustration, right).

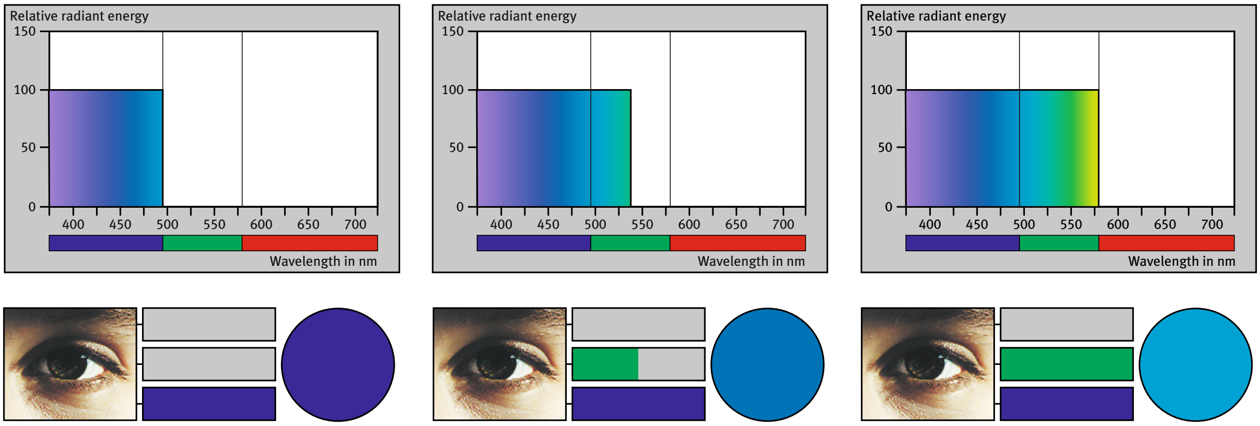
The *hue* is characterized by the transitions between the primary colors. *Saturation* results from the difference between the most stimulated and the least stimulated receptors. The illustration at the bottom of the next page shows the variations gray, unsaturated yellow and a pure yellow, each with equal lightness.

Lightness is a measure of the strength of the total energy converted by all cones. With equal hue and saturation the distance between the cones' stimulation is maintained. A dark green occurs when the green receptor is only partly stimulated. Brighter green tones of equal saturation occur when all three cones absorb equally more energy.

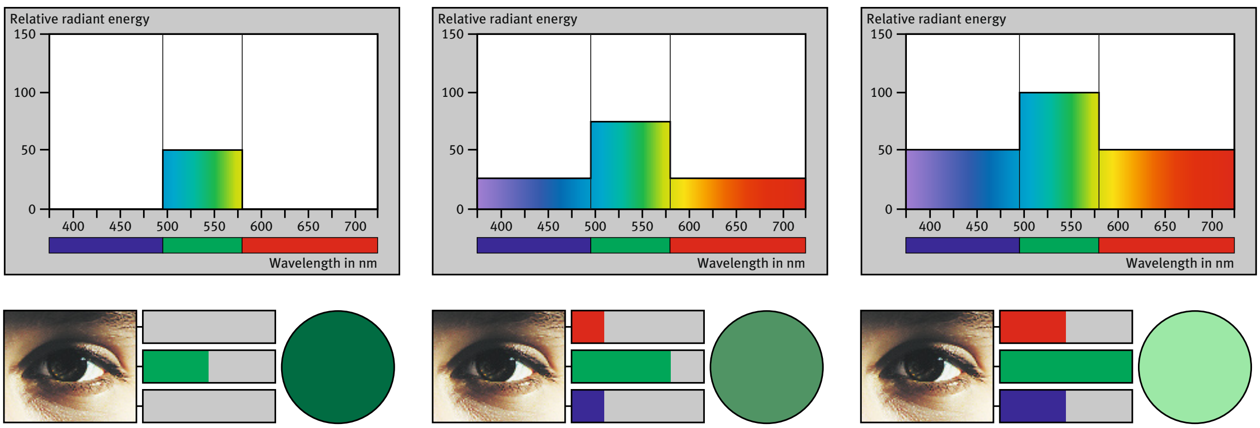
Different spectra can create the same impression of color in the eye



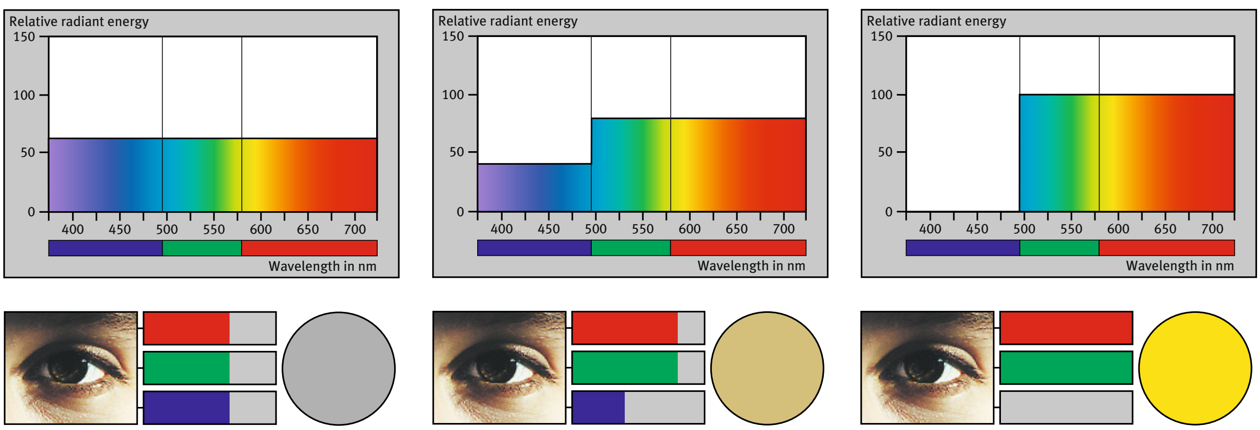
Different hue



Different lightness



Different saturation

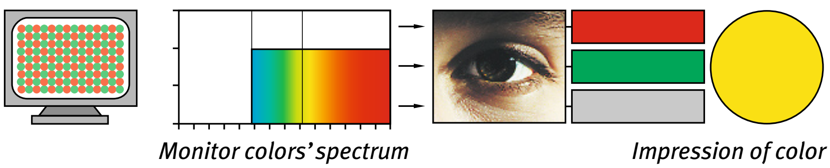


Additive and Subtractive Color Models with Ideal Colors

For the cones there are two basic types of color models: additive and subtractive. The *additive* form works with three color light sources, each tuned to a particular cone type. Every color can be synthesized, depending on the proportions of the three color light sources.

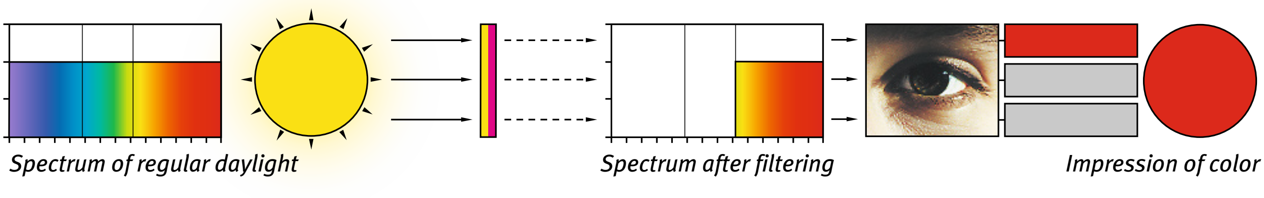
Examples of additive color models are computer monitors and color televisions. With both of these, each element on the screen is made up of three fluorescent dots in red, green and blue. Depending on the intensity of the electron rays, the three fluorescent dots are activated to different degrees. In this way each element (monitor pixel) can assume any color. The combination of all monitor pixels results then in the final image.

Additive color models with fluorescent bodies (e.g. monitors)

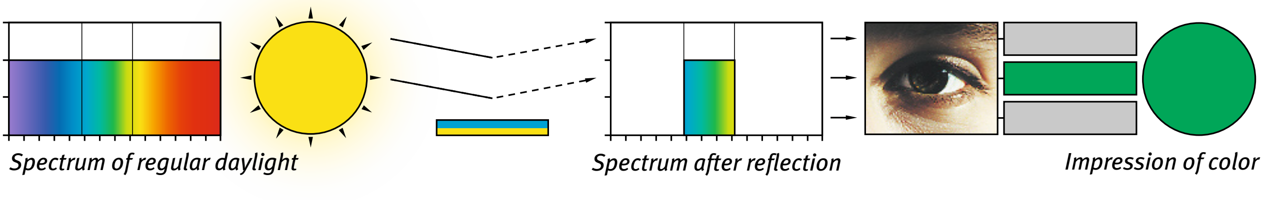


The *subtractive* form works in the opposite way. White light shines through different filters, each of which filter out a part of the spectrum. Each filter can filter out the spectral area for a particular cone type. A cyan-colored filter lets through the wavelengths between blue and green only. The cones for red do not receive any light.
An example of subtractive color models is a color transparency. It consists of three filter layers with the colors cyan, magenta and yellow, which in combination can also produce every color.

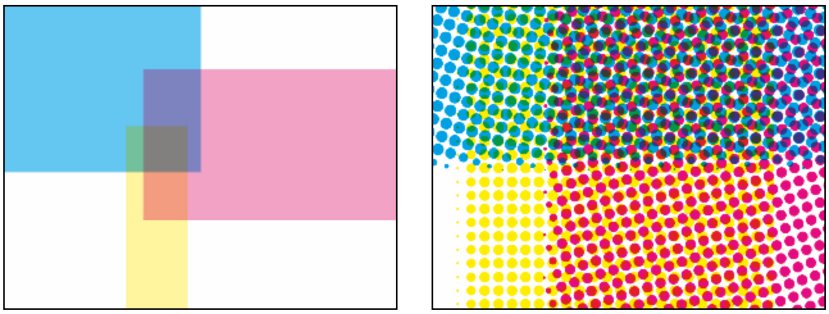
Subtractive color models with transparent bodies (e.g. color transparencies)



Subtractive color models with reflective bodies (e.g. prints)



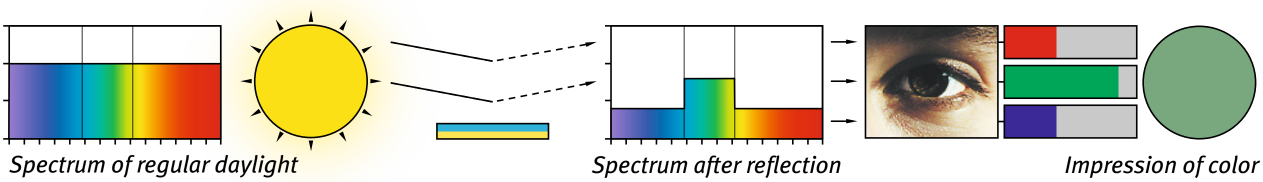
Color Models in Offset Printing
Looked at simply, offset printing also works with the subtractive principle. As opposed to a transparency though, the color filters' intensity cannot be changed directly. An offset press cannot apply the color thick or thin in different areas. To this end the filter is altered by means of a raster. With a raster of 100% area coverage, the ink works as a maximum filter. With a raster of 50% area coverage, the effect is accordingly less.



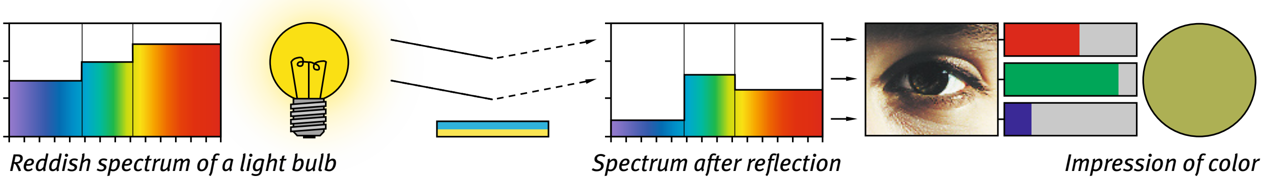
Color models in offset printing: left, a fine raster as used in high-quality four-color productions; right, an enlarged section

The Influence of Lighting on Subtractive Color Models
The color stimulus that results from subtractive color models is influenced heavily by the lighting. If the lighting's spectrum contains more red, then the color, after filtering, will contain a high proportion of red. Light with more blue in its spectrum results in a bluer impression of color.
For this reason, color-critical work in printing and prepress stages, such as color matching artwork, proofs and print proofs, is done under standardized lighting conditions.

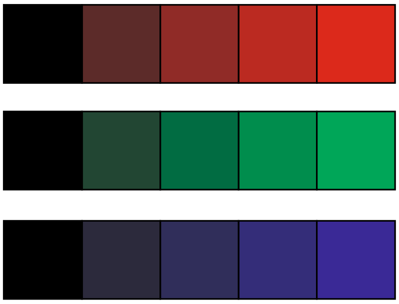
Perception of a reflective body in daylight



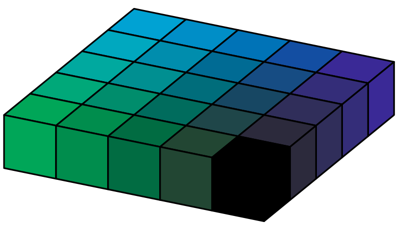
Perception of the same body under artificial light



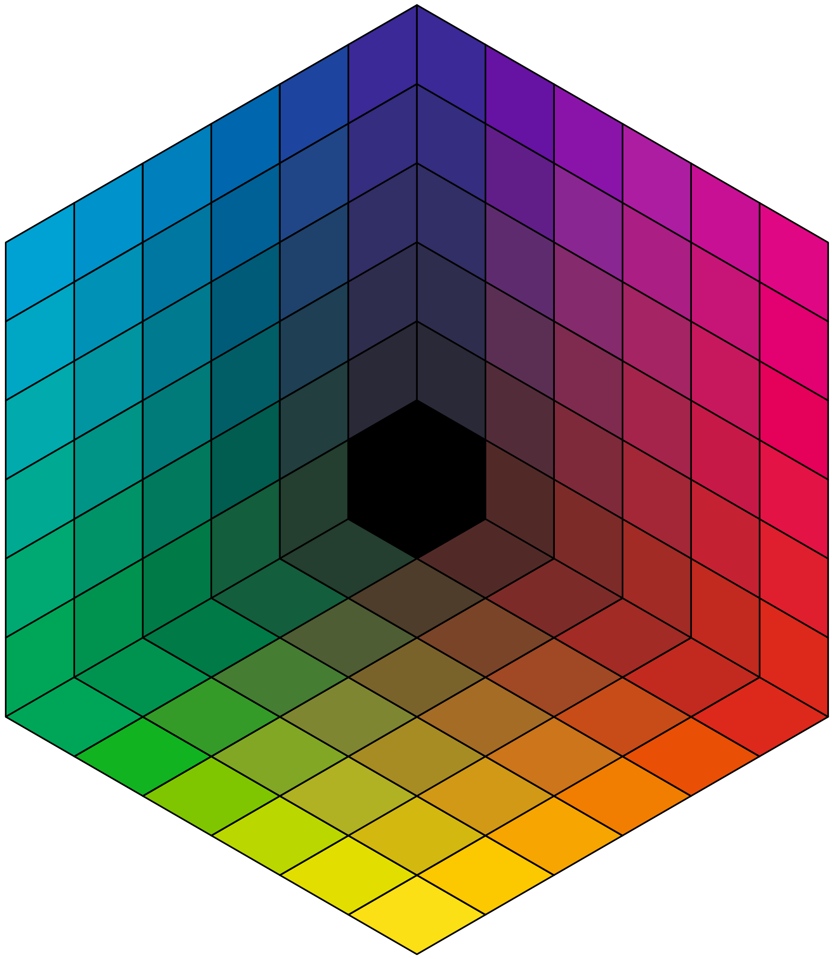
Additive and Subtractive Color Models in the Color Cube



The additive primary colors evolve from black



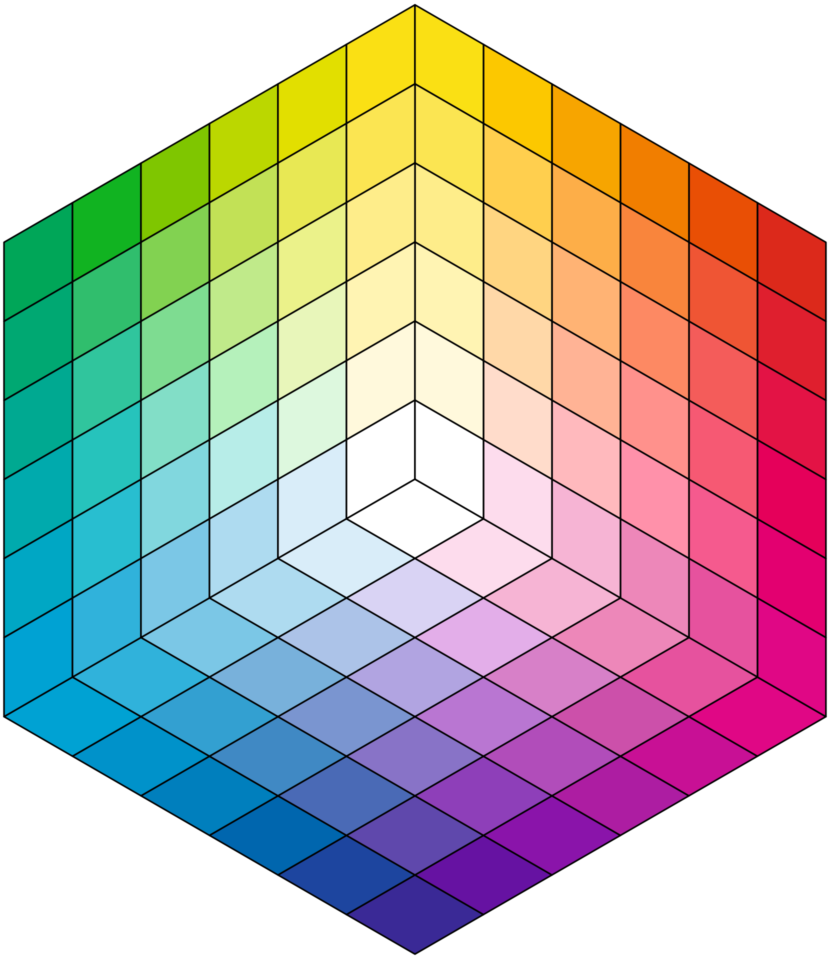
The additive color models of two primary colors produces a plane



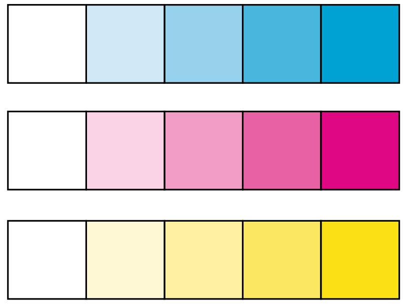
The additive color models of three colors produce a cube that begins with black

The Depiction of Additive Color Models in the Cube Model

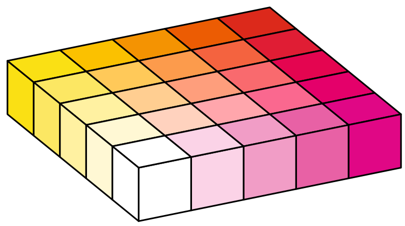
The cube is particularly suitable for the spatial depiction of additive and subtractive color models. In the additive models of red, green and blue, each cone type is represented by an axis, which starts at black and extends to the cone's maximum color. To depict all the colors possible through the stimulus of two cone types, a plane beginning at black stretches between both axes that are at 90 degrees to each other. Each point on this plane can be depicted with proportions of both primary colors. The corner opposite black depicts the mixed color of the two primary colors (cyan, magenta and yellow). If one adds the third primary color at 90 degrees to the other two, the three then form a cube. Each point in the cube is depictable with proportions of the three primary colors red, green and blue. The three, with maximum intensity, produce white and the cube is complete.



With the subtractive color models of three colors, the cube begins with white



The subtractive primary colors evolve from white

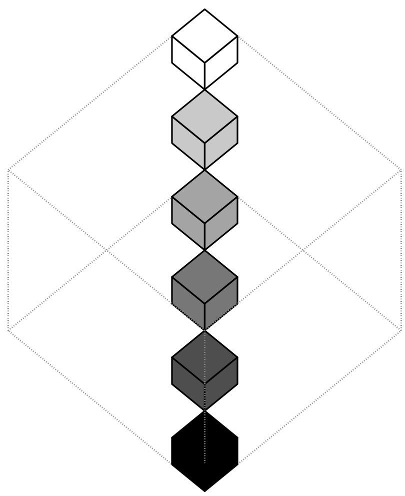


The subtractive color models of two primary colors produces likewise a plane

The Depiction of Subtractive Color Models in the Cube Model

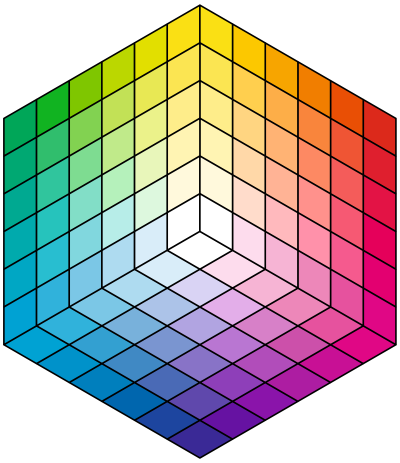
Subtractive color models are the opposite to additive color models. From white, individual areas of the spectrum are filtered out with cyan, magenta and yellow filters. The influence of two filters can be depicted on one plane. Two filters, both at maximum, produce the primary colors red, green and blue. With all three filters together, the white light is completely absorbed, leaving black.

Within the cube there is a connecting axis between black and white. Here lie the gray tones. This connecting axis is consequently called the gray axis.



The gray axis in the cube

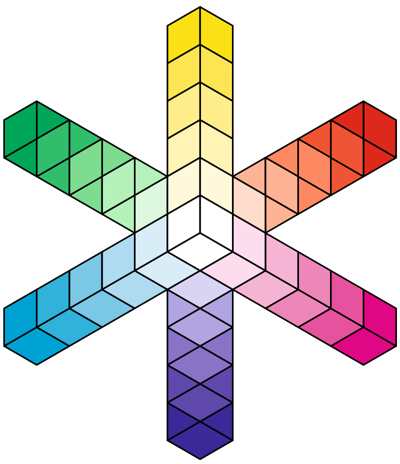
Hues in the Cube

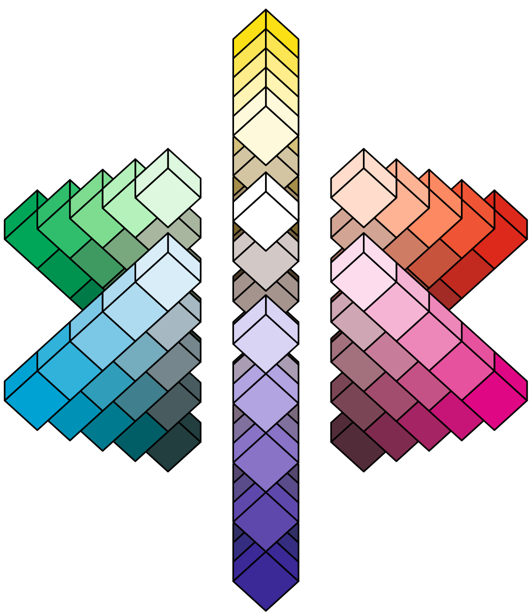


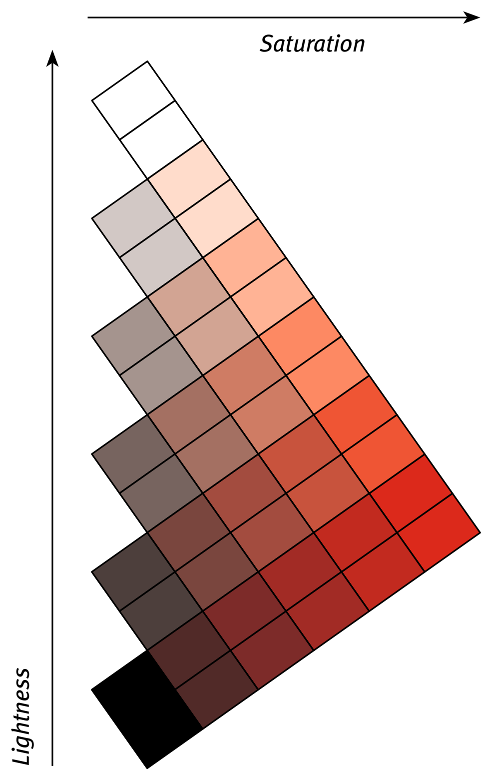
If one looks at the cube from above, the hues proceed from the white point to the corner colors. The hues form triangles between the gray axis and the most saturated corner colors.

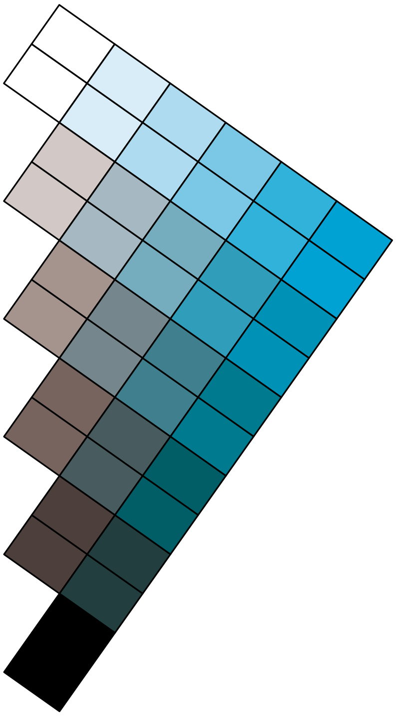
It is normal in a diagram of an individual hue to draw in the gray axis on the left and, towards the right, show the development to the saturated corner color. In such a color triangle of a hue, the height of an individual color indicates its lightness and the distance from the gray axis its saturation.

The diagrams in the left column show once again the steps that lead to the color triangles of a hue. These are illustrated on the right-hand page.

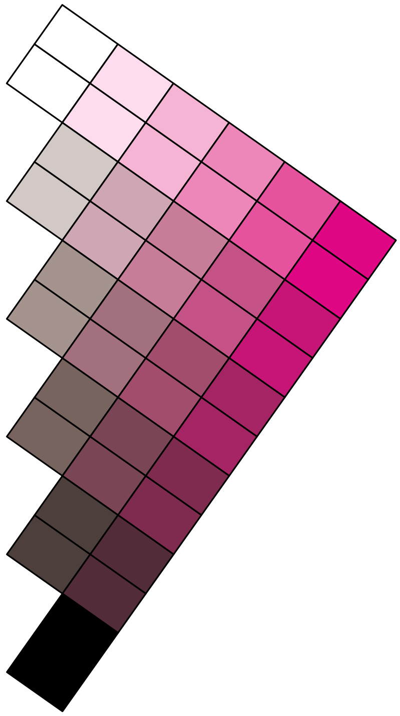




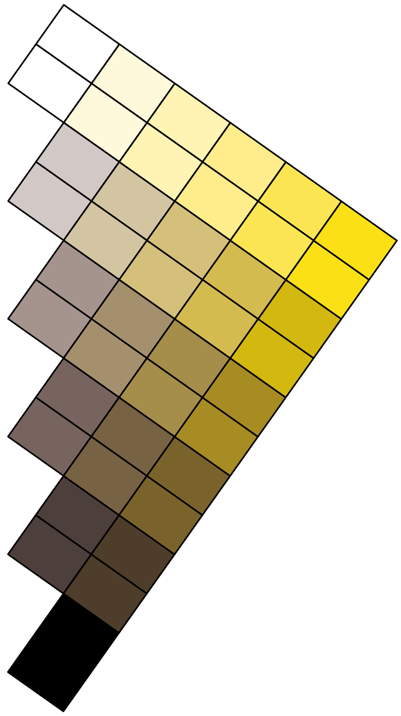




Cyan

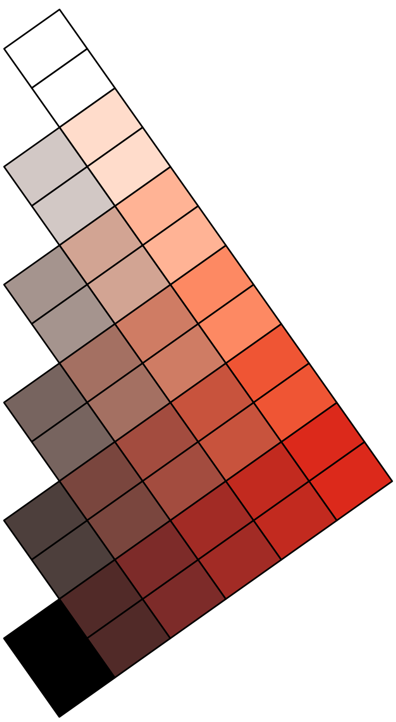


Magenta

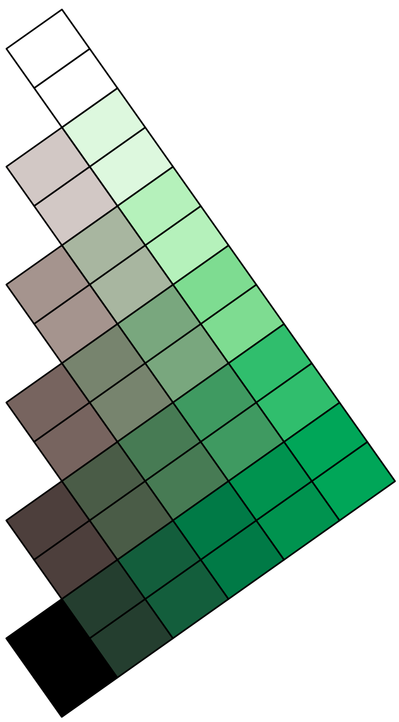


Yellow

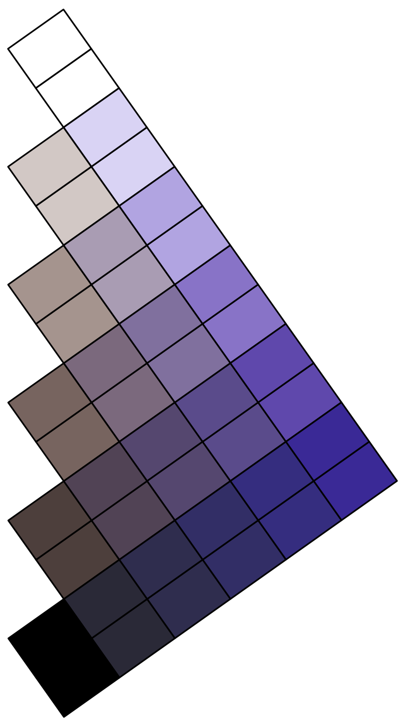
Red



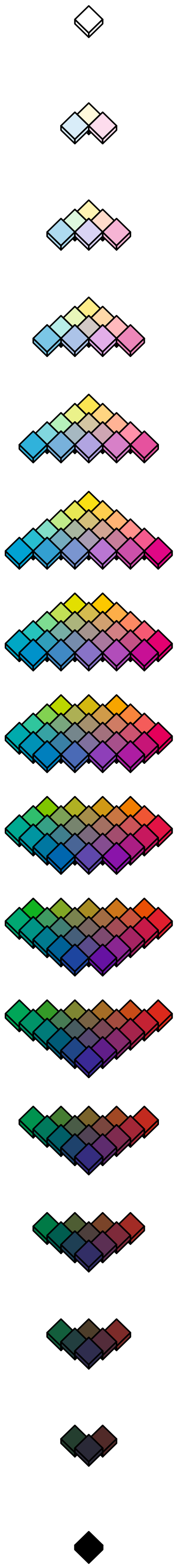
Green

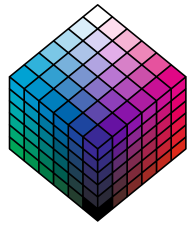


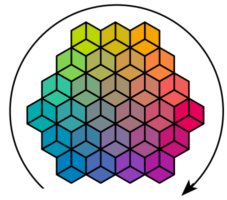
Blue

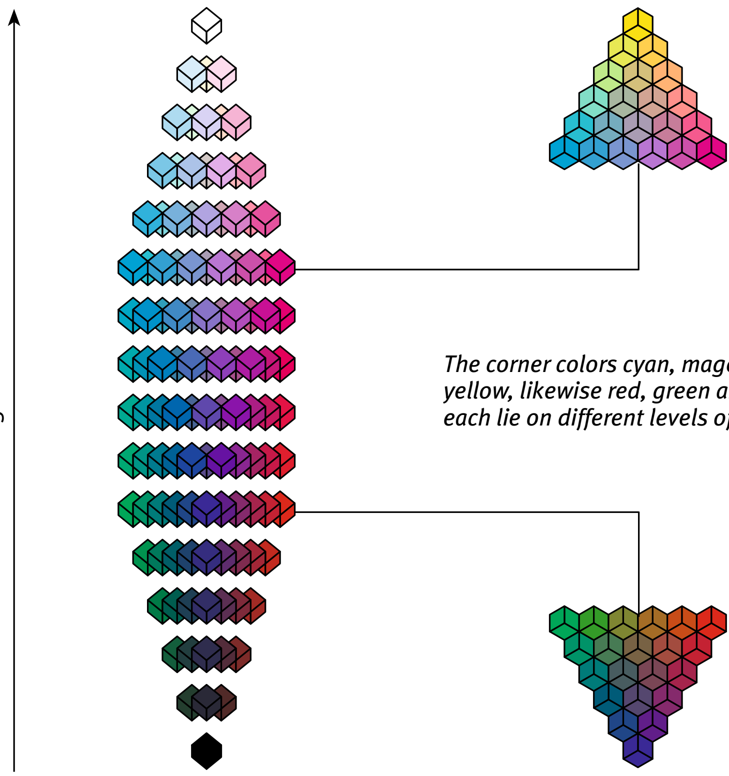


The Levels of Equal Lightness in the Cube





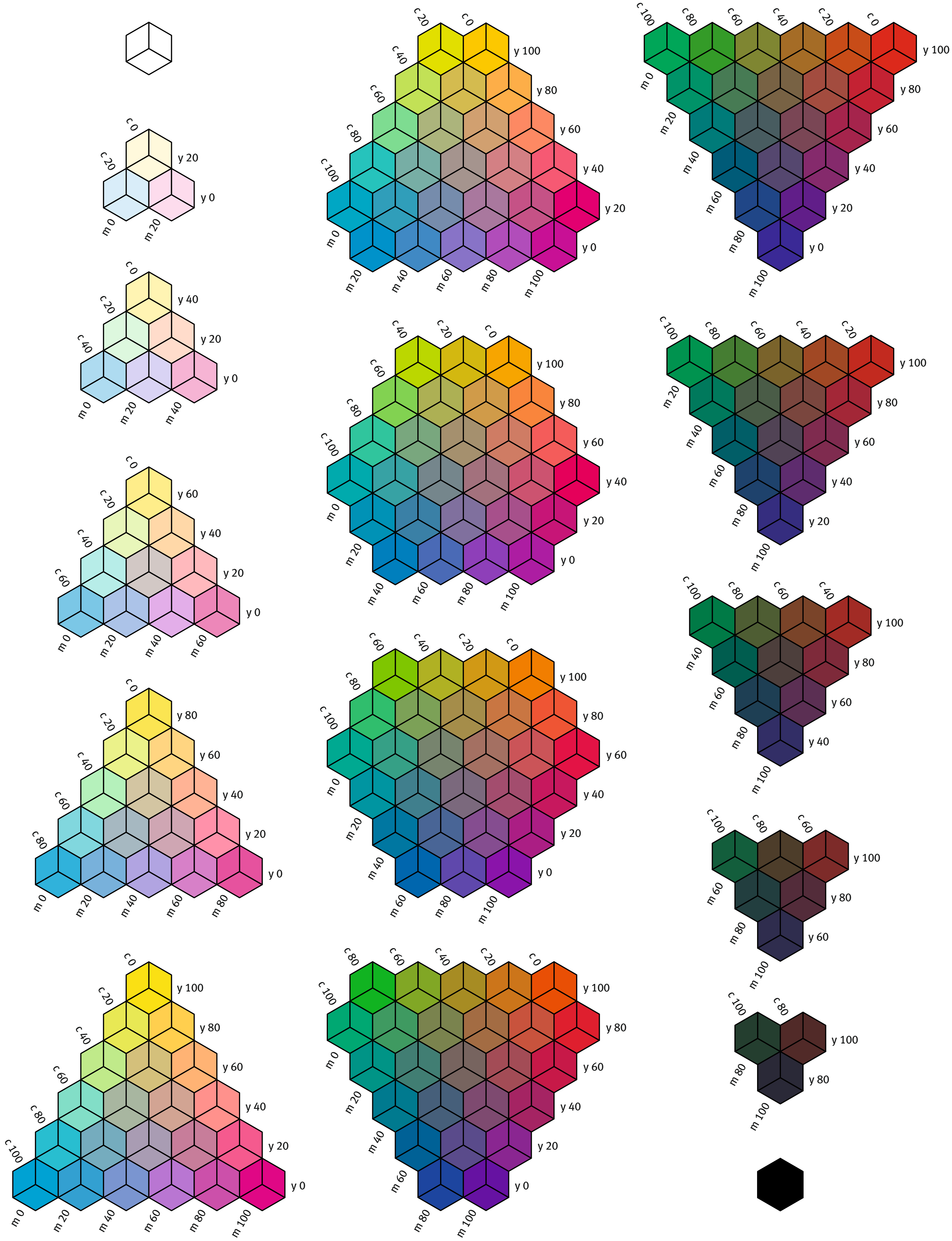




The corner colors cyan, magenta and yellow, likewise red, green and blue each lie on different levels of lightness

Looked at from the side, the cube can be divided into levels of equal lightness. On one level the saturation increases outwardly and can be described by the distance from the gray axis. Looked at from above, the hue changes in a circle around the gray axis.

In the diagram on the right-hand page, for precise definition, the colors are given in their percentual combination. The values at the side refer to the whole row going in the direction of the type. The cyan portion (c) of the colors increases from the left down, the magenta portion (m) from the right down. The values for yellow increase upwards.


c 0
c 20
y 20
y 0
m 0
m 20
c 0
c 20
c 40
y 40
y 20
y 0
m 0
m 20
m 40
c 0
c 20
c 40
c 60
y 60
y 40
y 20
y 0
m 0
m 20
m 40
m 60
c 0
c 20
c 40
c 60
c 80
y 80
y 60
y 40
y 20
y 0
m 0
m 20
m 40
m 60
m 80
c 0
c 20
c 40
c 60
c 80
c 100
y 100
y 80
y 60
y 40
y 20
y 0
m 0
m 20
m 40
m 60
m 80
m 100
c 20
c 0
c 40
c 60
c 80
c 100
y 100
y 80
y 60
y 40
y 20
y 0
m 0
m 20
m 40
m 60
m 80
m 100
c 40
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c 0
c 60
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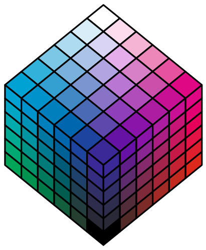
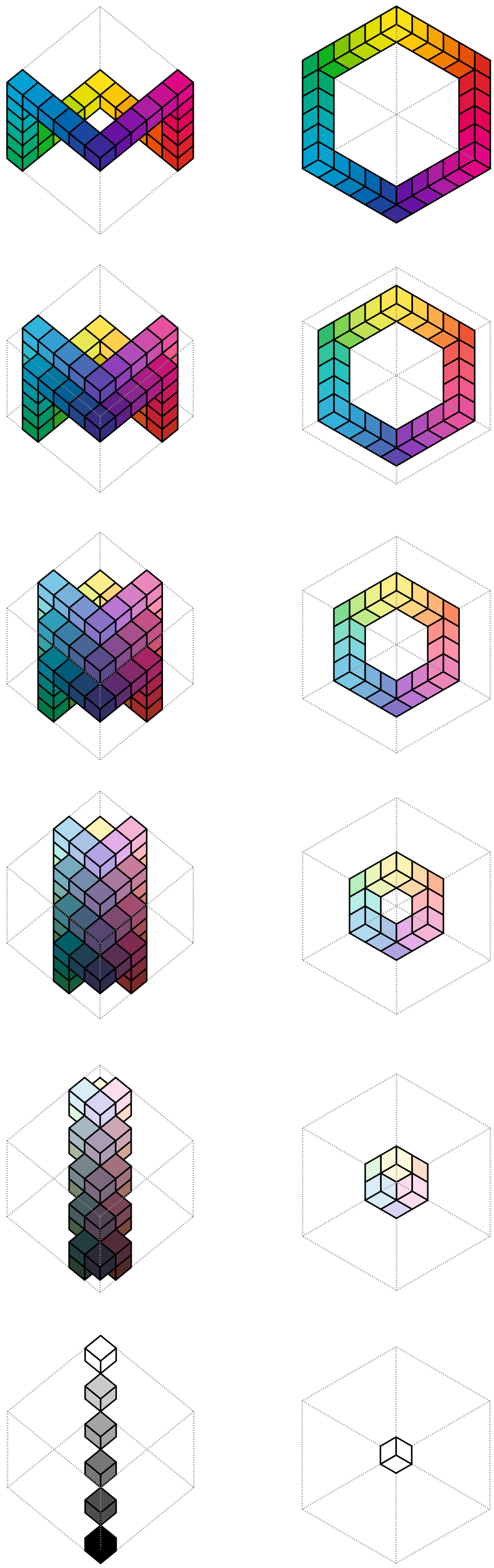
m 60
m 80
m 100
c 100
c 80
y 100
y 80
m 80
m 100

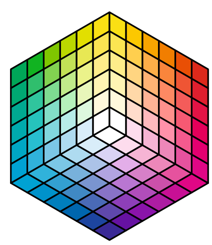
The Areas of Equal Saturation in the Cube

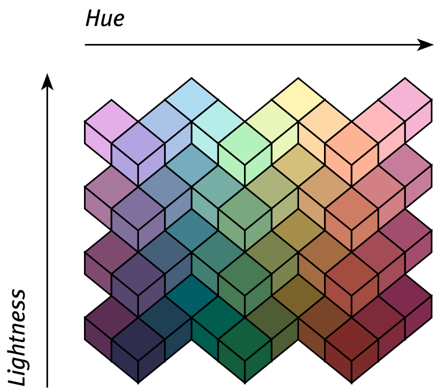


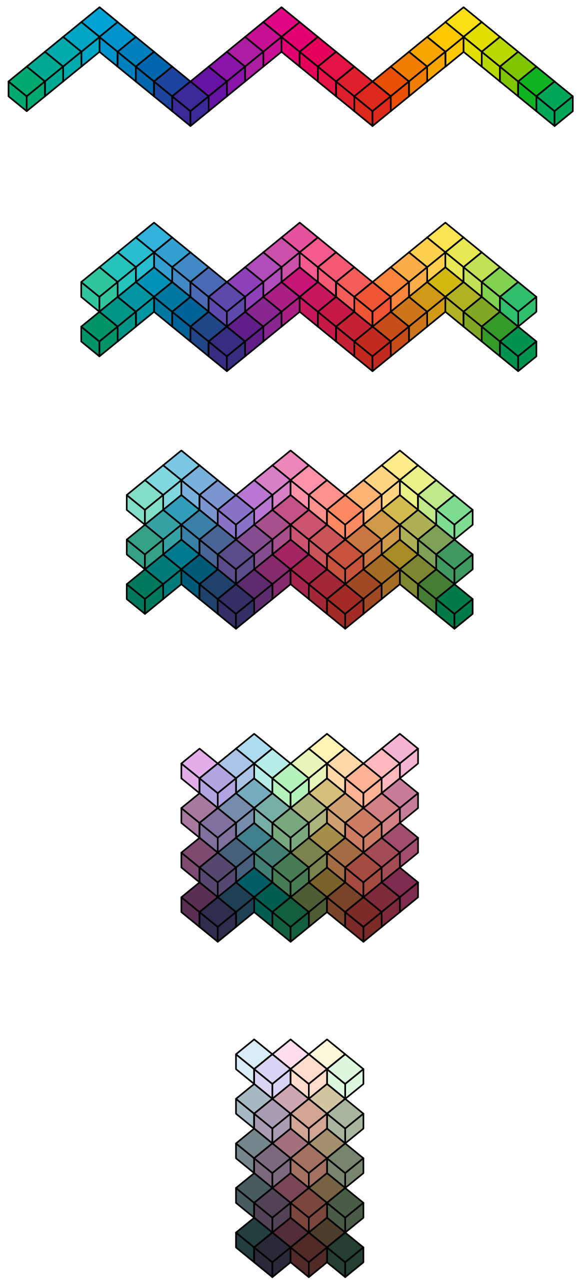
The areas of equal saturation as seen from the side ...



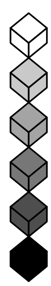
... and from above







The colors of equal saturation distinguish themselves by an equal distance from the gray axis, i.e. they form rings around the gray axis like the annual rings of a tree. On the very outside only one ring is left.



If one unwinds the individual rings to form a plane, this plane shows all the colors of equal saturation in the cube.

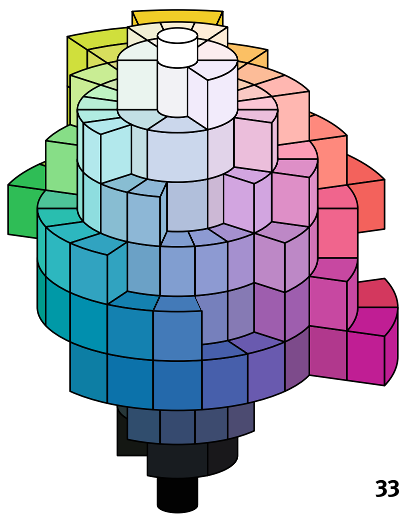
The lightness increases from the bottom up, the hue changes from left to right.


2

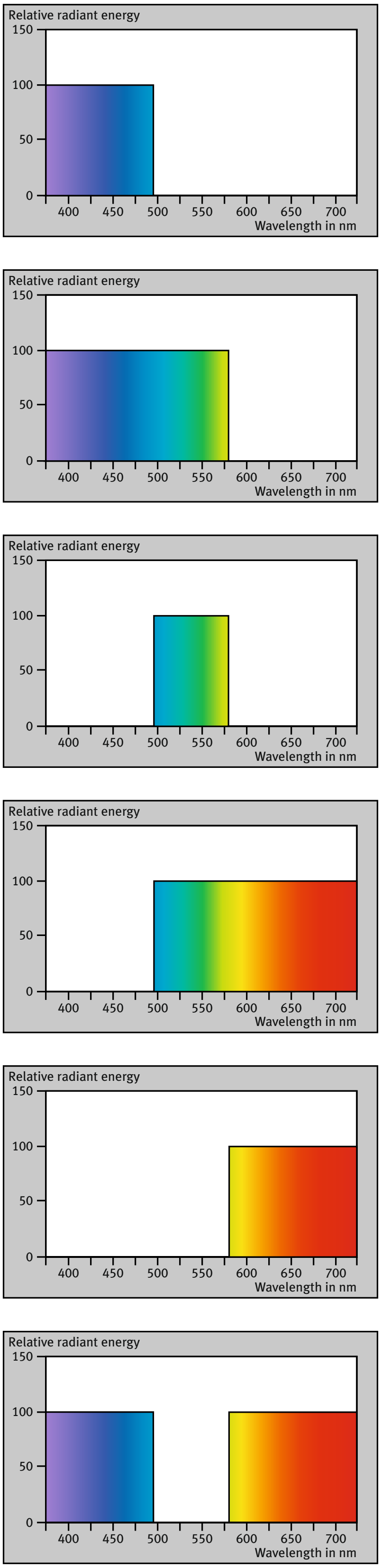
Color Theory with Realistic Colors

Color management would be childs play if there were ideal colors. Unfortunately, in practice it is far from simple. For a deeper understanding of color reproduction in offset printing, on monitors, with printers and other devices, much more theory is necessary.

This chapter teaches the fundamental principles, why red is not always red and what the Lab color space, that acts as the base color space in color management, is all about.



The Limitations of the Cube with Ideal Colors



As practical as the model of ideal colors in a cube may seem at first sight, it unfortunately doesn't work in practice. If we look at realistic primary colors in print and on a monitor, we see astonishing differences.

In the left column the spectra of the ideal primary colors blue, cyan, green, yellow, red and magenta are illustrated. The diagrams on the right-hand page show in the left column the spectra of these primary colors as they are emitted by a monitor and an approximation of the color impression that they give. In comparison, in the right column, the spectra of the primary colors in offset printing are shown. The color examples are reproduced here somewhat darker and less saturated in order to maintain the visual difference between monitor colors and colors in print.

The Importance of the Different Spectra

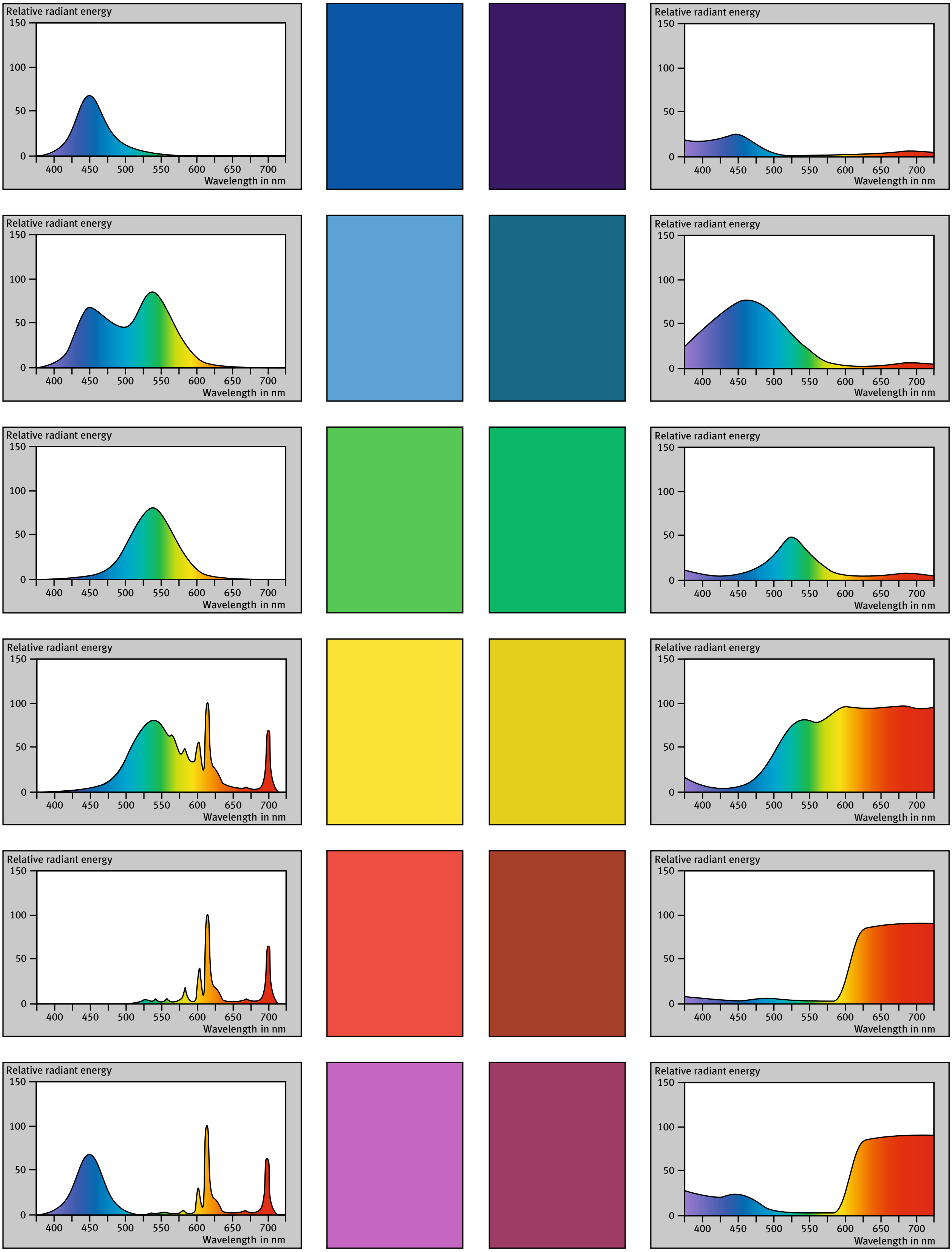
Comparing the spectra of the ideal colors in the cube (left) with the monitor and print spectra (right) gives interesting results:

The primary colors in print have spectra that are less saturated and often darker, compared to the ideal spectra. Either the receptors are not stimulated to the full (darker colors) or the receptors that don't actually belong to these colors are also lightly stimulated (unsaturated colors). The spectra of the monitor's primary colors on the other hand show very narrow and high deflections that are always targeted at a particular receptor cell.

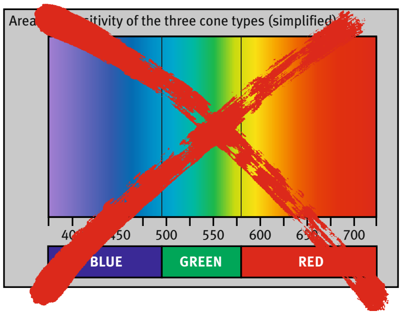
The difference between a monitor's primary colors and those in print is surprisingly big. Human vision is obviously able to perceive very narrow spectra much more saturated than broader spectra. The expanded model of vision on the next double spread shows how this happens.

The left column shows the spectra of the ideal primary colors (in the order of blue, cyan, green, yellow, red and magenta) as a comparison to the spectra of realistic colors on the right-hand page.

In the left column, on the right-hand page, the spectra of a computer monitor's primary colors are illustrated. Due to the limited color space in print, the color samples are not true to the original. The column on the far right shows the spectra of the primary colors in print. For a comparison to the monitor colors, the print colors have been reproduced less saturated.


Relative radiant energy
150
100
50
0
400
450
500
550
600
650
700
Wavelength in nm

The Expanded Model of Vision



Sorry. It's not that simple!

In comparison to the ideal cones on the preceding pages, the processes in the eye are somewhat more complicated. The areas of sensitivity in the cones are not defined exactly but overlap each other. Each cone has a maximum sensitivity that drops towards the sides. So only narrow spectra can stimulate a single type of cone. This is why the monitor's primary colors are perceived more saturated than those in print.

A further phenomenon is the different sensitivity to brightness for individual spectral areas. The eye perceives the green area of the spectrum lighter than the neighboring areas red and blue.

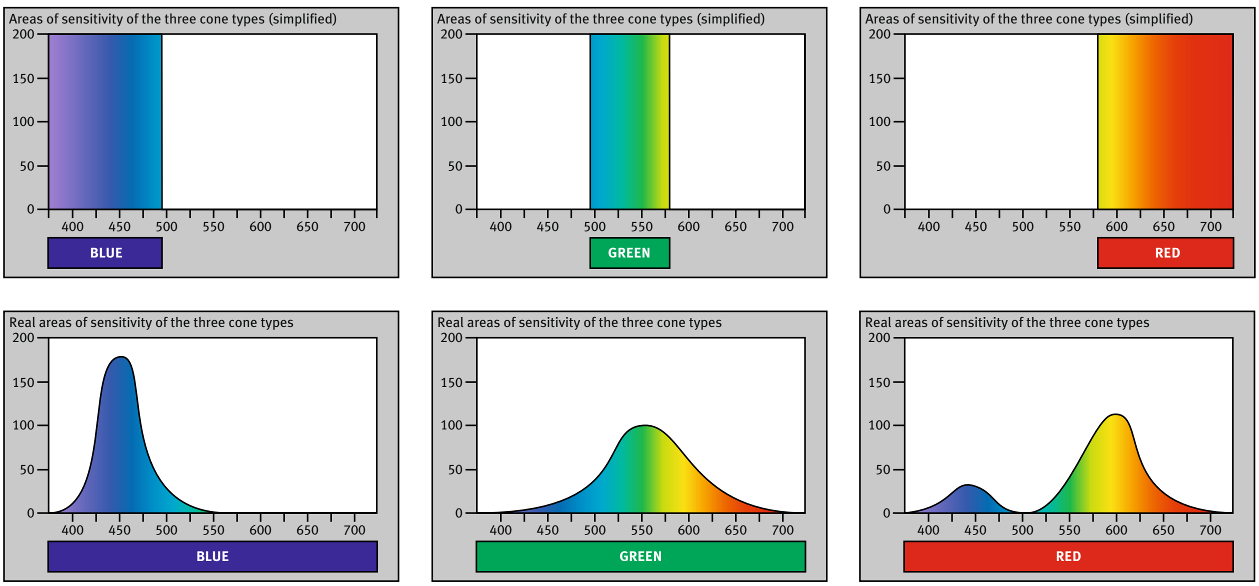
The other rules from the first chapter are, however, still valid:

1. With surface colors the color perceived in the eye is dependent on the light source's spectrum.
2. Different spectra can give the observer the same impression of color.

Colorimetrics, as the science of color, studies the connection between the spectrum of a color stimulus and the color perceived by the human. Since the first mathematical models were not so clear, there are now more suitable ones that are finding more and more applications in computer-based design.

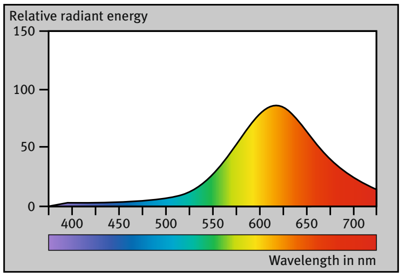
The predominant model at present is the LCH color space.

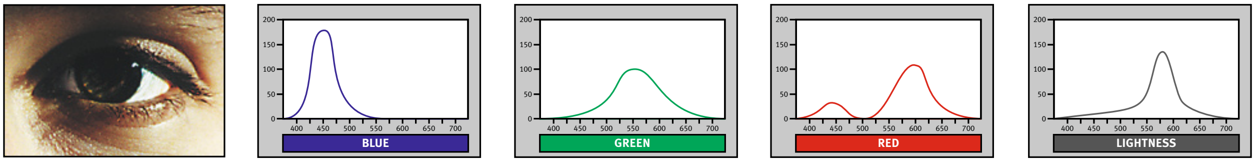
This comparison shows how greatly the areas of sensitivity in the simplified cone model differ from the eye's actual perception.



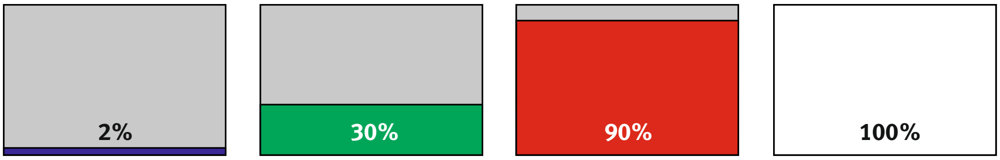
Process of color perception

Spectrum of the incoming color stimulus

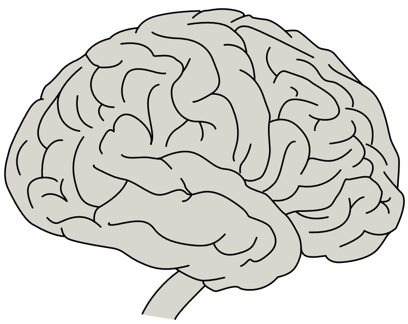




Areas of sensitivity in the eye's cones and their stimulation (right: the rods' sensitivity to brightness)

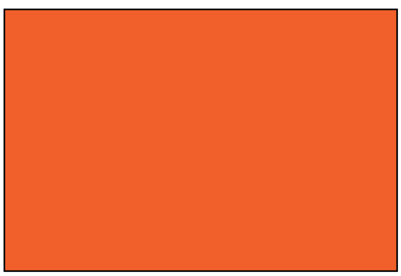


The receptor cells turn the spectrum's light energy into electrical impulses. In the receptor's areas of highest sensitivity, the spectral light energy causes a stronger impulse than in the neighboring areas.
The rods, which are responsible for sensing light in half-light, show a deflection of 100% in daylight.



The processing of color information in the brain

Impression of color first occurs in the brain. Here, the impulses of the rods and cones are "calculated" together. Meanwhile, there are measuring devices and formulae that reflect very well the chain of events from color stimulus as a spectrum to impression of color. The mathematics used for these though is so complicated that they would go far beyond the scope of this book. Unlike the simplified model this mathematics no longer works with primary colors, out of which other colors can be mixed, but with the concepts of hue, lightness and saturation.



The impression of color as perceived by the observer

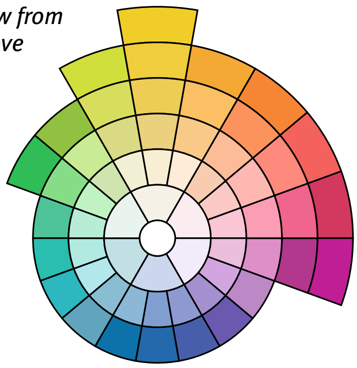
The LCH Color Space

The LCH color space is a complete model of human color vision. The perceived color is ordered here after the attributes **L**ightness, **C**hroma (saturation) and **H**ue.

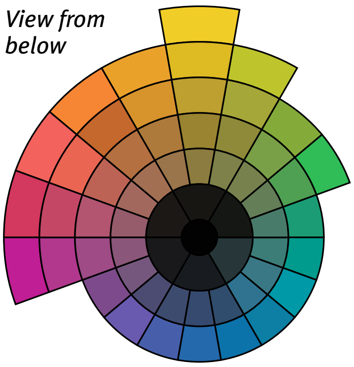
Just as a human can perceive different spectra with the same impression of color, so different spectra can produce the same LCH values. Consequently, the LCH color space actually describes our perception of color, irrespective of whether the perceived color comes from a leaf, paint, rasterized print colors or rays of light from a monitor.

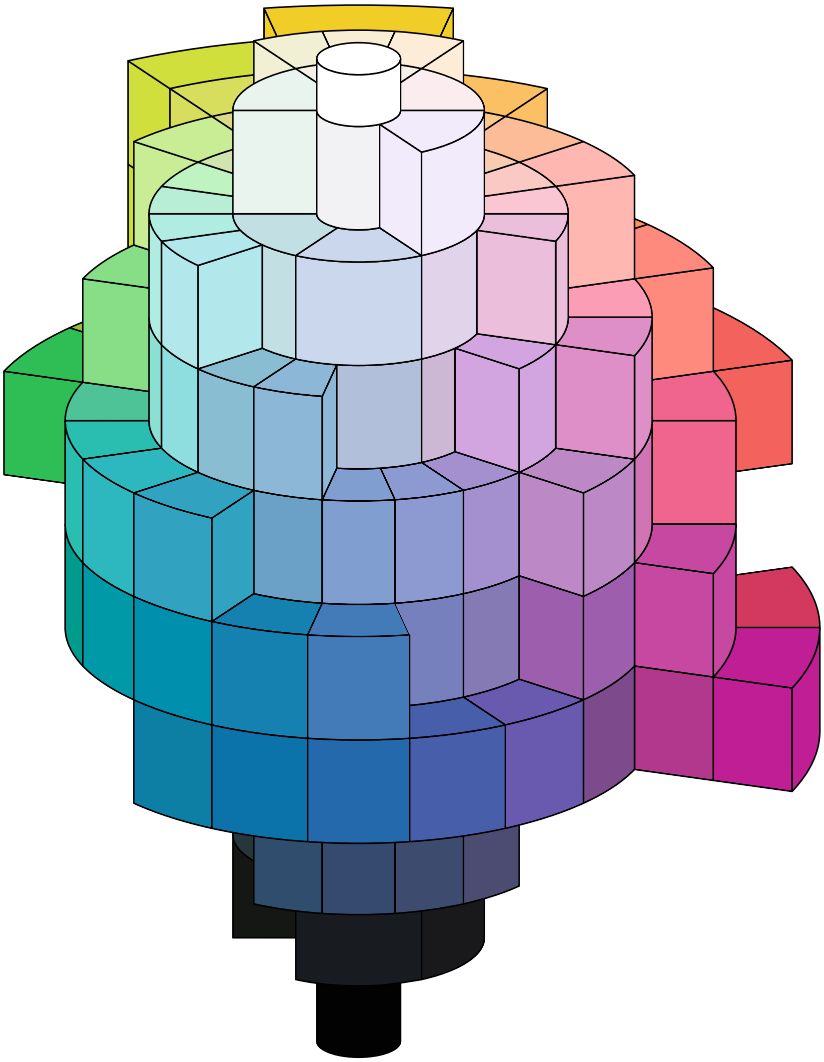
Because expensive and complicated measuring devices are required for determining LCH color values, this color space has up until now been mainly applied in research and industrial quality control. But because it serves as a basis for the color description of different input and output devices such as monitors, printers and scanners, it is now finding a place in the graphics industry.

View from above

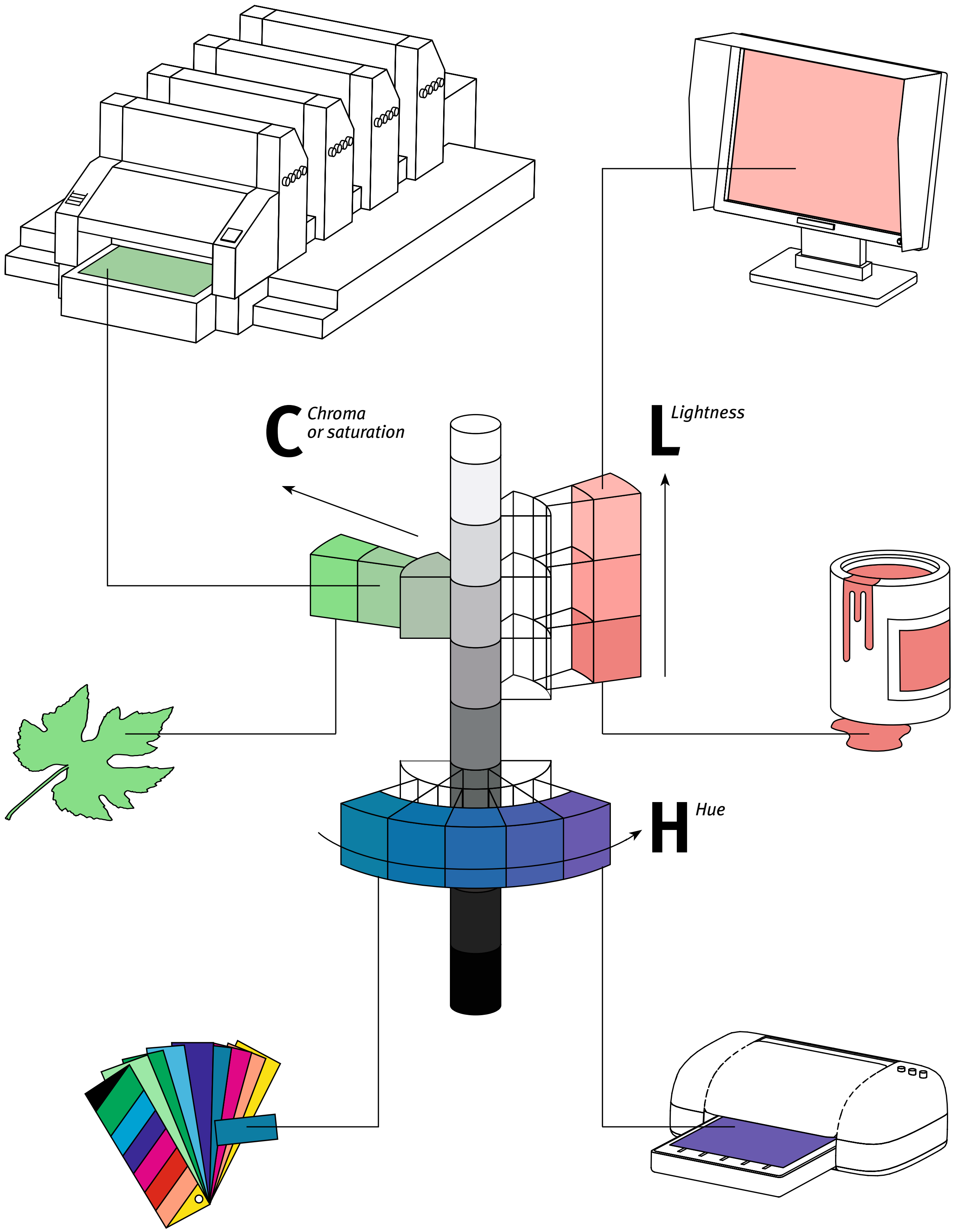


View from below





A color model of the LCH color space: Only colors that are reproducible in four-color offset printing without great deviation can be seen. All other areas remain "invisible" in this illustration. Decades of research work in color perception have been put into the LCH color space. In many experiments, subjects were shown color samples that they should order as equidistant as possible after the criteria of lightness, hue and saturation.

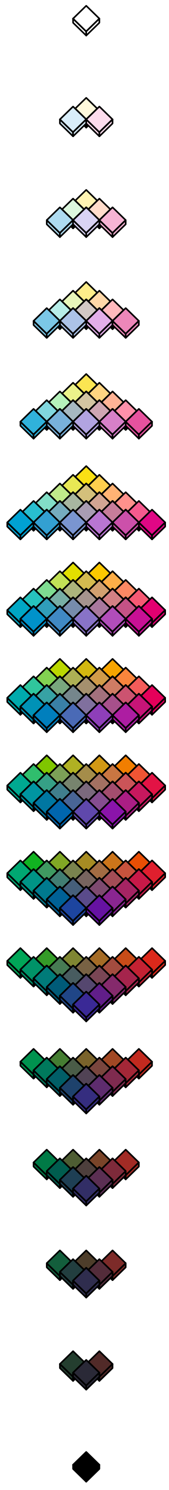

C Chroma or saturation
L Lightness
H Hue

Similarities between the LCH Color Space and the Cube

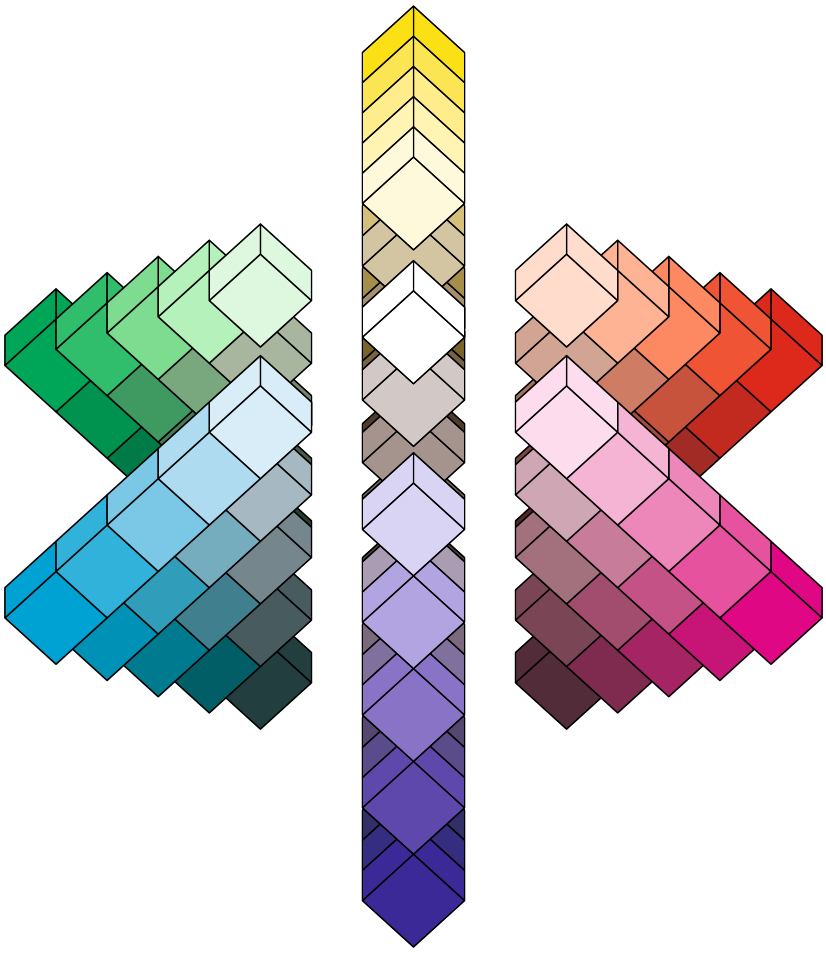
As the illustrations show clearly, the LCH color space, in its structure, has some things in common with the cube:

1. The gray axis runs vertically from black to white.
2. The saturation increases outwardly.
3. The different hues form themselves around the gray axis.
4. Levels of equal lightness run parallel to the gray axis.

The LCH colors shown in this book are limited to colors obtainable in four-color offset printing without too much color deviation.



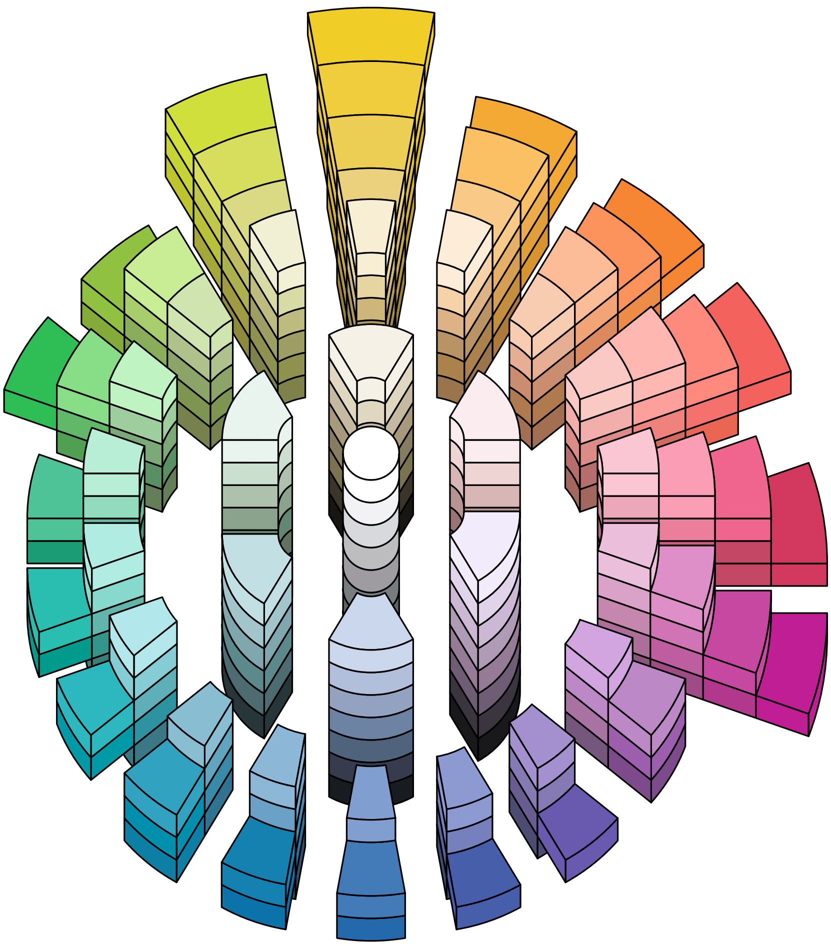
The levels of equal lightness in the cube model



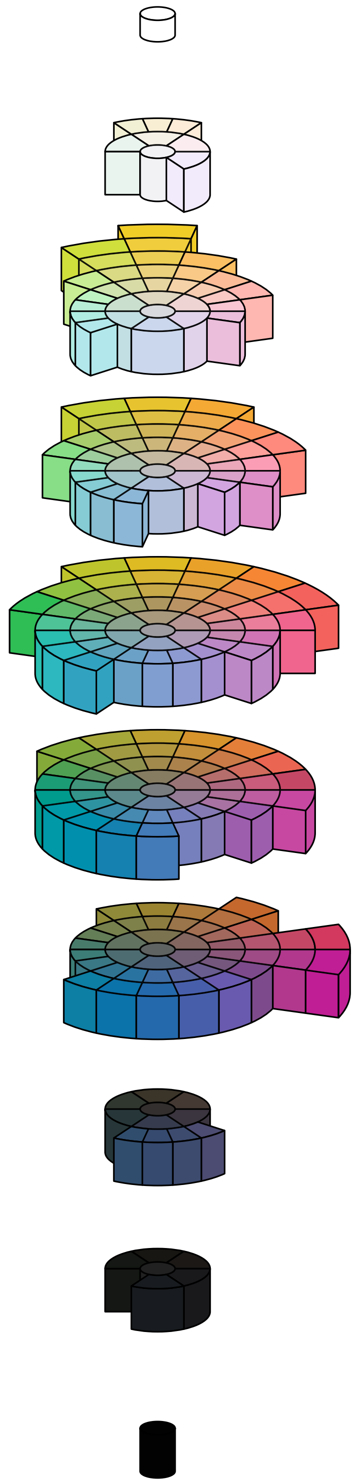
The cube model broken down into its hues.
For a clear depiction, the diagram is limited to the six primary colors yellow, red magenta, blue, cyan and green. The gray axis can be seen in the center.

The division used here of the LCH color space into 18 hues, 10 degrees of lightness and a maximum 7 degrees of saturation, allow for a clear visualization of individual color values on later pages. This division can be refined for other applications as needed.

This, for example, is how the RAL Design System, likewise based on the LCH color space, works with 39 hues. This color system, spread widely through the world of paint and other color agents, has played only an minor role in prepress.



The colors of the LCH color space, obtainable in four-color offset printing. Each hue is defined by the angle of its position around the gray axis. For the LCH model in this book, divisions of 20° per color have been used. For the unsaturated colors near to the gray axis, the colors have been divided in steps of 60°.



The levels of equal lightness in the LCH color space

Differences between the LCH Color Space and the Cube

Alongside the similarities by the criteria hue, lightness and saturation, there are also fundamental differences between the cube model and the LCH color space.

The Cube Describes the Color Model
The cube always requires as a reference point primary colors, from which all other colors can be derived when mixed. Thus, the cube's practical application is describing the ratios of a set group of colors. A color value scale is one example.

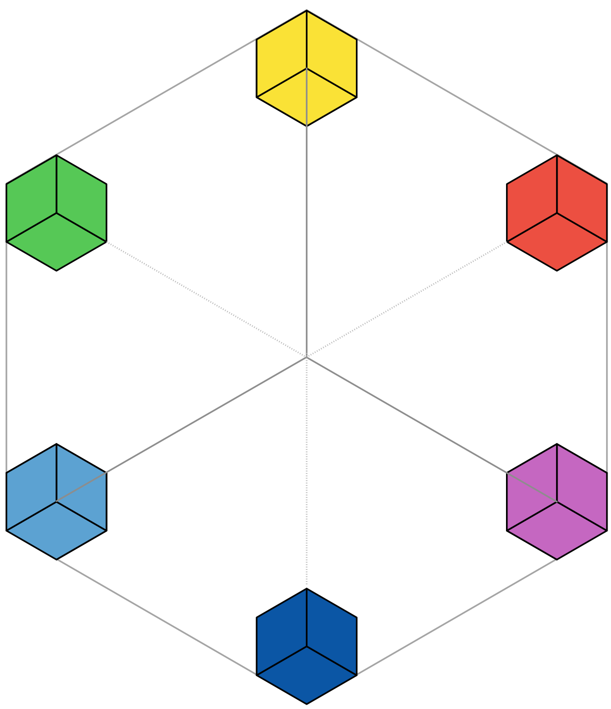
The primary colors sit at the corner points in the cube, regardless of whether they are monitor or print colors, which in actual fact differ greatly from each other.

The monitor's primary colors can, of course, only be reproduced in print with a reduced saturation. In order to keep the difference between monitor and offset printing colors, the primary colors in printing are likewise shown with a reduced saturation.

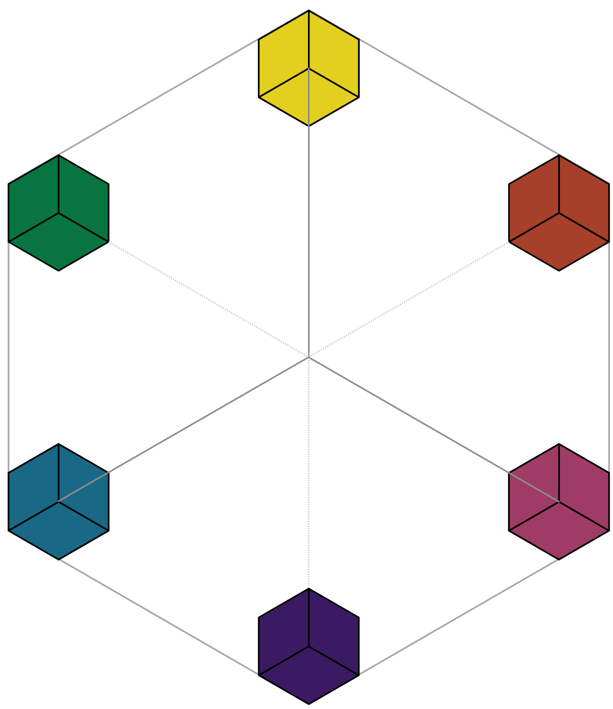
However, the cube is unsuitable when mixtures of two groups of primary colors of different origins need to be compared. The blue on a monitor has the same position in the cube as the blue in print. However, in direct comparison, the two blue tones vary very much from each other.

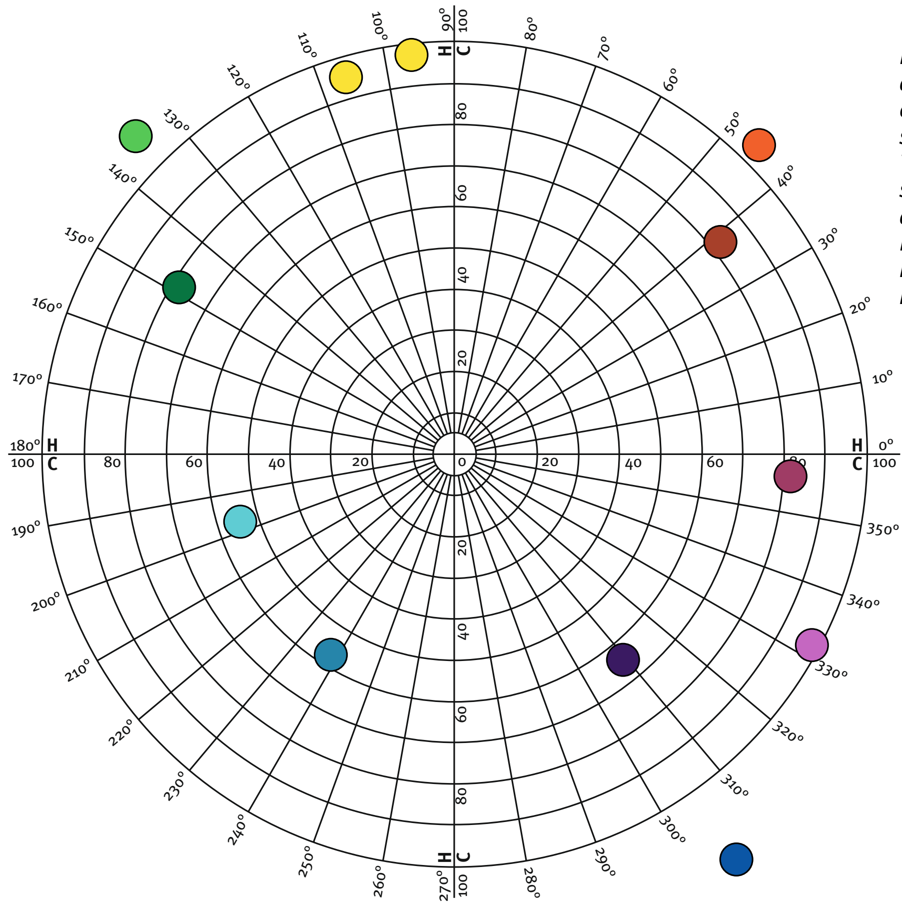
The LCH Color Space Describes the Color Order
Because the LCH color space describes the conversion of color spectra by the attributes hue, lightness and saturation, it functions without primary colors. With it, the differences between primary colors of varying origins and between any mixed colors can be determined exactly.

Monitor display of the primary colors



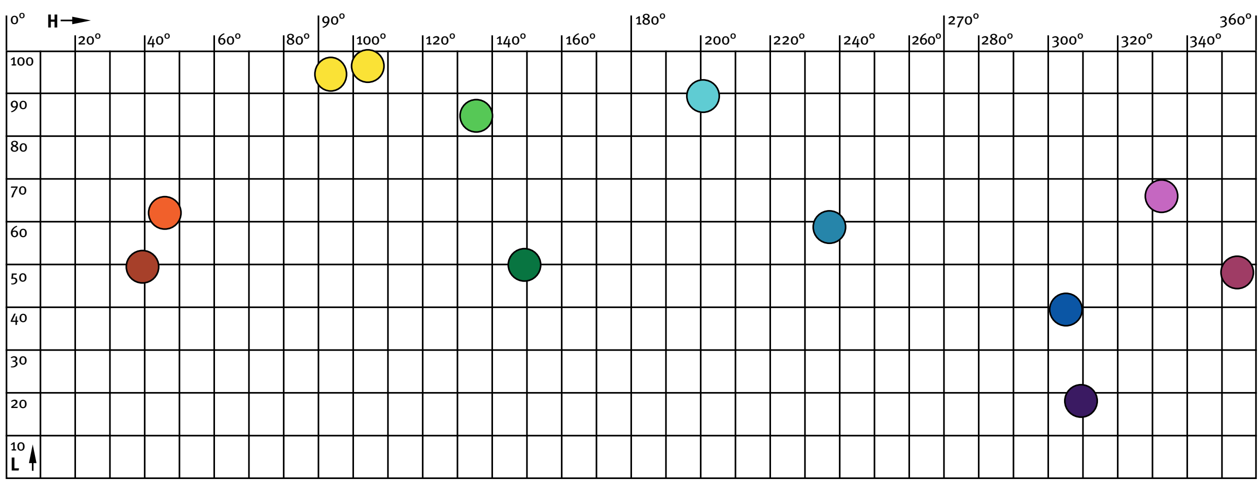
Reproduction of the primary colors in offset printing





In the LCH color space, the monitor and print primary colors sit in different positions according to their saturation (C) and hue (H).
The monitor's primary colors are more saturated than those in offset printing and so sit further outwards.
Because the LCH color space is shown here from the top, the order of colors in lightness is not clear.

Here, the LCH color angles (H) are taken down to one level. The side view now makes clear the differences in lightness between the monitor and print colors (L). The monitor's primary colors sit higher up in this illustration because they are brighter than the primary colors in offset printing.



From LCH to the Lab Color Space

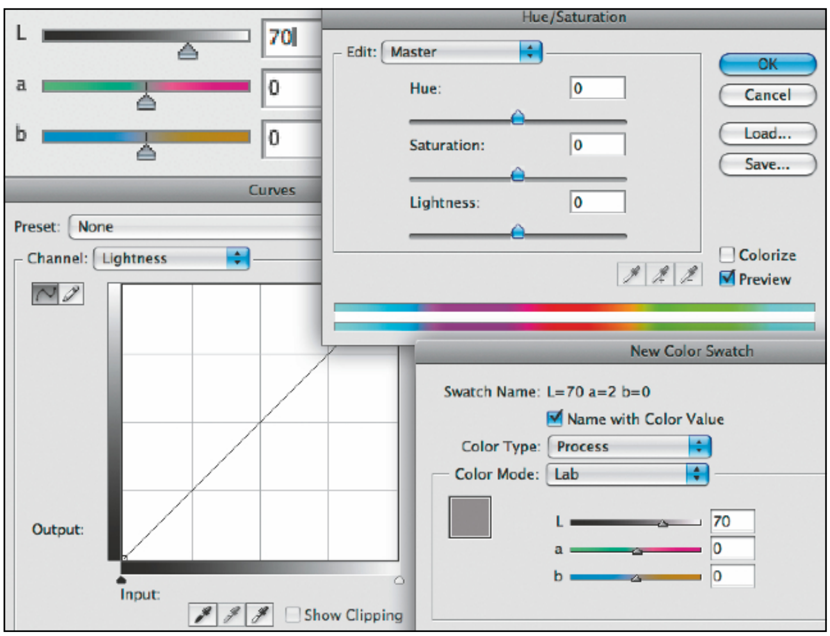
The Lab color space is a variation of the LCH color space. All colors have the same position as in the LCH color space. Instead of defining the hue by degrees and the saturation by the distance from the gray axis, the Lab color space spreads a right-angled system of co-ordinates across hue and saturation. The resulting order is considerably more impractical for comparing color shades, but is much easier for noting measured values. Hence, in color-measurement technology, the depiction of a color in space with Lab co-ordinates is more common than with LCH co-ordinates.

Also in the world of digital data formats, describing a color with Lab co-ordinates has asserted itself. For pixel images there are, for example, TIFF-Lab and EPS-Lab formats. Images in these formats are saved as device-independent. In this way they can be optimized for different output processes.

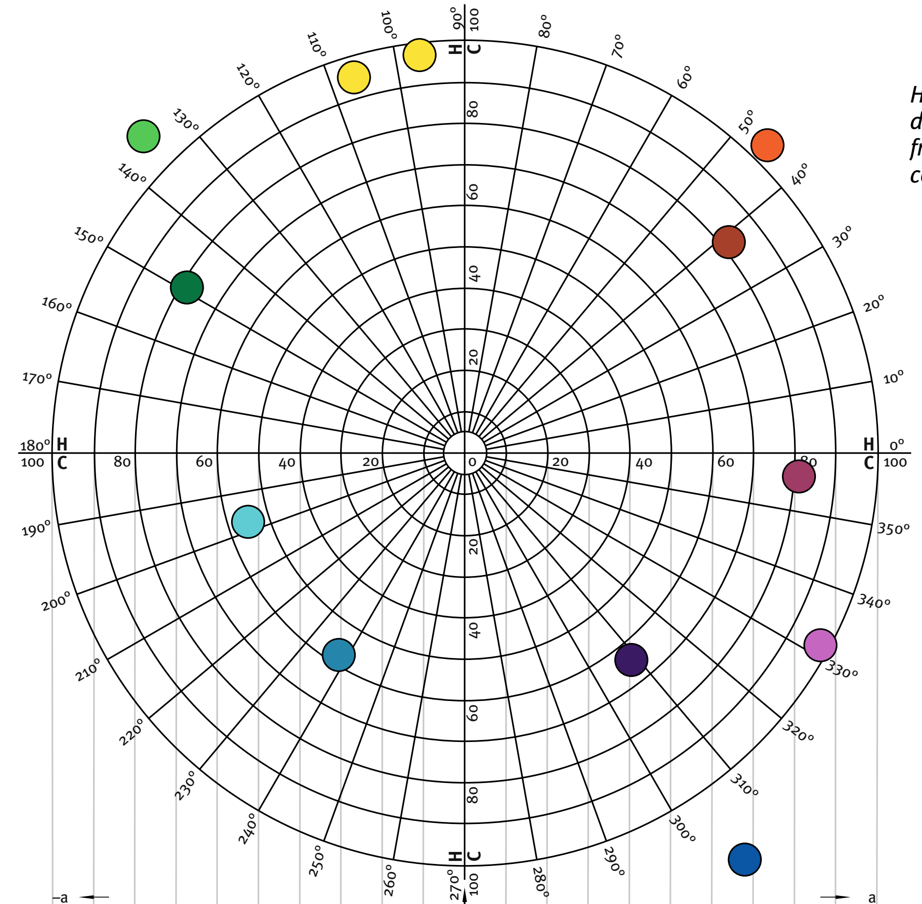
As long as the point is to save images in a data format independent of the output device, it doesn't matter whether Lab or LCH values are worked with internally. If the aim, though, is a composition or color correction with the criteria hue, lightness and saturation, then the LCH color space is the first choice.

Different Spellings from the Scientists and Practitioners

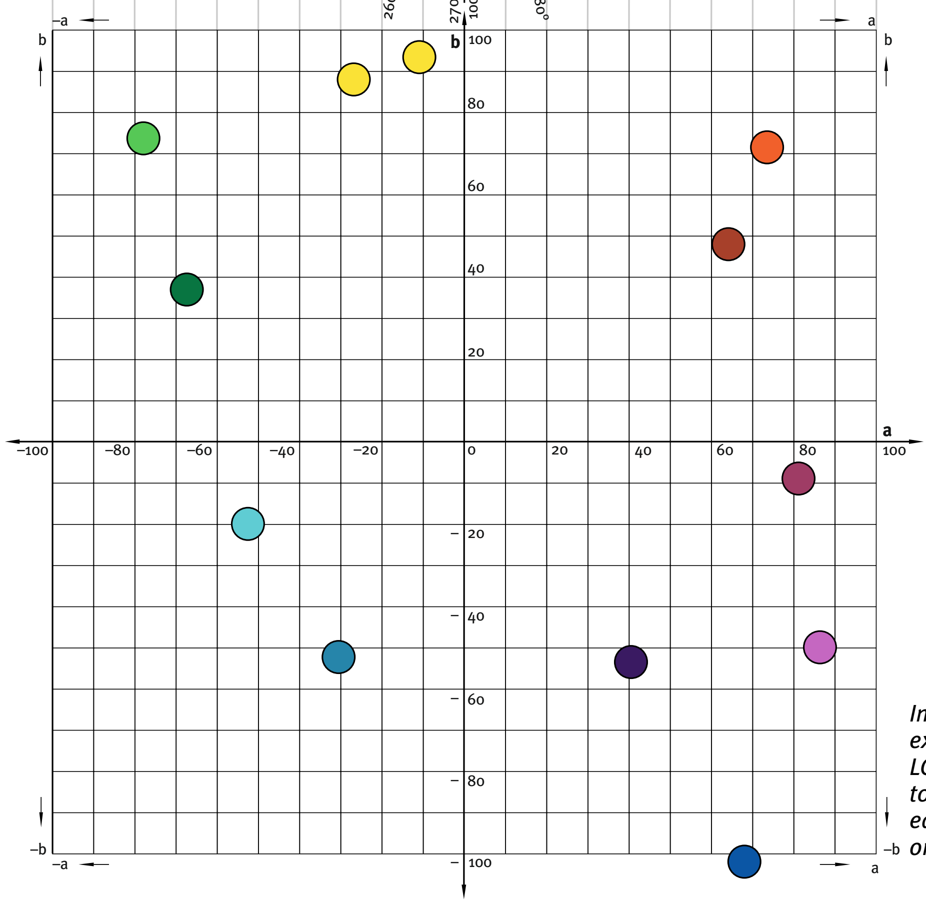
In colorimetrics, as the science of color measurement, there are different variations of the Lab color space. For those working in the graphics industry this plays a secondary role as the variation CIE L*a*b 1976 is worked with throughout. Consequently, the abbreviation Lab, which is also used in this book, has asserted itself in program menus and handbooks.



More and more programs support the LCH and Lab color spaces as device-independent references

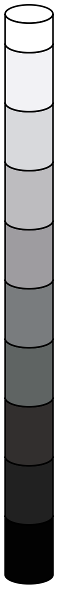


Hue and saturation of a color are defined by angle to and distance from the center (gray axis) in the LCH color space.

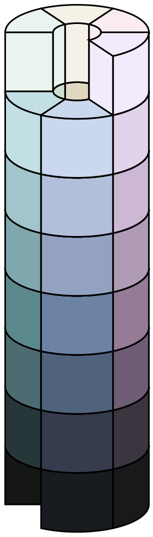


In the Lab color space each color has exactly the same position as in the LCH color space. Instead of the angle to and distance from the center, each color is described by the co-ordinates a and b.

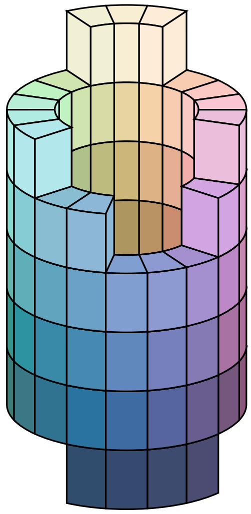
Color Saturation in the LCH/Lab Color Spaces



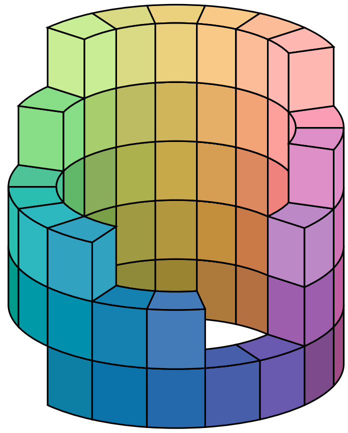
C=0



C=15



C=30



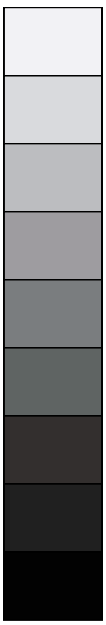
C=45

In the LCH/Lab color spaces, colors of identical saturation form rings around the gray axis, similar to the cube. In the illustration below, these rings have been unwound. The resulting planes show all the colors of a saturation level that can be reproduced in four-color offset printing. For a more exact description of the colors, they have been given their LCH/Lab co-ordinates.

C=0

H	–
a	0
b	0

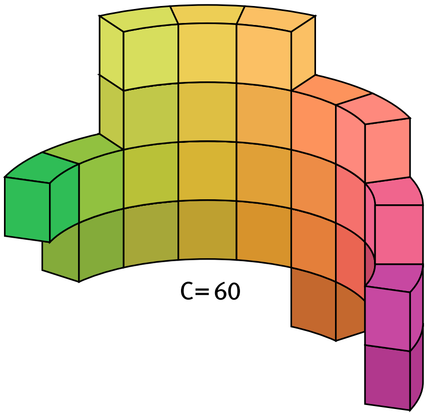
L
95
85
75
65
55
45
35
25
15



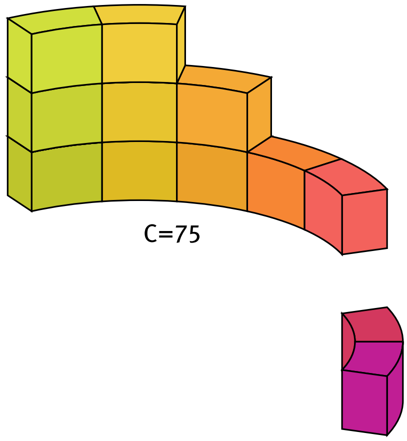
C=15

H	270°	210°	150°	90°	30°	330°
a	0	–13	–13	0	13	13
b	–15	–7	7	15	7	–7

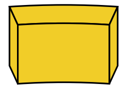
L
95
85
75
65
55
45
35
25
15



C=60



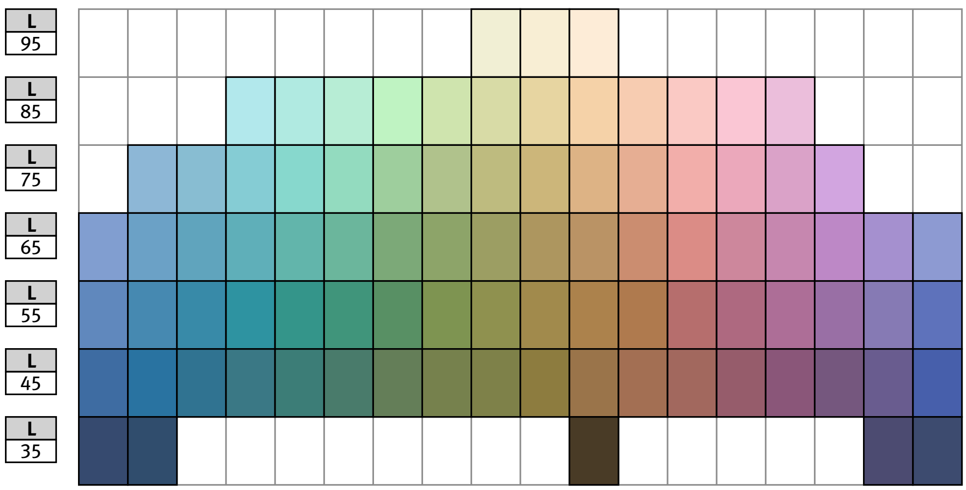
C=75

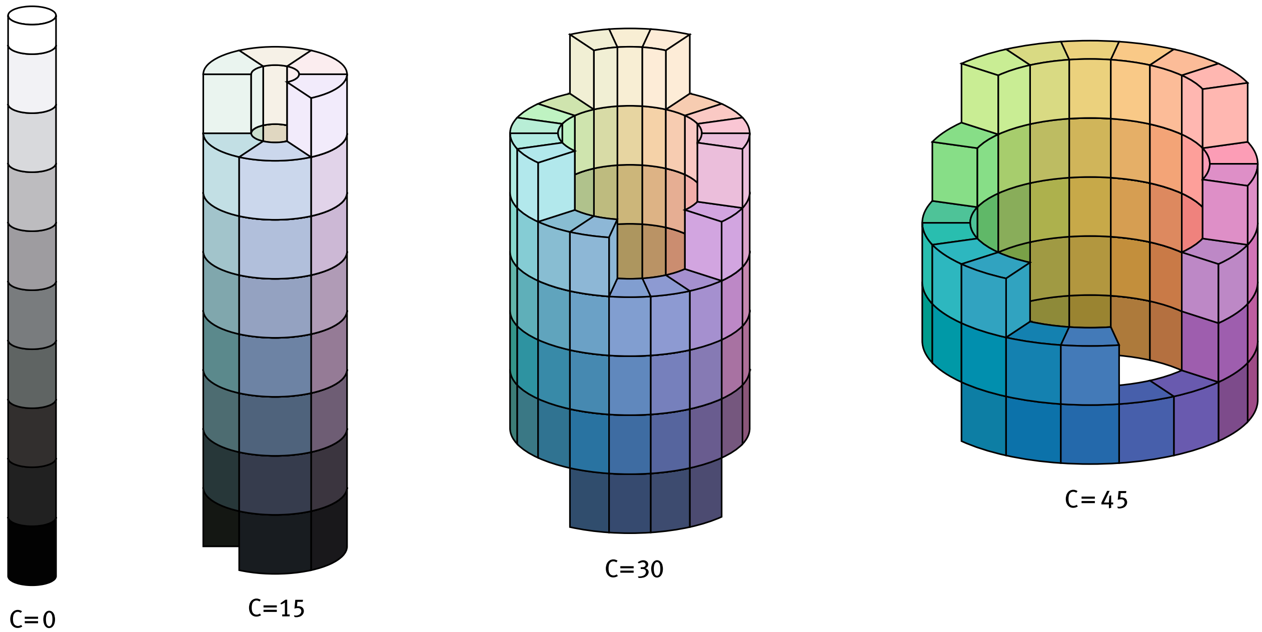


C=90

C=30

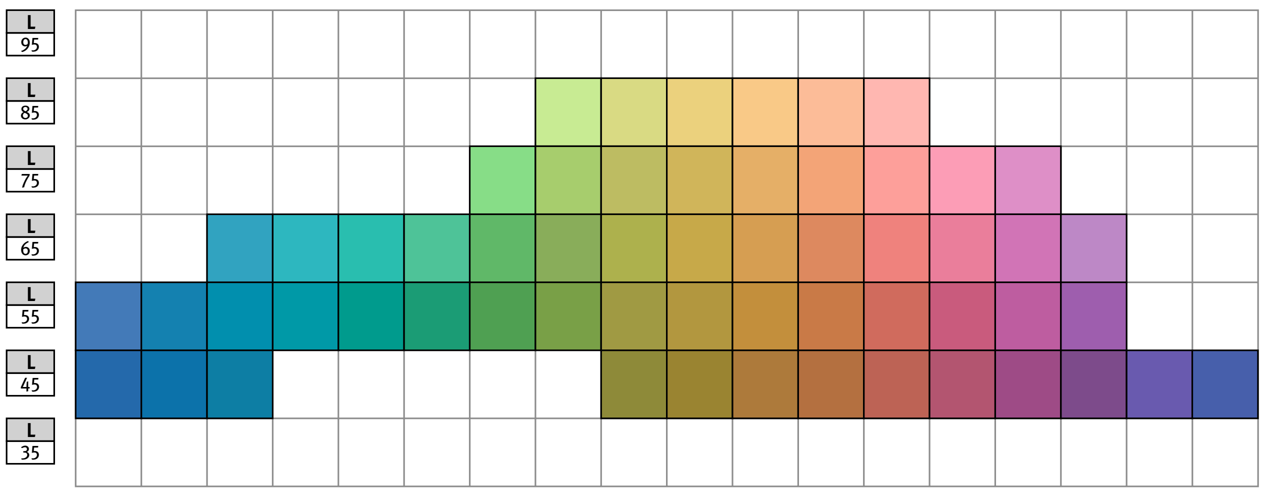
H	270°	250°	230°	210°	190°	170°	150°	130°	110°	90°	70°	50°	30°	10°	350°	330°	310°	290°
a	0	−10	−19	−26	−30	−30	−26	−19	−10	0	10	19	26	30	30	26	19	10
b	−30	−28	−23	−15	−5	5	15	23	28	30	28	23	15	5	−5	−15	−23	−28

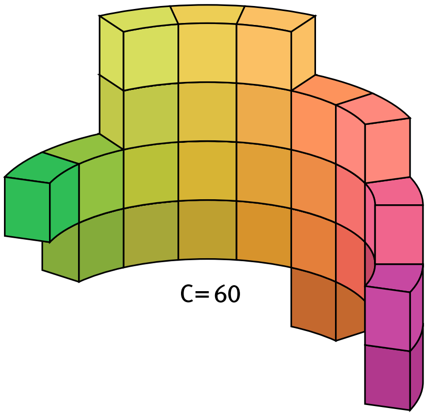




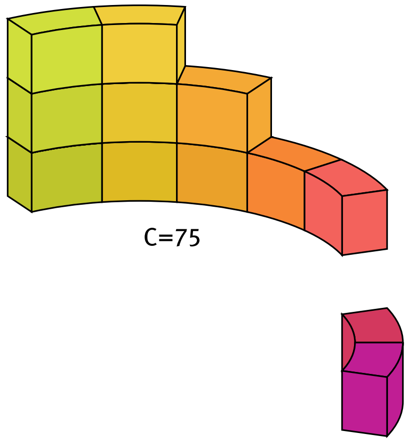
C= 45

H	270°	250°	230°	210°	190°	170°	150°	130°	110°	90°	70°	50°	30°	10°	350°	330°	310°	290°
a	0	−15	−29	−39	−44	−44	−39	−29	−15	0	15	29	39	44	44	39	29	15
b	−45	−42	−34	−22	−8	−8	22	34	42	45	42	34	22	8	−8	−22	−34	−42

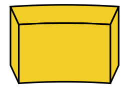




C=60



C=75



C=90

C=60

H	150°	130°	110°	90°	70°	50°	30°	10°	350°
a	−52	−39	−21	0	21	39	52	59	59
b	30	46	56	60	56	46	30	10	−10
L 95									
L 85									
L 75									
L 65									
L 55									
L 45									

C=75

H	110°	90°	70°	50°	30°	10°	350°
a	−26	0	26	48	65	74	74
b	70	75	70	57	37	13	−13
L 95							
L 85							
L 75							
L 65							
L 55							
L 45							

C=90

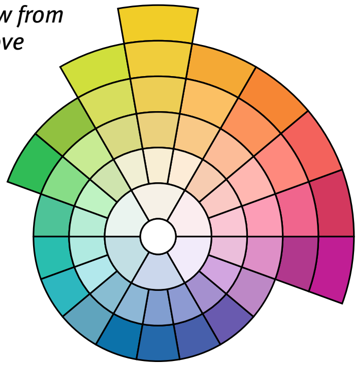
H	90°
a	0
b	90
L 95	
L 85	

Lightness in the LCH/Lab Color Spaces

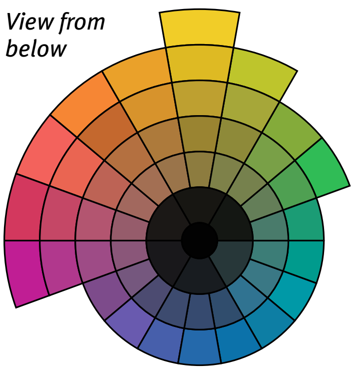
The illustrations on the right show the levels of equal lightness in the LCH/Lab color spaces. The color divisions are the same as those for saturation on the preceding pages. The rings, displayed in each level of lightness, show colors of the same saturation in steps of C = 15.

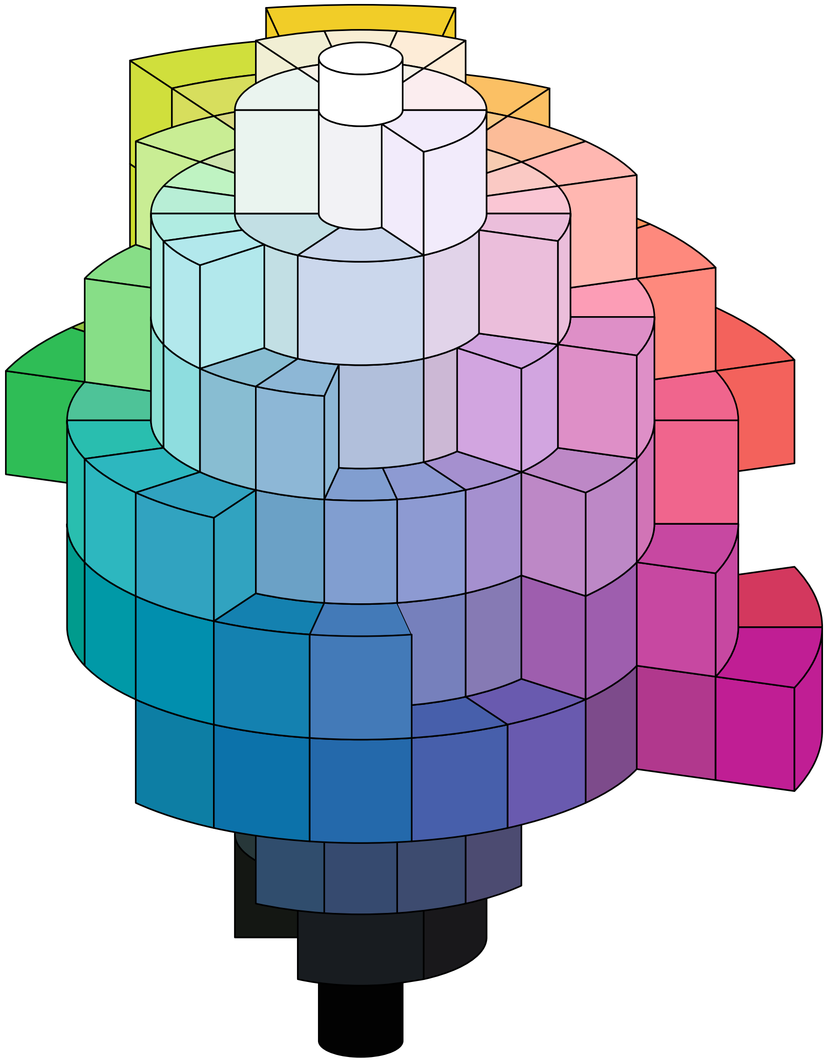
It will become clear that the yellow tones can be reproduced in four-color offset printing with greater saturation than the blue area. While yellow in the lightness level L 85 reaches a saturation of C 90, blue in the lightness level L 45 shows a maximum saturation of C 45.

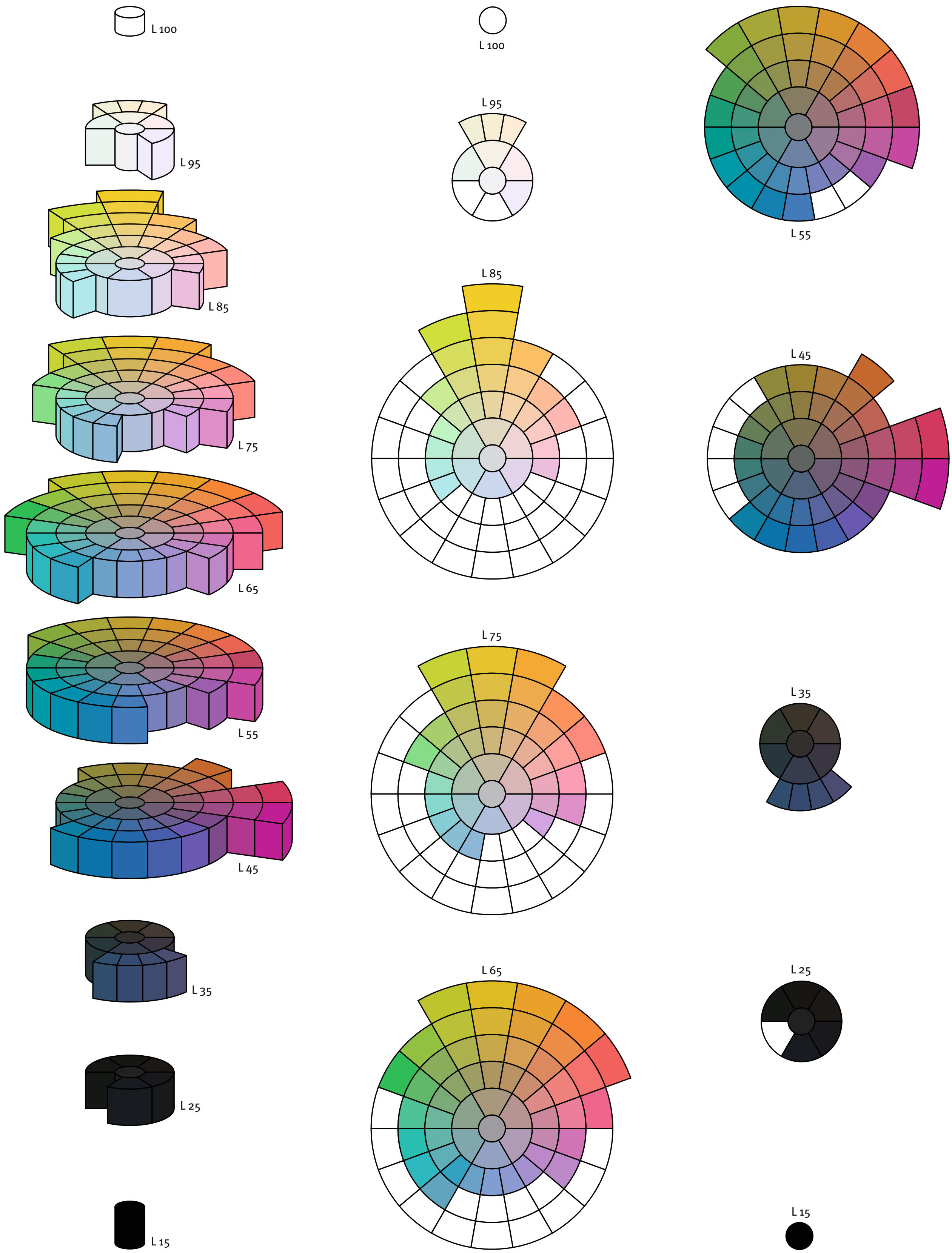
View from above



View from below






L 100
L 95
L 85
L 75
L 65
L 55
L 45
L 35
L 25
L 15
L 100
L 95
L 85
L 75
L 65
L 55
L 45
L 35
L 25
L 15

Measuring Lab Colors: the Spectrophotometer

Spectrophotometers are the most important color-measuring devices in color management. They provide Lab or LCH color measurements that can be used for a large number of tasks. In the years between the first and current, third edition of this book there has been a dramatic fall in price for these devices, due to the use of new technology and production in far greater numbers. While spectrophotometers were in the past expensive and awkward to use for specialists, today they have become an everyday tool for a wide range of users. Their most important areas of use in color management are the calibration of proof systems, checking individual proofs, monitor profiling and color control of print processes.

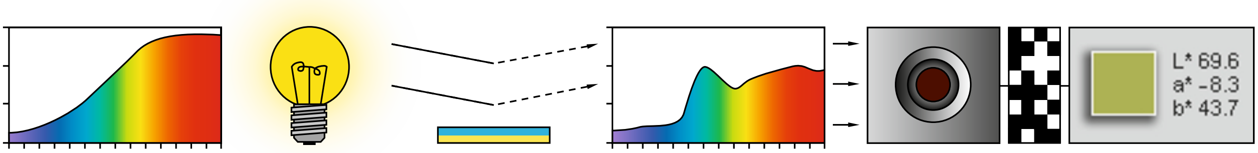
Functionality of Spectrophotometers

The functionality of spectrophotometers follows a standardized principle: a sample is illuminated by an internal light source. The spectrum reflected from the sample is detected by a sensor that records the radiant intensities for different wavelengths and translates them into digital measurements. From these measurements software then determines Lab or LCH color values.

On page 23 we showed how the color stimulus in the eye is dependent upon the spectrum of the lighting as well as the object being viewed.

The same goes for the spectrophotometer: depending on the spectrum of the device's internal lighting, different spectra are reflected back to the devices' sensors from the same sample. In order to make the measurement results from different spectrophotometers comparable, there are so-called standard illuminants. These describe the spectrums of ideal light sources. The standard illuminant specified in color management is "D50". This can be set in the device's utility software so that the color calculator can convert the values accordingly.

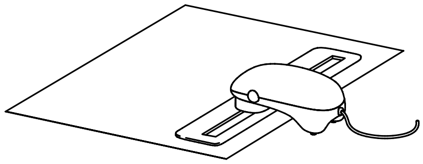
Principle of the spectrophotometer

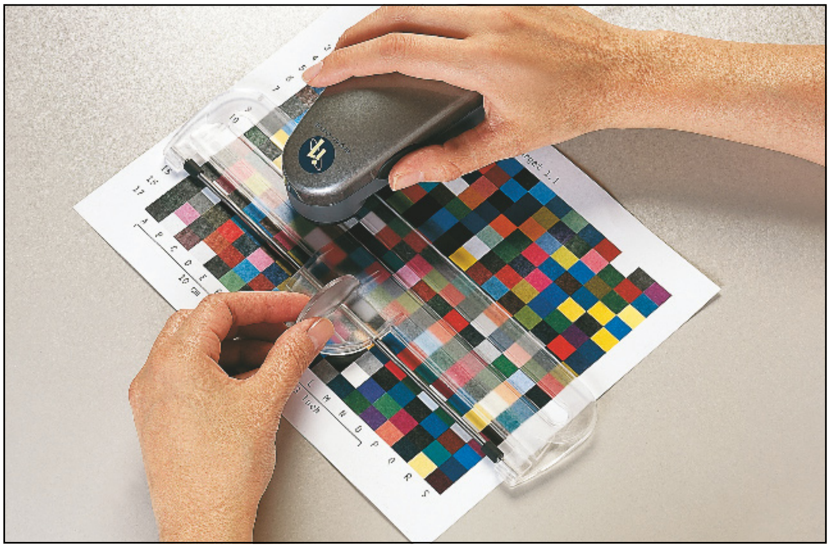


Spectrum of the internal light source *Spectrum after reflection* *Sensor* *Color calculator*

Handheld Measuring Devices with Alignment Guides

Spectrophotometers are available in different shapes and sizes. A handheld measuring device with an alignment guide allows for a comparatively inexpensive construction and the possibility not only for individual measurements but also to quickly scan larger test sheets and control strips. The widest distributed device can measure prints as well as monitors. Devices of this type are those used most often in color management. For this reason a simplified illustration of this type will be used in the following chapters to demonstrate measurement technology (right).





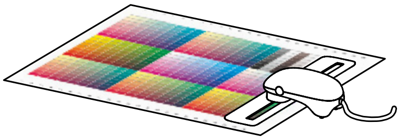
The EyeOne Pro (left) from X-Rite is the most used spectrophotometer in color management worldwide

Scanning Measuring Device

Scanning measuring devices are highly suitable for uses where often very many measurements are made. But because they do not allow for individual measurements they are not as flexible as the devices with alignment guides.

The i1 iSis from X-Rite is one of the fastest scanning measurement devices

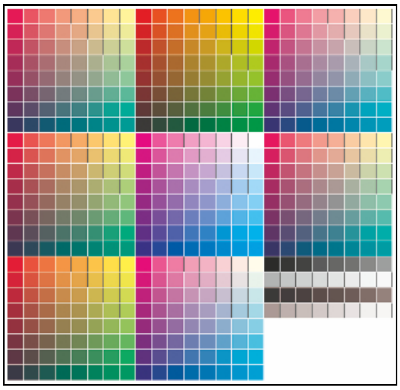
Practical Applications of the Lab Color Space



There are many uses for the Lab color space and the spectrophotometer in daily practice. For successful color management the stages, calibration, characterization, control and visualization are of equal importance.

Calibration

The calibration or linearization of a device serves to maintain a consistent color reproduction – an essential process, particularly with digital proof systems. For this, a test sheet is printed on the relevant device and scanned with a spectrophotometer. The calibration software compares the Lab measurement values with target values and calculates an internal correction. This correction or calibration ensures that the device's color reproduction conforms to a set specification.



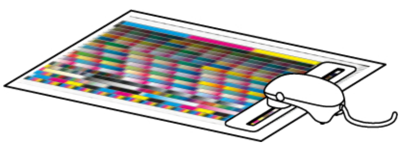
Test sheet for the calibration of proof systems

Because the color reproduction is dependent upon the device as well as the printing medium, there are different target values for high-quality printing systems, especially digital proof systems, for various printing media with different target values for calibration and linearization. So, if different printing media are to be used with the same proof system then each individual one must be calibrated. However, calibration alone does not ensure that a particular color space will be simulated. So-called color profiles are required for this. These will be described in the next chapter.

Characterization

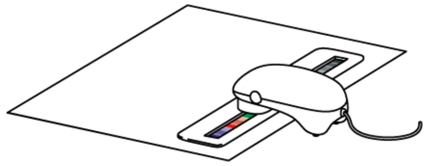
Characterization, a purely metrological process, is the precursor to profile creation. If an output device reproduces color consistently then it can be characterized. For a print system a test chart is output that covers the entire possible color space that the system can reproduce. When scanning the test chart with a spectrophotometer the Lab measurement values characterize the color space that the print system actually reproduces – hence we speak of characterization data. The next chapter shows color profiles are created from this data.

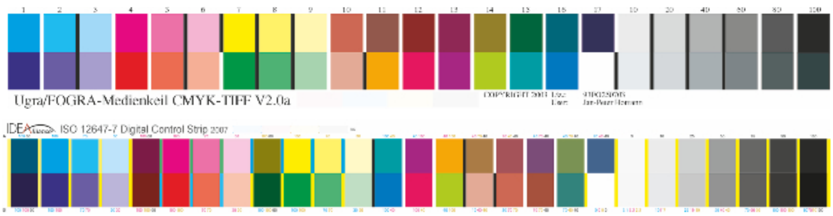
Test chart for the characterization of proof printers. More color tones are measured for characterization than for calibration.



Control

In professional production processes, which operate with consistently calibrated systems and color profiles, a further important stage is quality control. This is particularly important for digital proofs. A control wedge should be printed with each proof. If this is measured then it can still be determined later on if the color reproduction of the proof is correct. This can be done either where the proofs are produced or the printers who receive them. In this way the highest operational standard in production can be reached for both sides. The most important measured value in the control is the **color distance Delta E,** which describes the difference between two Lab color values. The greater the Delta E, the further is the measured color in the control wedge from its target value.

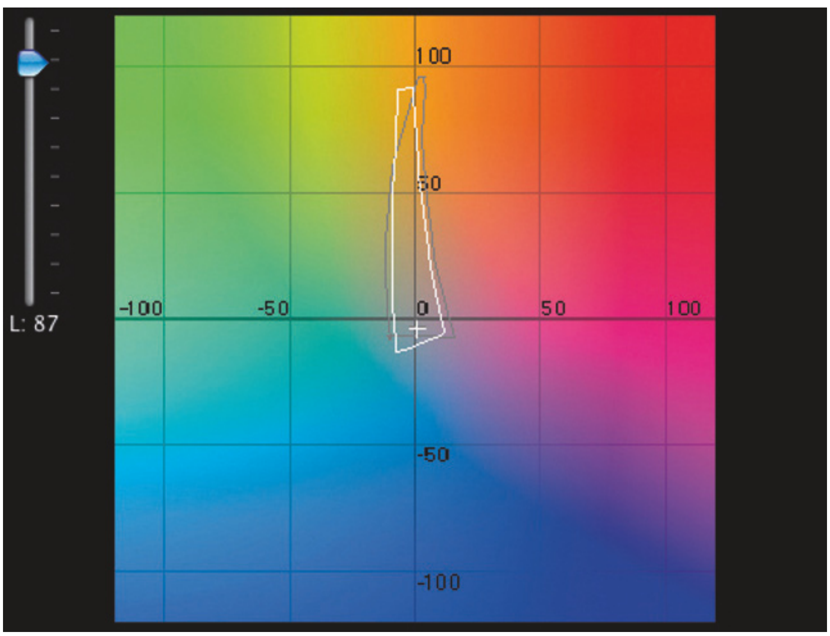




For quality control a color wedge is measured and compared with target values

Visualization

There are various programs that make it possible to compare the color spaces between output devices. In this way it can be determined, for example, if a proof printer is capable of reproducing the color gamut of the offset print. A typical representation of this is a cross-section through the two color spaces on a particular level of lightness in the Lab color space. Should the proof printer be able to reproduce an offset print correctly then the proof's color space must completely encompass that of the offset print.

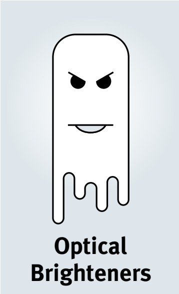


A section through the color space of an offset print (white) and an inkjet print (gray) at the lightness L = 87

In the saturated yellow tones a white peak juts out from the gray area. These are pure yellow tones of the offset print, which in principle cannot be reproduced in the inkjet print, as this yellow tends towards orange.

If one tries to closely simulate the cold yellow of offset print with this inkjet printer, one would need to add cyan to the mix. This, however, would lead to a visually grubby and darker color.

Lab Measurements of Paper with Optical Brighteners



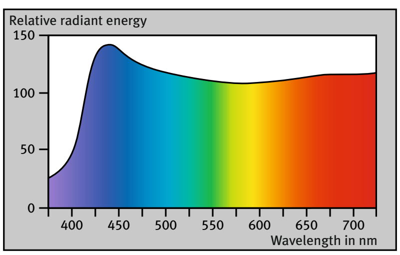
I would love to present color-management technology as a robust, logical and predictable system. However, there is a list of phenomena where theory and practice clash. In some cases, these lead to color management not working in the way technical standards specify or how it is demonstrated in many text books.

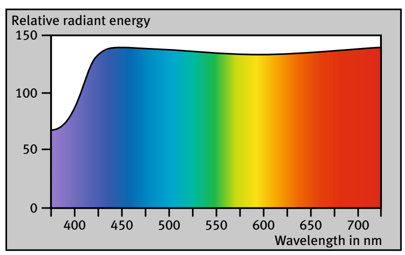
One of the greatest unsolved problems in color management is that of optical brighteners, which are used to make inexpensive papers appear as bright white as possible. These are additives in the paper that convert the invisible ultraviolet into the visible bluish portion of light. In the color measurement of such papers the blue area of the spectrum shows a considerable increase, which is not present with high-quality white paper without optical brighteners.

If the spectral measurement values are converted to Lab values, the papers with many optical brighteners give very blue color values which are not in harmony with the visual perception of the paper. The formulae that which Lab values are calculated from commercial spectrophotometers, simply do not work when papers with optical brighteners are measured. Because such papers are predominantly used in the areas of inkjet and color laser printing, as well as some areas of offset printing, practically every user of color management comes up against problems here.

And so, optical brighteners are the bane of color management, making every user's life difficult. This is reflected in the following chapters of this book: wherever certain areas of color management are explained, there follows an illustration of everything that doesn't work when optical brighteners are involved.

On the left is the spectrum of a paper for color laser print with many optical brighteners. On the right, for comparison, is the spectrum of a proof medium without optical brighteners.



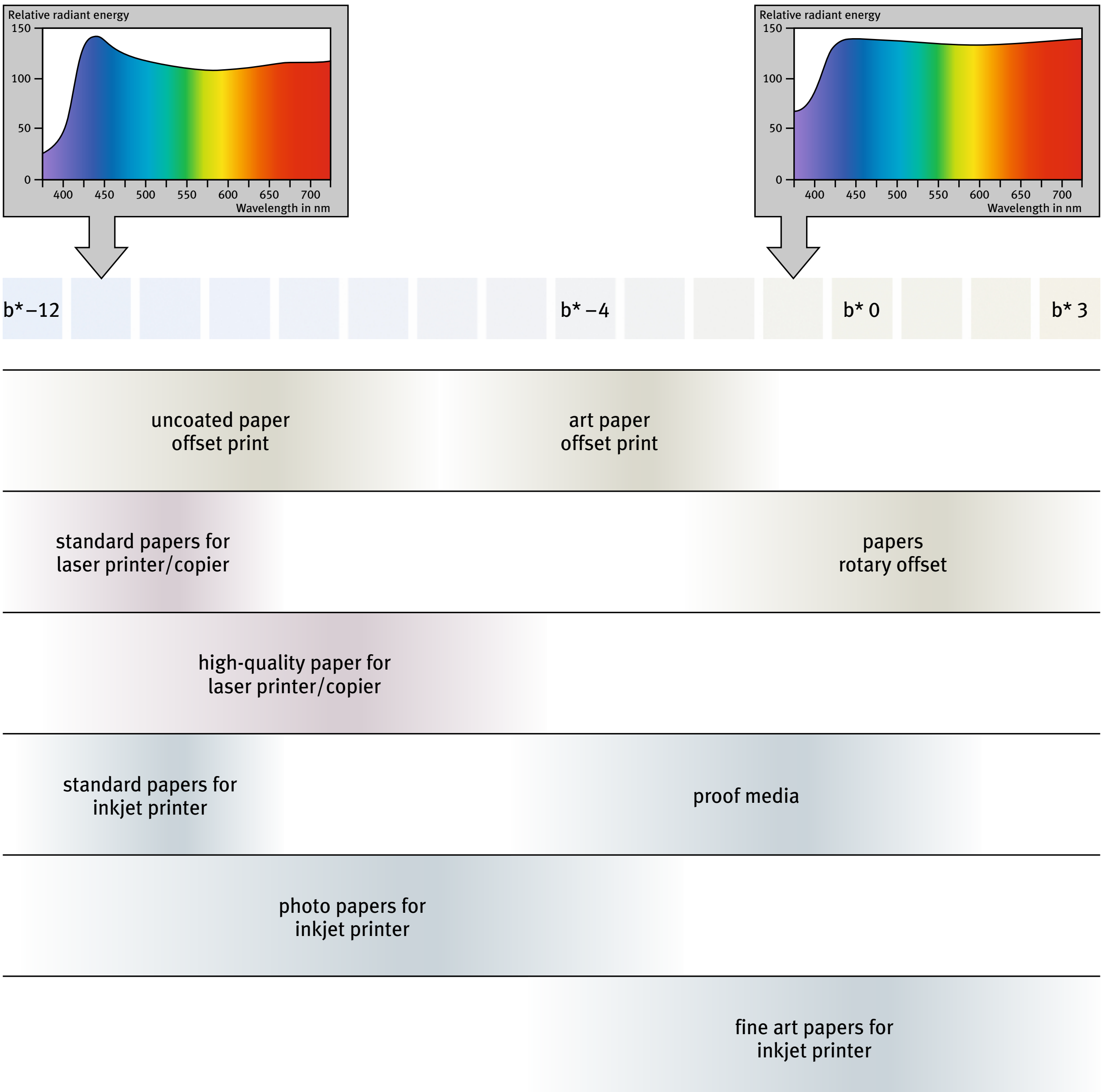


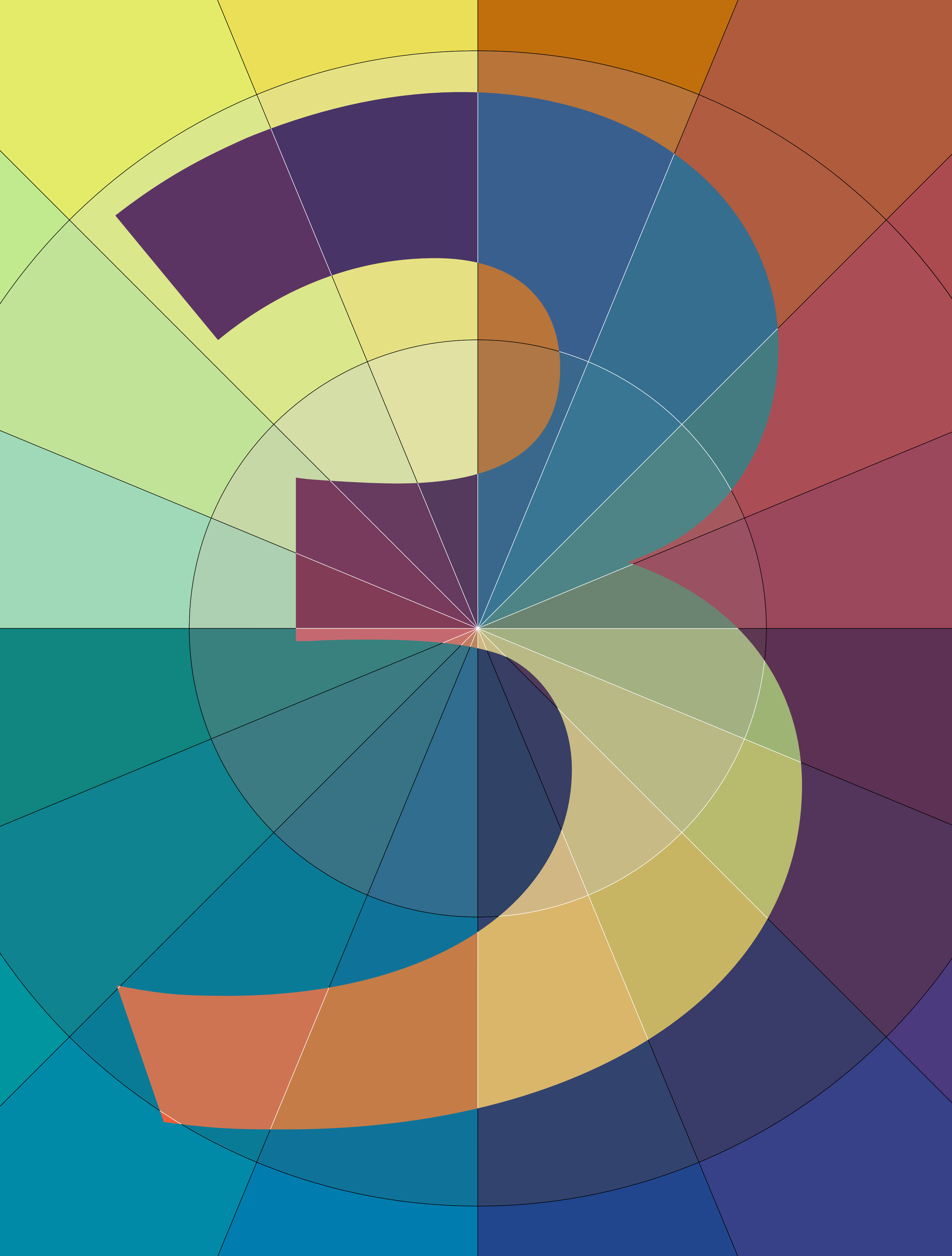
Lab Values of Typical Paper in Color Management

When measuring the whiteness of different papers with a spectrophotometer, the greatest differences can be found on the b* axis from blue to yellow. Papers without optical brighteners cannot be bluer than b* –2. Typical values for papers completely free of brighteners lie between b* –1 and b* 1.

Generally, the further the a paper's b* value goes into the negative, the more optical brightener it contains. It can be generally said that color management mostly works fine for papers with values between b* –3 and b* 3 and that problems increase the bluer the paper becomes.

A look at the illustration below shows that practically all papers used by photographers, graphic studios and agencies on an inkjet or color laser printer give problems in color management.

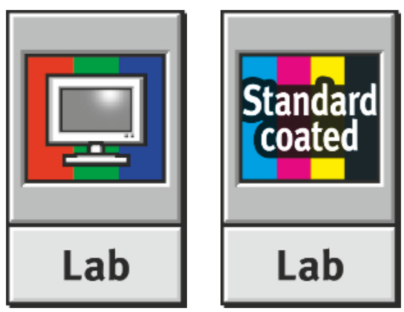



3

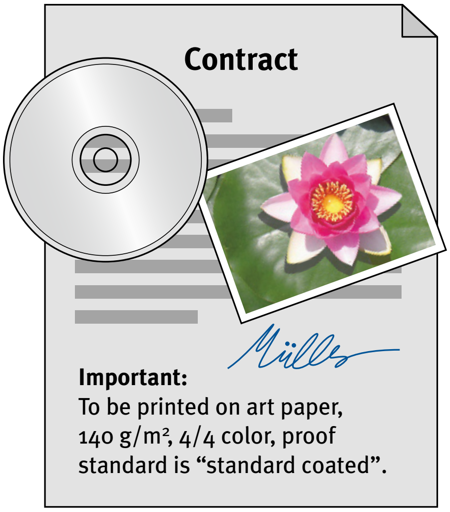
The Principles of Color Management

Color management serves the purpose of ensuring color accuracy throughout the whole workflow from initial draft through to the finished printed product. To achieve this it is necessary to map the color characteristics of each input and output device within the Lab color space and to store this information in color profiles. In this way the final colors of the print can be simulated at any stage during the production.

This chapter shows, with a simplified production procedure, how color matching in print works with the aid of color profiles.



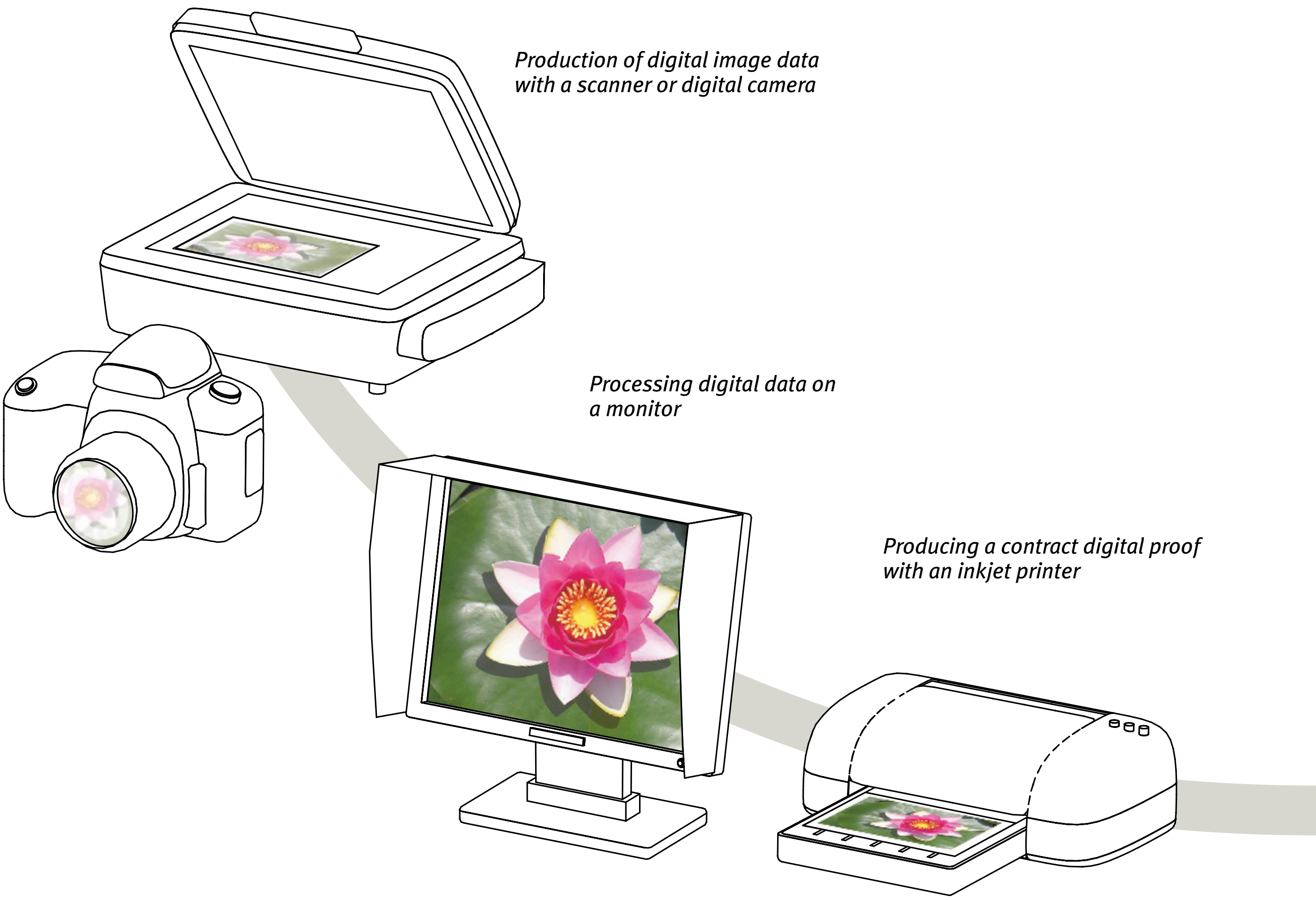
The Workflow from Contract to Print



Contract with predefined paper and proof standard as well as provided images (digital or analogue)

In four-color printing the paper is printed with the four basic colors cyan, magenta, yellow and black – in comparison to the ideal mixture of color in the cube, black now comes into play as the fourth color. Details on the relationships between cyan, magenta, yellow and black on different types of paper can be found in the next chapter. This chapter is concerned with the fundamental color-management processes.

Between the idea and finished printed material are many stages of production. For a high reliability of color it is necessary to decide on a general type of paper before the production starts. This is because the definition of colors in graphics, the optimization of scans in repro and the production of contractual proofs are always based on the paper in the final print. In the contract it is important to define the type of paper and determine the relevant proof standard. This chapter uses the general term **“standard coated”**.



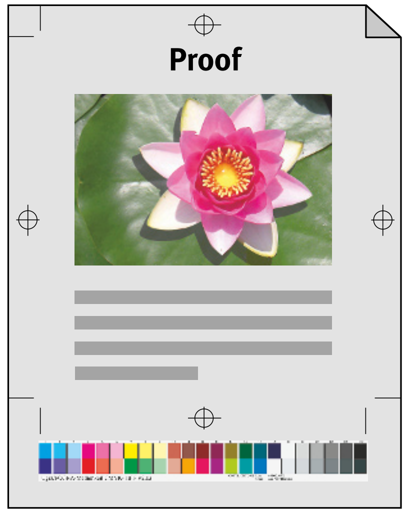
Production of digital image data with a scanner or digital camera

Processing digital data on a monitor

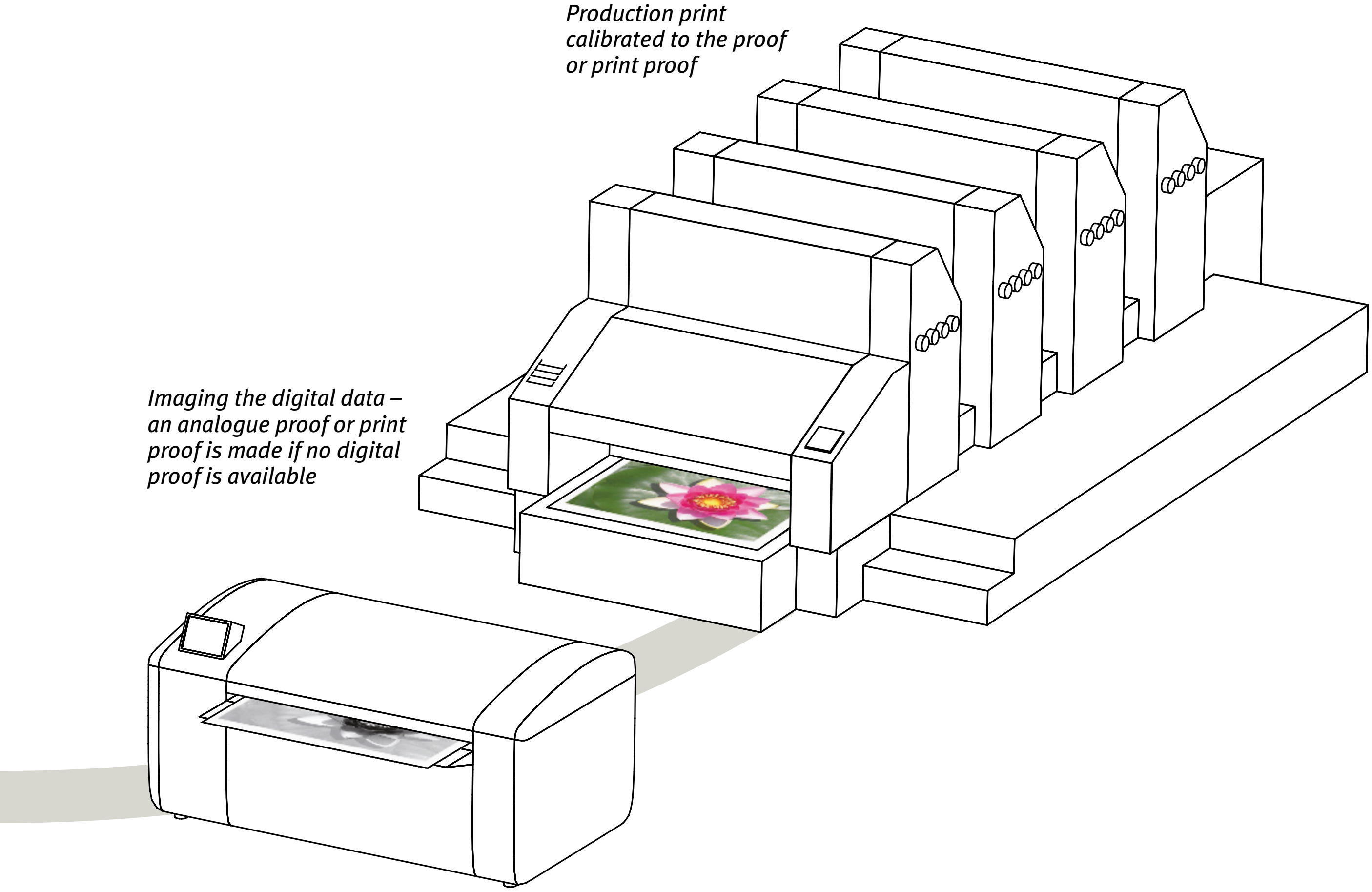
Producing a contract digital proof with an inkjet printer

After the print buyer and graphic designer have determined the general type of paper, the designer creates the layout and then the artwork. During this he ensures that the image data is prepared for the appropriate type of paper and arranges a contract digital proof of the final document. Depending on experience and equipment, the designer will either carry out all this himself or in co-operation with other service providers.

Although the process may seem simple on paper, in practice it can sometimes be complicated. Digital cameras, scanners, monitors and inkjet printers reproduce colors different from those in offset. Color management balances out these differences with the aid of so-called **color profiles.** Apart from this, all those involved need to decide who carries out which part of the process and how data is to be delivered. This chapter gives the basics for successful **communication.**



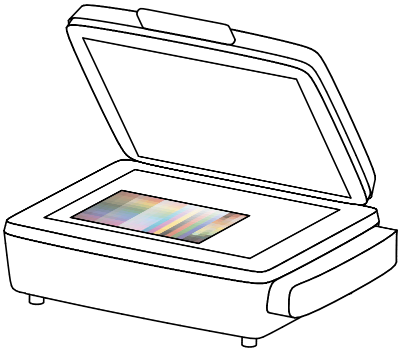
Contract digital proof according to the paper type (standard coated) predefined in the contract



Production print calibrated to the proof or print proof

Imaging the digital data – an analogue proof or print proof is made if no digital proof is available

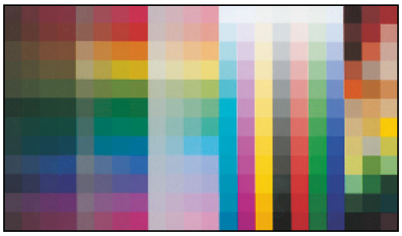
Profiling Scanners and Digital Cameras



A scanner is, basically, a technical reproduction of the human eye. The color filters in the scanner represent the three types of receptor in the eye for the basic colors red, green and blue. However, different filters are used depending on the type of scanner. There are filters that filter out relatively narrow segments of the spectrum, and others that tend to be quite broad. Different scanners will convert the same template into different RGB values. Such differences can be corrected with a scanner profile.

Two things are needed to profile a scanner:

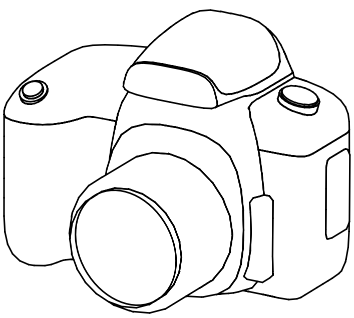
1. A reference target with a representative selection of colors (left),
2. A reference file containing all the color values of the reference target as Lab values.



The reference target is scanned in for profiling. The scanned RGB values are assigned to the correct Lab values in the reference file. The result is the scanner profile – basically nothing more than a table translating the colors as seen by the scanner into the correct Lab values. Each scanner requires its own color profile and often users created scanner profiles for individual devices.

Scanner profile

Digital Cameras
Individual profiles are only used in special cases with digital cameras. As a rule digital cameras already deliver color-optimized RGB image data to certain standards, of which there are, however, many. The relevant standard profiles are used in image-editing programmes to define the so-called RGB color space. The differences between the various RGB standards are explained in detail in Chapter 5.



Profile for RGB color spaces

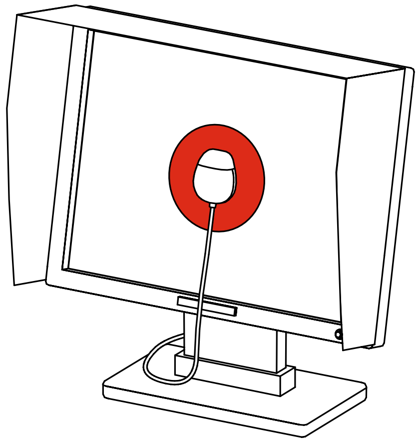
For exchanging data there are specific standard RGB color spaces for images from digital cameras

Camera profile

An individual profile is only created in special cases for a digital camera

Profiling Monitors

A classic CRT display mixes its colors additively from the basic colors red, green and blue. Its picture is made up of vertical rows that are divided horizontally into pixels. Each pixel in a row comprises three tiny phosphors for each of the basic colors. Each phosphor's brightness is controlled by a cathode ray accordingly. The colors then merge in the eye. Modern TFT monitors, technically speaking, work differently, but try to emulate the colors of CRT monitors the best they can.



Color measurement on a monitor

As we know from the previous chapter, monitors are able to display colors that are brighter and more saturated than print allows. Because no monitor is the same as another, image data is reproduced differently on each one. Such differences can be corrected with a monitor profile.

Two things are needed to profile a monitor:

1. A test file containing a representative selection of all the monitor's displayable RGB colors,
2. A color-measuring device to measure the monitor's display and convert them to Lab values (right).

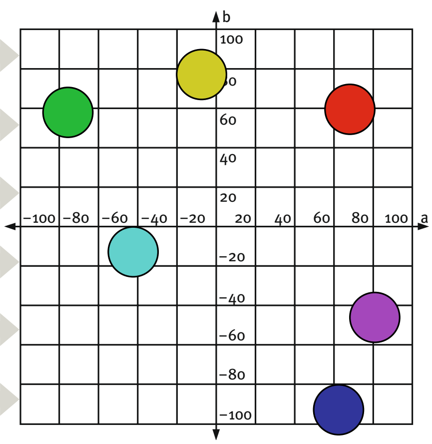
For profiling, the color samples in the reference file are displayed one after the other on the monitor. The color-measuring device analyses their spectra and converts the results to the Lab color space. Each RGB color in the test file is allocated to a Lab color value. Each Lab value is now also coupled with its RGB conversion. The result is a monitor profile – simply a table converting the monitor's RGB colors to Lab values.

Monitor profile

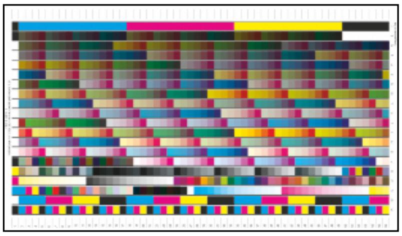
Different from the scanner, take care when using monitor profiles that contrast and brightness as well as ambient light do not change.

Below: Detail of a color-management profile's table
In reality the number of recorded color values varies between 27 and 32,000 depending on the profile's accuracy.

	R	G	B	L	a	b
	0	191	191	75	−44	−14
	191	0	191	54	81	−46
	191	191	0	80	−17	75
	191	0	0	48	68	60
	0	191	0	71	−78	63
	0	0	191	30	64	−92



Characterizing and Profiling Printing Processes

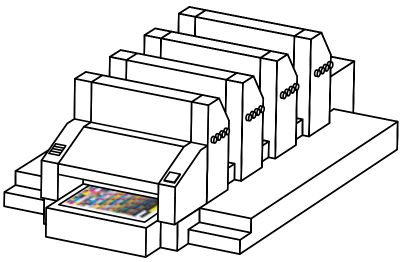


A test chart for characterizing printing processes consists of many different CMYK color zones. The layout is dependent on the measurement technique being used.

Different from scanners and monitors, the profiling of printing processes is much more complex. This is based on the variability with which color can be applied to paper. Essentially, printing processes can be described by the following parameters:

- printing process,
- type of paper used,
- printing inks used,
- strength of ink application.

This means it is not possible to profile the printer or printing machine as an individual device, but only **a printing process** with all its parameters. If a proof printer or printing machine is to be used with different papers, then different color profiles will be required. Where it is possible to control the range of inking, it might be necessary to profile the printing process with different ink applications.

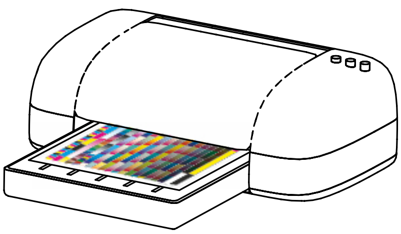


Output of the test chart in offset printing

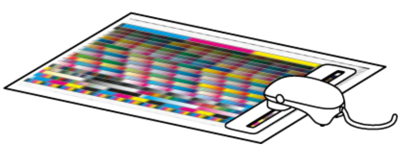
To create a profile a digital test sheet, with a representative selection of colors, is printed under tight known conditions (paper, color, ink application) and measured with a color-measuring device. The measured values are saved as a so-called characterization data set.

The Difference between Characterizing and Profiling

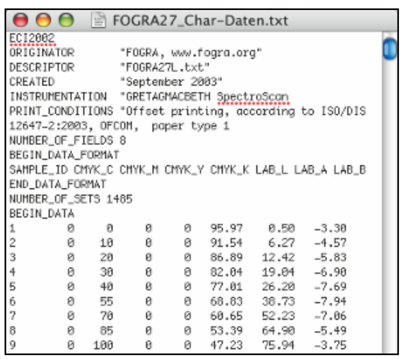
Characterization data are simply text files with tables in which every CMYK value in the test chart is coupled to the Lab value from the color measurement. The color profile is calculated from this data. Color profiles for print, in particular, contain, along with the color tables, numerous other pieces of information that are essential for its operation. Because different profile variations can be calculated from a characterization table, it is usual to save separate characterization data.



Output of the test chart with an inkjet printer



Measuring a test chart with a spectrophotometer. The measurement results form the characterization data for the printing process.



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DESCRIPTOR        "FOGRA27L.txt"
CREATED           "September 2003"
INSTRUMENTATION   "GRETAGMACBETH SpectroScan
PRINT_CONDITIONS "Offset printing, according to ISO/DIS
12647-2:2003, OFCOM,  paper type 1
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SAMPLE_ID CMYK_C CMYK_M CMYK_Y CMYK_K LAB_L LAB_A LAB_B
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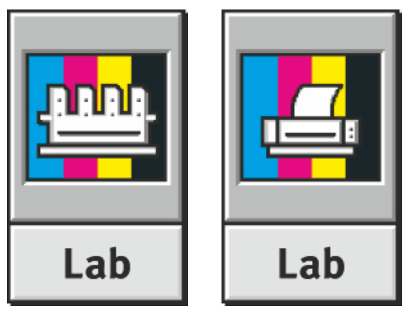
NUMBER_OF_SETS 1485
BEGIN_DATA
1         0     0     0     0   95.97    0.50   -3.30
2         0    10     0     0   91.54    6.27   -4.57
3         0    20     0     0   86.89   12.42   -5.83
4         0    30     0     0   82.04   19.04   -6.90
5         0    40     0     0   77.01   26.20   -7.69
6         0    55     0     0   68.83   38.73   -7.94
7         0    70     0     0   60.65   52.23   -7.06
8         0    85     0     0   53.39   64.90   -5.49
9         0   100     0     0   47.23   75.94   -3.75
```

Characterization data are simple text files, in which each CMYK value of the test chart is assigned to the Lab value in the color measurement.

Profiles for offset and proof printing



Profiles for offset print or an inkjet printer are calculated by profiling software from the characterization data.

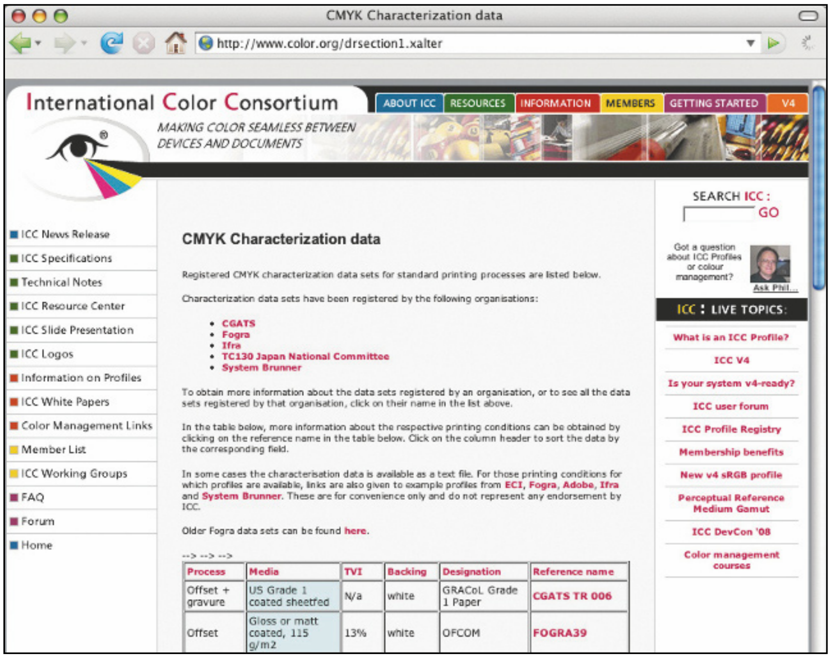
Standard Profiles for Offset Printing and Proof Systems

Standard Profiles for Offset Printing

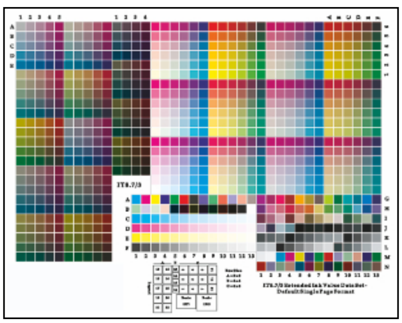
Practice shows that creating and using individual profiles for offset printing has many problems. The use of standard profiles for offset, however, is considerably safer and more efficient for the whole industry. Industry organizations, like, e.g., FOGRA and CGATS, provide characterization data on the internet. There are differnet data sets for different paper types like, e.g., coated, webcoated or uncoated. Several organizations and vendors like e.g. ECI, SWOP, GRACoL and Adobe, offer profiles based on this standard characterization data. They will be discussed in detail in the next chapter.

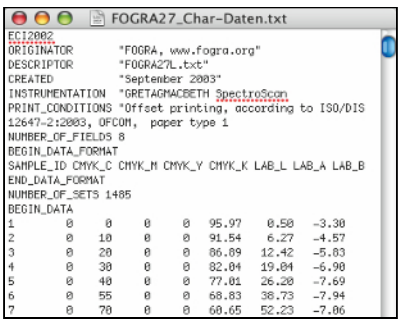
Standard profiles for offset printing

The illustrated profiles stand for offset printing on coated paper and weboffset printing on light weight coated paper (webcoated).



*An overview for standard characterization data can be found at **www.color.org**.*




FOGRA27_Char-Daten.txt

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DESCRIPTOR      "FOGRA27L.txt"
CREATED         "September 2003"
INSTRUMENTATION "GRETAGMACBETH SpectroScan
PRINT_CONDITIONS "Offset printing, according to ISO/DIS
12647-2:2003, OFCOM,  paper type 1
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SAMPLE_ID CMYK_C CMYK_M CMYK_Y CMYK_K LAB_L LAB_A LAB_B
END_DATA_FORMAT
NUMBER_OF_SETS 1485
BEGIN_DATA
1       0     0     0     0   95.97    0.50   -3.30
2       0    10     0     0   91.54    6.27   -4.57
3       0    20     0     0   86.89   12.42   -5.83
4       0    30     0     0   82.04   19.04   -6.90
5       0    40     0     0   77.01   26.20   -7.69
6       0    55     0     0   68.83   38.73   -7.94
7       0    70     0     0   60.65   52.23   -7.06
```
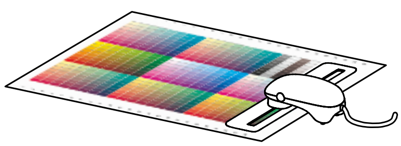

There are internationally valid ISO standards for test charts and characterization data, which ensure that characterization data can be imported into different profiling programs.

Standard Profiles for Proof Systems

A constant color reproduction is the deciding factor for proof systems. Therefore, it is necessary to calibrate them regularly with a spectrophotometer. If a proof system is calibrated for a particular printing medium, then it is no problem to work with the standard profile supplied by the manufacturer of this medium. This avoids having to create an individual profile for the printing medium being used. However, if a proof paper is used for which the manufacturer does not supply a profile, it is necessary to create an individual profile.



If a proof system is regularly calibrated then the standard profiles from the proof solution supplier can be used.

Color Conversion with Color Profiles

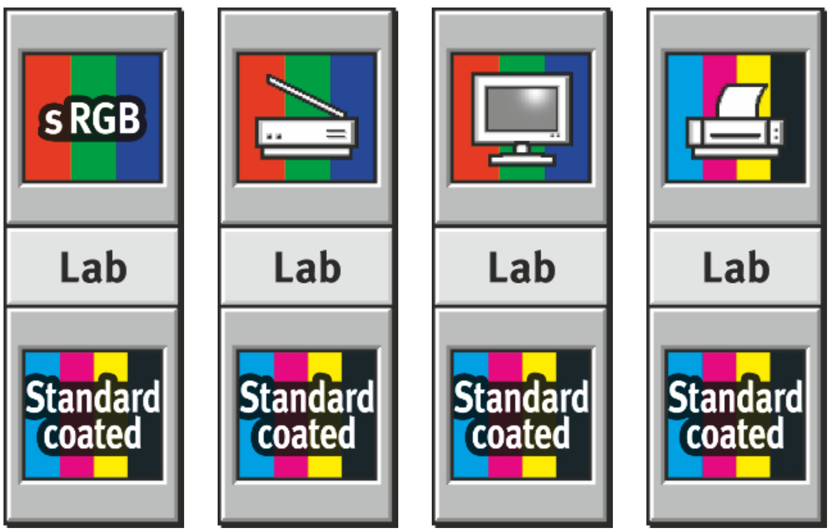
Each color profile contains a large table that couples the RGB or CMYK colors of the respective device or color space with Lab color values. The Lab color space serves as the interface for the color conversion with color profiles. For example, if a scan's RGB data is to be converted to CMYK data for the printing standard ISOcoated, the scanner profile translates these to Lab values that are then coupled with CMYK values in the standard coated profile.

Color management ensures then, by means of color profiles, that each of the scanner's RGB color values is coupled with a CMYK value of offset printing that is assigned to the same Lab value. Because the Lab color space describes colors as the human eye perceives them, a visually correct conversion between the scanner and offset printing standard is ensured.

Because each color profile has a connection to the Lab color space, conversions between any color spaces can be made with color profiles, so long as precise profiles are available. However, if conditions have changed since profiling, e.g. the monitor's contrast and brightness settings, then the color conversion will be imprecise and consequently no longer optimal.

Typical color conversion with color profiles

For color conversion the profiles are connected to each other via their interface to the Lab color space.



Color-accurate Work with CMYK Data

CMYK file

Large parts of this book are concerned with simulating the colors of the final printed result on a monitor and proof printer when preparing data for offset printing. For this reason the introduction to color-management processes on the following pages uses the handling of CMYK data in relation to the standard coated color space as an example. This is followed by working in RGB color spaces and the preparation of RGB data for printing.

There are no general mandatory standards for scanners, monitors and color printers. An important field of operation for color management is thus the individual adjustment of these devices to the CMYK standards for offset printing. The next sections show the configuration of color-management systems for this purpose. However, it must be decided in advance if coated, uncoated or news print will later be used. The stages of scanning, soft proof on the monitor and digital proof are then optimized for the predefined printing standard. In this example it is the standard coated color space for printing on coated paper.

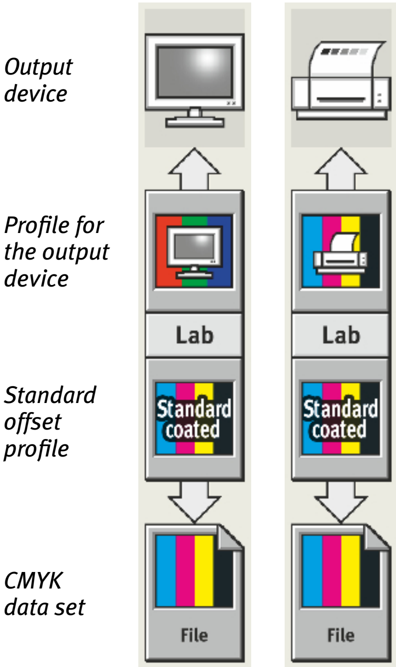
Working with Profiled Scanners and CMYK Data
The RGB raw data from the scanner is first run through the scanner profile and then converted to Lab data by means of the conversion table. The resulting Lab values are then converted CMYK data in the standard coated profile. The end product is the CMYK data set of a scan optimized for standard coated (illustration right).

Producing RGB data with a scanner

Scanner profile: Data conversion from RGB to Lab

Standard offset profile: Data conversion from Lab to CMYK (standard coated)

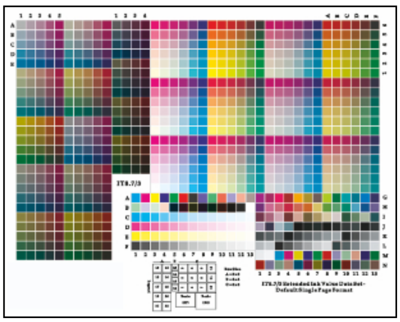
Result: an optimized CMYK data set for standard coated

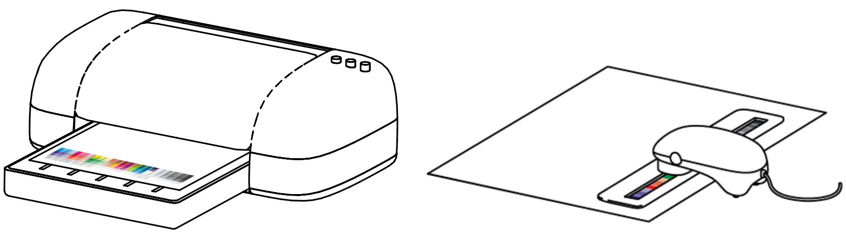


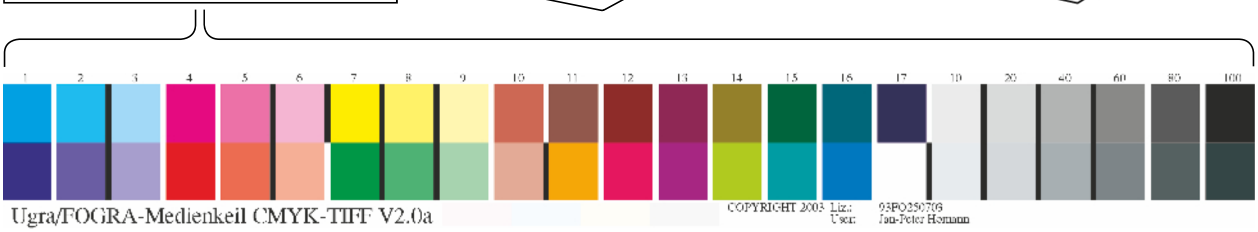
CMYK Data on Profiled Monitors
For the display of CMYK data for a determined printing standard (e.g. standard coated), the data first runs through the standard coated profile and then the monitor profile. The standard coated profile converts the CMYK data to Lab values, which the monitor profile "translates" into RGB data for the monitor. So, for CMYK color of the printing standard, an RGB color is triggered on the monitor that is assigned to the same Lab value. CMYK data from unknown sources will be displayed on the monitor as they would later appear in print according to standard coated.

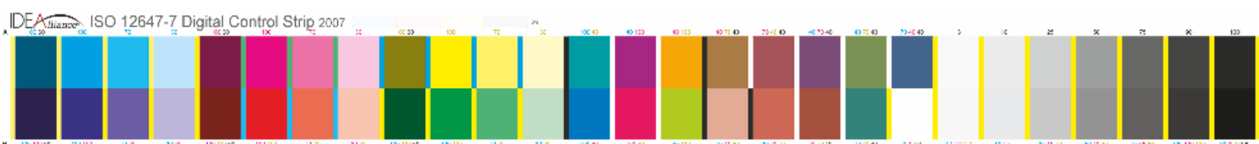
CMYK Data on Profiled Proof Printers
The use of profiles for output on proof printers is largely identical to that with monitors: the CMYK data first runs through the standard coated profile, which converts them to Lab values. Finally, this Lab data is "translated" into a specific CMYK color space by the profile for the proof process.

Quality Control of the Proof Print
On page 55 it was shown how an output device's color reproduction is controlled with the use of a control wedge. Extending this process, it can be used to control the proof print. The aim is not just to control the output device but also its interaction with the color-management color profiles. This test allows a clear prediction of how well the offset print will be simulated on a proof printer. If standard coated is to be used for proofing then the control wedge must also comply with the standard coated color values.







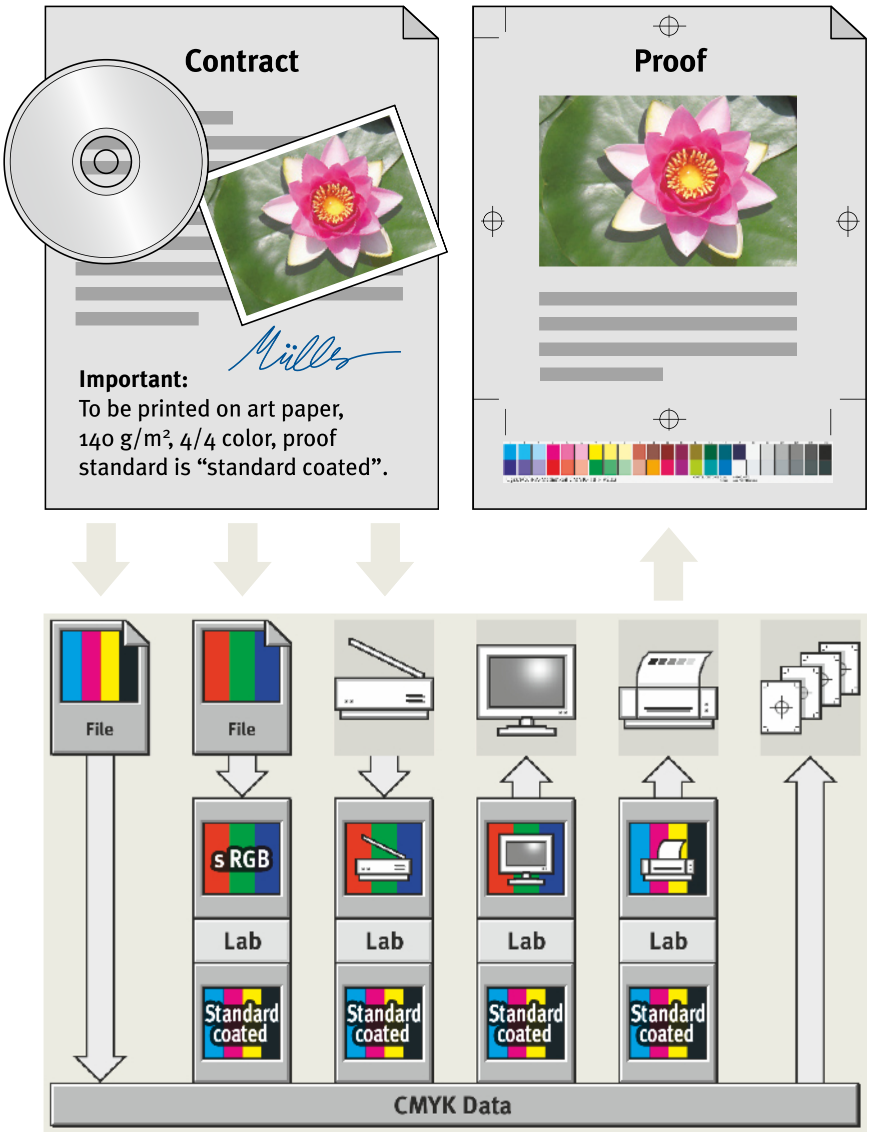


A wedge for the quality control of the proof (bottom) consists of selected zones from a test chart for the characterization data of offset printing (above).

To check the quality of the proof a control wedge is printed with active color management and then measured with a spectrophotometer. The measurement results are then compared with the characterization data for offset printing.

Simple Workflow with CMYK Data

In a simple color-management plan with CMYK data of a defined printing standard (in this case standard coated) the described processes come together to create the following picture:



At the start of a print project it is decided which type of paper will be used and which standard will be used for the proof. This is recorded in the contract to the service provider. The digital and analogue image data are provided with this information.

Supplied CMYK data is transferred directly. RGB data runs through the profile for the RGB color space and are converted to the predefined CMYK standard (e.g. standard coated). Data from analogue artwork, after being scanned in, is run through the scanner and press profile.

For the monitor display of CMYK layouts with imported CMYK images, the entire data firstly runs through the standard CMYK profile and then the monitor profile.

The contractual color output with a proof printer works with a similar group of profiles – however, the monitor profile in this case is replaced with the profile for the proof process.

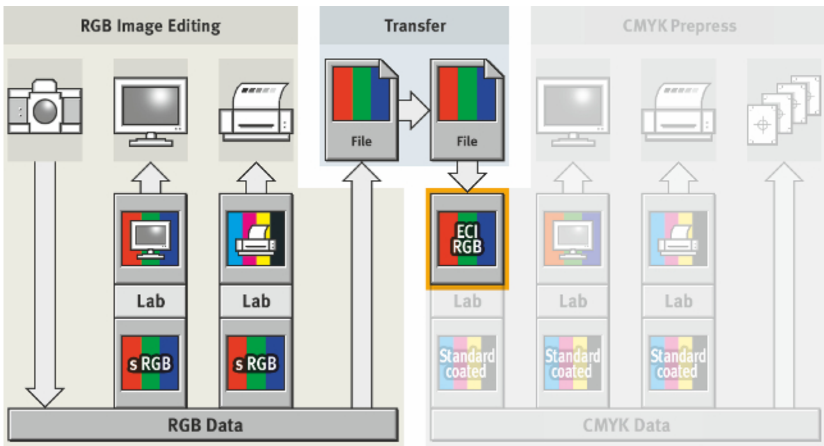
The CMYK data run through no further color profiles when imaging films or printing plates.

The contract proof acts as the reference for color assessment for all those involved, from the print buyer to the graphic designer to prepress. The printers also require the proof for exact color matching on their machine.

Color Management with RGB Data

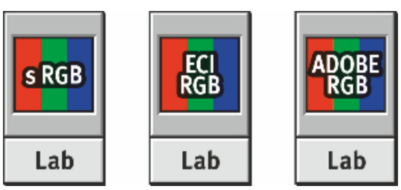
RGB file
(without indication of a specific color space)

Preparation for offset printing is not always the primary reason for processing digital imagery. In this case the RGB color space is the central point of reference for color management. All images that are saved to the computer with a scanner, digital camera or an image database must be converted to the defined RGB working color space, unless they already exist in this color space when opening or importing them. The illustrated example shows the process with a semi-professional digital camera that provides images in the sRGB color space. When the images are displayed on the monitor or output on a color printer, they first run through the sRGB profile and then the respective output profile.



Workflow with RGB data and data exchange with prepress: if a different RGB color space is used during image processing as in prepress, a resultant color shift occurs in data transfer, as depicted in these two photos.

Below: DQ-Tool (Digital Quality-Tool) from the German Photographic Industry Association:
The color impression of skin tones in sRGB color space (center) and the ECI-RGB color space (right)



Along with sRGB and AdobeRGB, ECI-RGB is also prevalent as a working color space in Germany

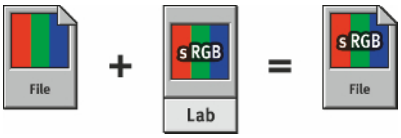
Breaking Point RGB Data Transfer

Data transfer is one of the most critical points in color management: if the receiver of an RGB image uses a different RGB working color space then the image's RGB values will be interpreted falsely and, in conversion to CMYK, will be adulterated in color. This error will pervade right through to the print. The producer of an RGB image must clearly convey to the receiver the RGB working color space in which he has produced or processed the image.

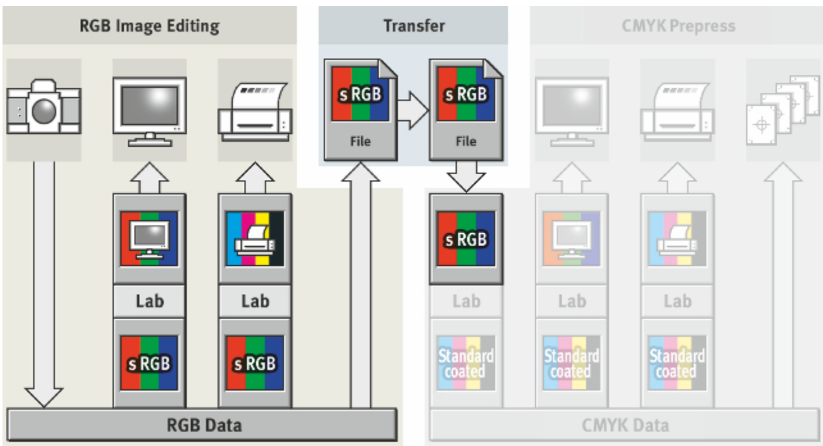
Color Management with Embedded Profiles

In order to convey to the receiver the working color space in which the image data has been produced or processed, the profile for the working color space should be embedded in the image file when being saved. If the receiver has configured his application program (e.g. Photoshop) to assume the embedded profile then nothing more can go wrong when transferring RGB data.

RGB file with embedded sRGB profile



Files containing embedded color profiles are depicted in the following illustration



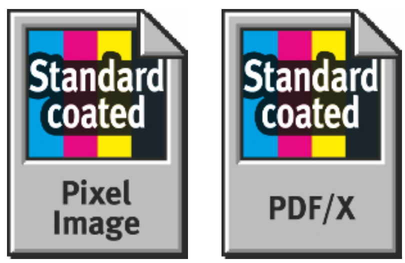
When the deliverer embeds his RGB working color space in his RGB images, and the receiver can interpret this, then there is no resultant color shift during data transfer.

Embedded Profiles in CMYK Data

Embedding profiles when preparing RGB images for print projects is a call of duty, only in this way can a color-safe transfer to the chosen CMYK standard be assured. With CMYK images it's a little different. Basically the rule applies that profiles should also be embedded in CMYK images. Only in this way can it be determined later if the images have been prepared, for example, for offset printing on coated paper or newsprint.

If CMYK images with embedded profiles are placed in a layout then incorrect color-management settings in the layout program can lead to undesired color transformations in the images. The latest layout programs such as Adobe InDesign CS2 or newer have standard color settings that can prevent undesired color transformations in imported images. With earlier versions this was not the case. This topic will be discussed in greater detail in Chapter 5.

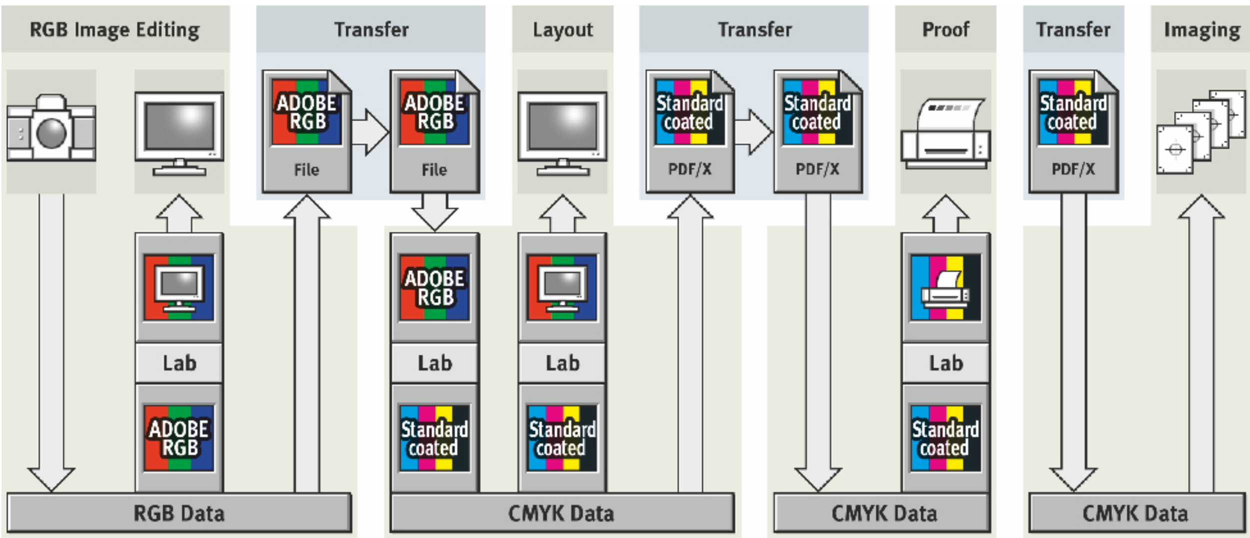
Along with individual image files, PDF files of complete layouts can also be labeled with the CMYK standard for which they have been produced. In the PDF/X format for delivery to the printers this is actually compulsory. Details on this topic can be found in Chapter 6.



In the illustrations on the following pages and in the next chapters, different file formats will be defined, which are indicated by their profile. Along with pixel images these are notably PDF/X files.

Division of Work and Communication

Work with RGB data has shown that the data transfer between two stages of work is a critical point in color management. In practice there are further stages of work in which data is transferred. The following illustration shows the use of color profiles and data transfer at different stages of work as far as the print-ready PDF file including proof, the final film or plate exposure and the edition print in accord with the proof.

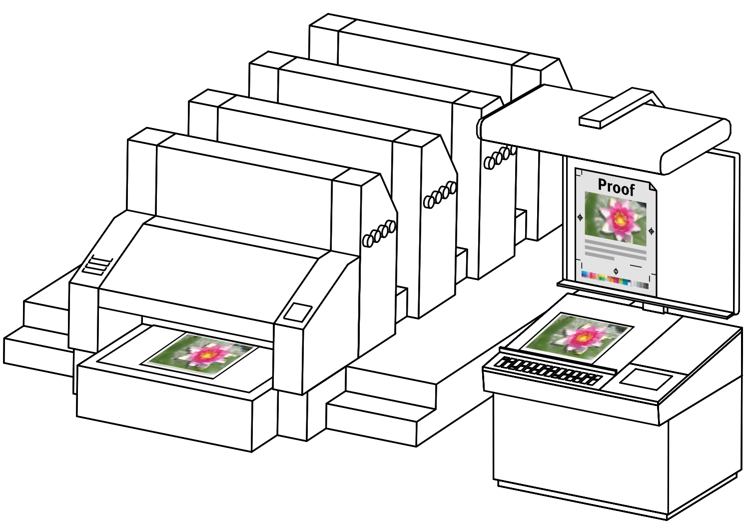


A typical procedure in RGB image editing is the output of AdobeRGB data from a digital camera, the display on a profiled monitor and data transfer with the embedded AdobeRGB profile.

For the transfer into the layout of a print project, the AdobeRGB images are converted to the standard coated color space with a standard CMYK profile.
This color space is simulated on a profiled monitor and a CMYK PDF with an embedded standard coated profile is produced for the printers.

A contract digital proof needs to be made from precisely this PDF, which also reproduces the standard coated color space.
This is then signed off by the print buyer.

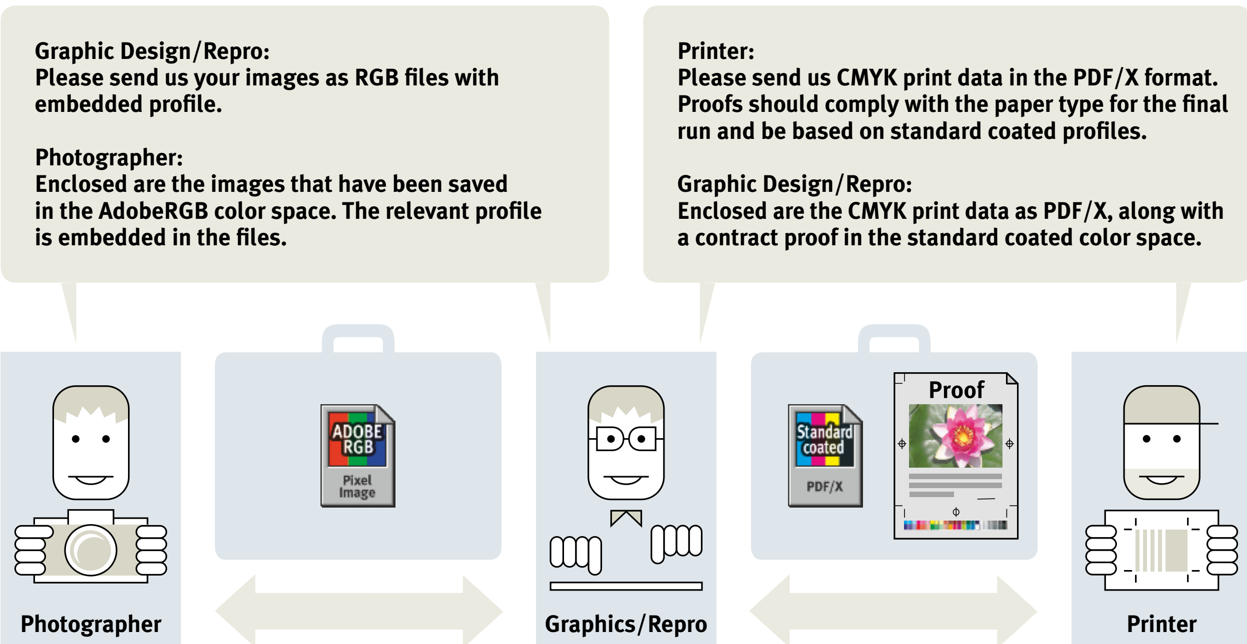
No further color management is required to image the films or print plates.



For the final run, the printer controls the color on the printing machine to obtain an optimal match to the provided proof.

A divided work process forms the basis of the following chapters of this book, in which data and proofs are exchanged between people and workstations. As the name color management suggests, not only is the technology important for an efficient and secure use of color, but also the communication between all those involved. In order to clarify roles and responsibility, the following stages of work shall be defined:

1. Photographer: production and processing of RGB images;
2. Graphic design/repro: conversion of image data to CMYK, layout, artwork and contract proof according to the agreed offset standard;
3. Printers: edition print in accord with the contract proof.



The photographer provides the graphic designer or prepress service with RGB data with an embedded profile.

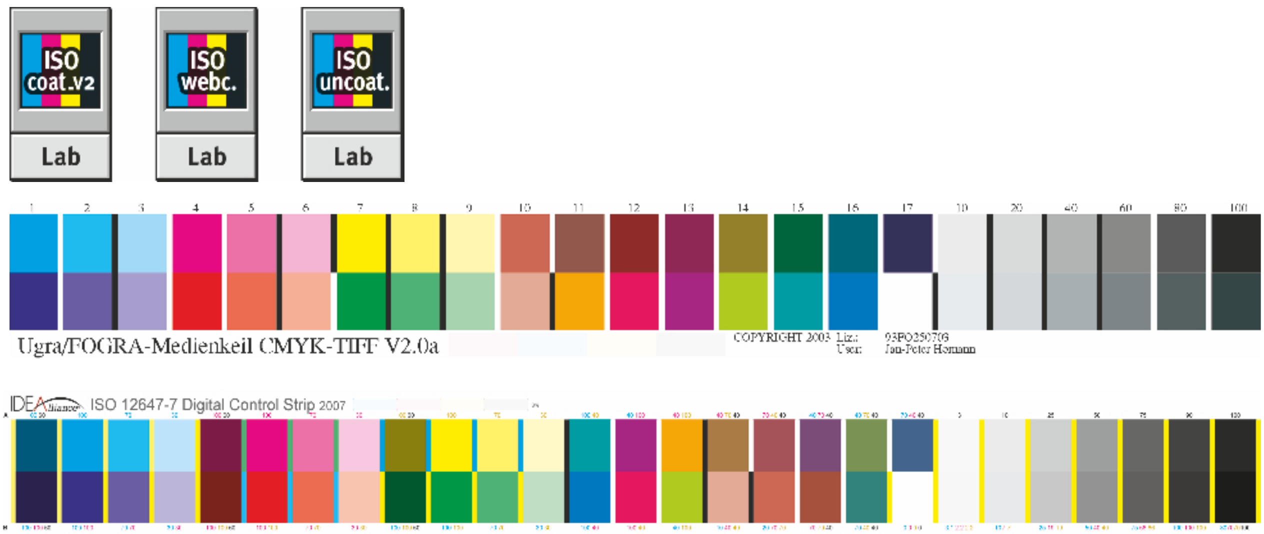
These then convert the photographer's RGB data from its RGB working color space (obviously from the embedded profile) to the standard CMYK color space that has been agreed upon with the printers. CMYK PDF/X data and a contract proof are then passed on.

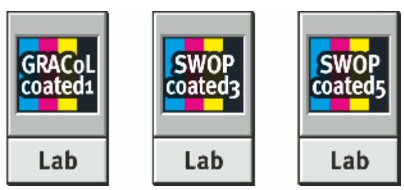
The incoming PDF/X data and proofs are inspected at the printers. Afterwards the printer adjusts the final run to the contract proof.

Meanwhile, with the fall in price for high-end scanners, digital cameras and printers, there are now different scenarios for who undertakes which stage of work:

1. The graphic designer as a lone warrior who imports images from his digital camera into layouts and delivers the print data, including color print, to the printers.
2. A small agency processes images from professional photographers in their layouts and produces contract proofs itself.
3. A production department co-ordinates extensive print projects in liaison with photographers, graphic designers, prepress services and printers.

The basic color-management processes are in each case comparable. The expenditure for quality control is, however, considerably higher in the scenario with the production department than with the graphic designer as lone warrior. Along with the technical handling of color profiles, the agreement between all those involved plays a large role. Basically, the rule applies that the next stage of production tells the previous one what they want, and the current stage clearly communicates what will be delivered.





A Short Preview of the Following Chapter

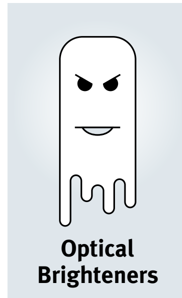
The work division that has just been discussed for the major stages of production will be defined more exactly in the following chapters. It concerns proven workflows by which large and small companies in Europe and the USA work.

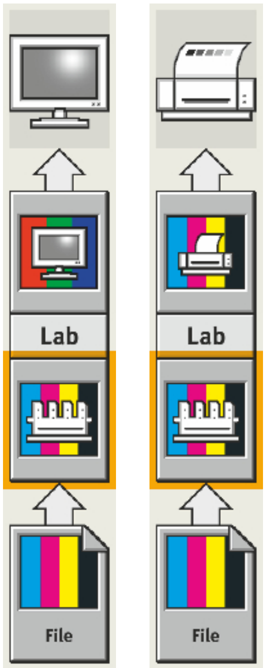
Standard profiles (ECI, Adobe, GRACoL, SWOP) and control wedges for proof control from FOGRA (top) and IDEAlliance (below) are fundamental tools in practice for the implementation of ISO 12647, GRACoL and SWOP, which is the subject of the next chapter.

With the international standard ISO 12647 and national specifications, there is a framework for which industry organizations, such as FOGRA, CGATS, SWOP, GRACoL, the German Printing and Media Industries Federation and the European Color Initiative (ECI), have developed very useful tools and means of control. The following chapter is dedicated exclusively to ISO 12647, GRACoL and SWOP along with the appropriate tools.

Papers with Optical Brighteners in the Profile Chain

There was a warning at the end of Chapter 2 about papers with optical brighteners, the bane of color management. The following example now shows their effect on some fundamental color-management processes.

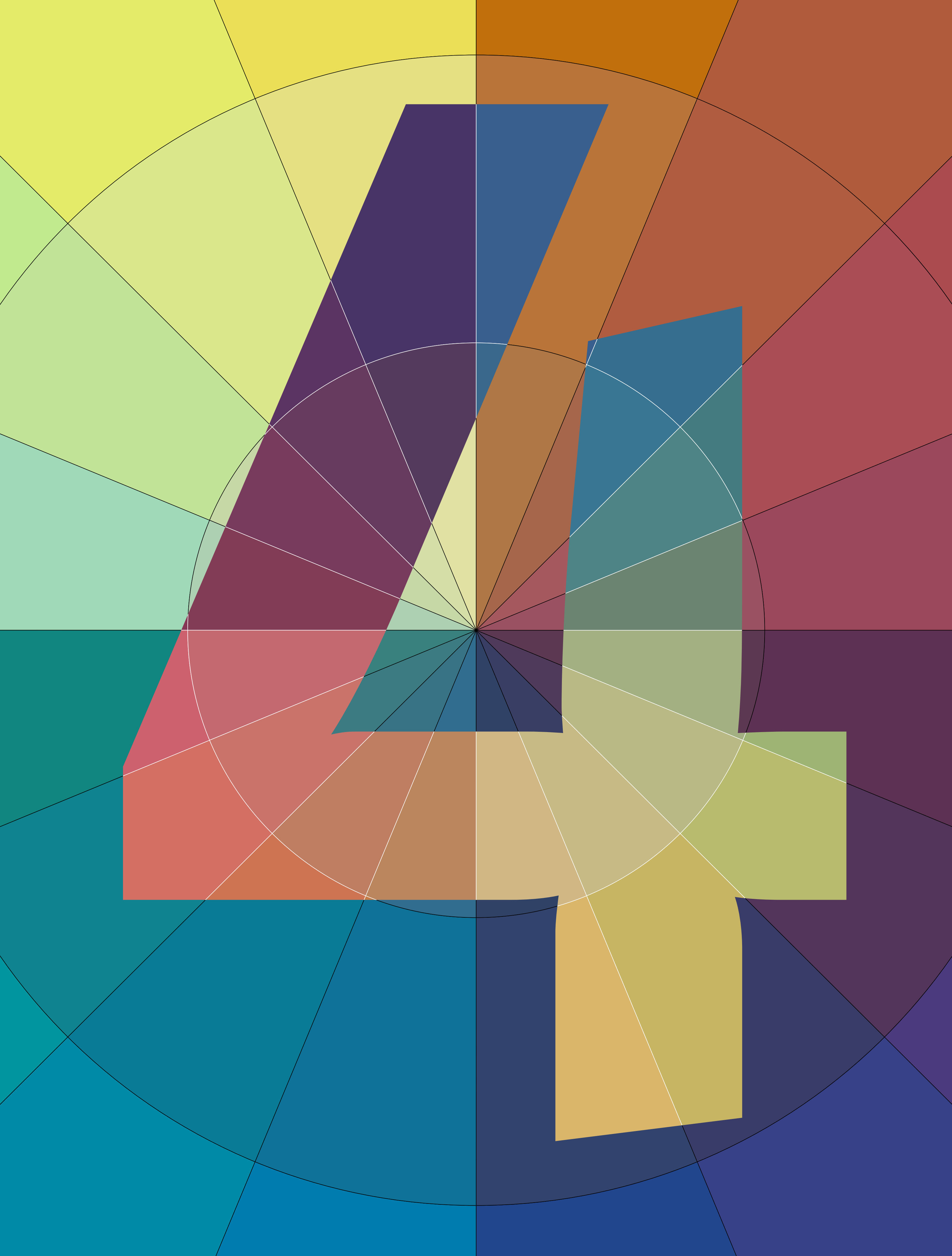




In color management, if the profile for offset printing is based on a reference print, on paper containing many optical brighteners, the colors on the monitor and proof will be reproduced too bluish.

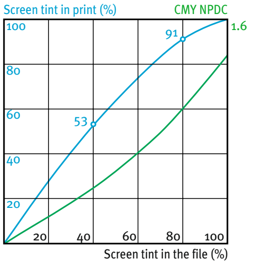
If the reference paper for the proof printer's profile contains many optical brighteners, the color reproduction will be too yellowish. The proof profile tries to compensate for the apparently too bluish paper with more yellow.

Here, for comparison, the color-neutral original.


4

ISO 12647, GRACoL and SWOP for Separation, Proof and Print

As discussed in the previous chapter, the workflow of a print production is very much divided into stages of work. Defined standards and stages of control are necessary to ensure that communication and data transfer runs efficiently between all those involved.



Apart from this it is useful to be accustomed to the basics of print and the influence of paper on color reproduction. This basic knowledge is the imperative requirement for optimizing scans with the aid of color management for the respective paper or producing a contract digital proof of the final print result.

The Role of ISO Standards

*The website **www.iso.org** provides information about the ISO standards*

In the production industry, standards and norms play a large role when different firms work together. Generally speaking they ensure a seamless integration. In the printing industry and in color management there is a list of international standards that have gained increasing importance over the years.

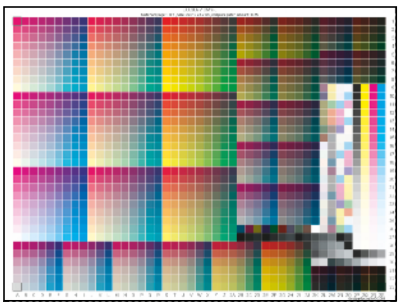
International standards are developed by the International Standards Organization – in short, ISO – in whose subdivisions, national bodies for different areas are active. In Germany it is the German Institute for Standardization (Deutsches Institut für Normung, DIN). Many ISO standards are translated into German and then published DIN norms. DIN norms and ISO standards can be obtained by everybody from www.iso.org, either in printed form or as a PDF file.

The ISO standards can be obtained at this website as well

If international standards are defined and there are concrete products that work according to these standards, then this is to the user's advantage because no one manufacturer can indiscriminately change these standards. For example, for ISO 15930, also known as PDF/X, there is a standard with precise parameters for the composition of PDF files for print. Even though Adobe further develops the PDF format and builds these features exclusively into its own application programs and RIPs, Adobe is still not able to arbitrarily change the PDF/X standard and thereby exclude its competition.

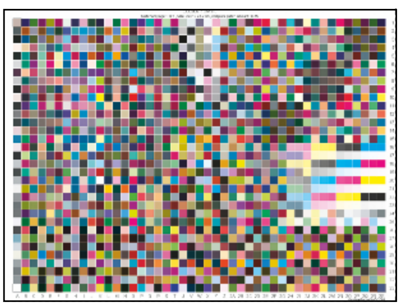
There follows a short summary of selected ISO standards that are relevant to color management and print production:

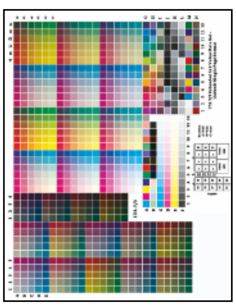
The test charts shown below are predefined in ISO 12642 for the characterization of printing systems. On the far left, the new ECI 2002 charts in visual and random layouts. In the middle, the classic, also known as IT 8/7.3, and on the right an IT 8/7.3 layout variation for a scanning spectrophotometer of a particular manufacturer.

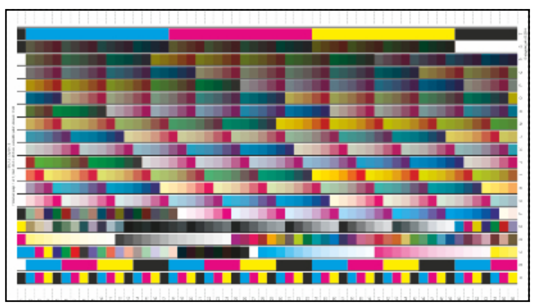


ISO 12642 for Test Charts to Create Profiles

In this standard the composition of test charts to create color profiles is predefined. If charts of this predefined standard are printed and measured, these measured values can be used to create profiles with all programs that support these charts. Along with ISO 12642 test charts the manufacturer can also offer in each case individual profiles, which, however, are not supported by other manufacturers. If you want to compare different programs for creating profiles, ISO 12642 test charts should always be used.

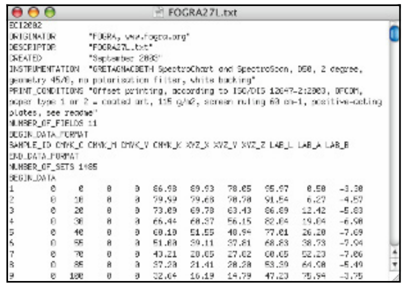






ISO 12640 for Characterization Data

ISO 12640 predefines in which form the color-measurement data from the ISO 12642 test chart should be saved after measuring. In the past, many programs used for creating color profiles saved this data in their own formats. Color measurement data saved in accordance with ISO 12640 can be imported by various programs to create color profiles.



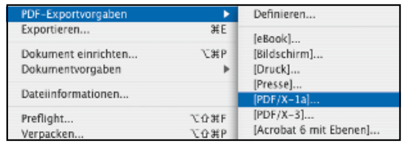
When FOGRA or other organizations publish characterization data, these are in the form of text files in accordance with ISO 12640

ISO 15076 / ICC for Color Profiles

For a long time only the ICC standard applied for color profiles, which was developed and defined in the graphics industry by different manufacturers. Since 2003 a co-operation has existed between the ISO and International Color Consortium so that this development can be better co-ordinated with other ISO standards for the graphics industry.

ISO 15930 PDF/X

This ISO norm describes the requirements of PDF data being delivered to the printers. Thereby, there is a differentiation between PDF/X-1a and PDF/X-3. With the former only CMYK and spot colors are allowed in the PDF file. With PDF/X-3, individual text, graphic or image objects may contain any profile (even RGB profiles). PDF/X-1a and PDF/X-3 will be discussed in great detail from Chapter 6.



Print-ready PDF files can be created quickly and simply in many programs with a direct export as a PDF/X file

ISO 12647 for Separation, Proof and Print

For a long time in color management there was an inflation of profiles for the separation of RGB images, the soft proof on the monitor and the digital proof. Different results were attained depending on where the images were separated and proofed. ISO 12647 ensures everything is in the right place by predefining that the CMYK separation of RGB images should be geared to four different types of paper. If print data and proofs are produced in this way then the printers are able to print accordingly. So it is not necessary for the printers to create individual profiles for their machines.

For a long time ISO 12647 was only known to designated color-management specialists. The collective initiative of FOGRA, bvdm and ECI, supported by Adobe and proofing vendors is to be thanked that powerful tools are meanwhile available for the whole branch, which simplify color management based on ISO 12647 dramatically.

The ISO 12647 is divided into several parts. The most important are
12647-1: terms and definitions
12647-2: offset printing
12647-3: newspaper printing
12647-7: digital proofing

The North American specifications GRACoL and SWOP are partly compatible with ISO 12647. Further details can be found on page 102.

An overview of the ISO paper types	
1/2	gloss and matt coated
3	LWC (thin rotary offset paper)
4	uncoated
5	uncoated yellowish

Originally, ISO 12647 defined five different types of paper. Over the years there were, however, further developments in the area of matt coated papers so that these could be grouped with gloss coated papers as type 1/2.

An Overview of Tools for ISO 12647 Implementation

The following illustration shows a summary of the tools surrounding ISO 12647, which are available at the time of going to press:

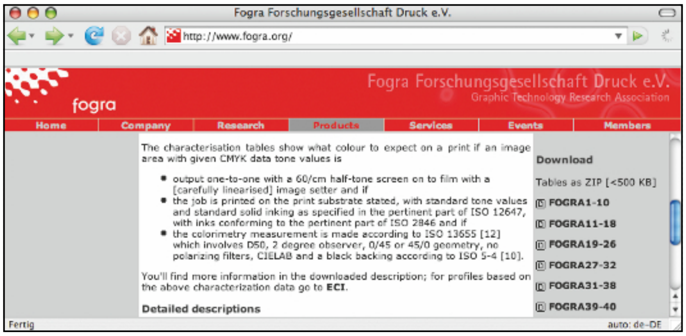
Reference Prints from Altona Test Suite

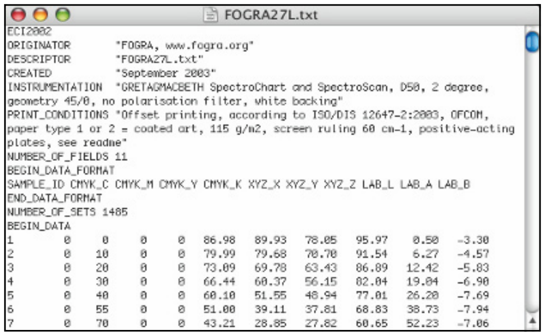
The Altona application kit serves to optimize production processes in prepress and in the printers

Among other things, it comprises reference prints that have been printed in exact accordance with ISO 12647. It can be obtained from ***www.altonatestsuite.de.***

Characterization Data from FOGRA

At ***www.fogra.org*** *FOGRA offers free characterization data based on the Altona Test Suite*





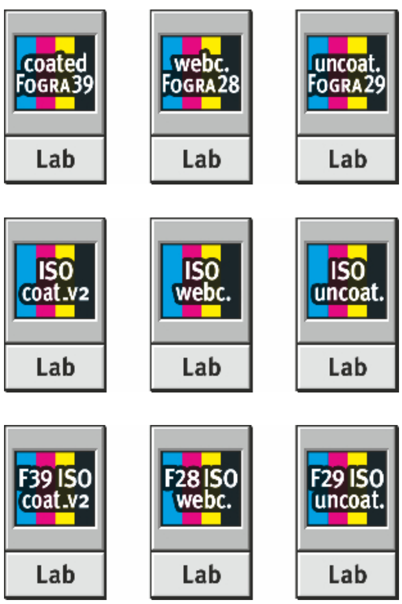
FOGRA27L.txt

```
ECI2002
ORIGINATOR        "FOGRA, www.fogra.org"
DESCRIPTOR        "FOGRA27L.txt"
CREATED           "September 2003"
INSTRUMENTATION   "GRETAGMACBETH SpectroChart and SpectroScan, D50, 2 degree,
geometry 45/0, no polarisation filter, white backing"
PRINT_CONDITIONS "Offset printing, according to ISO/DIS 12647-2:2003, OFCOM,
paper type 1 or 2 = coated art, 115 g/m2, screen ruling 60 cm-1, positive-acting
plates, see readme"
NUMBER_OF_FIELDS 11
BEGIN_DATA_FORMAT
SAMPLE_ID CMYK_C CMYK_M CMYK_Y CMYK_K XYZ_X XYZ_Y XYZ_Z LAB_L LAB_A LAB_B
END_DATA_FORMAT
NUMBER_OF_SETS 1485
BEGIN_DATA
1    0    0    0    0   86.98   89.93   78.05   95.97    0.50   -3.30
2    0   10    0    0   79.99   79.68   70.70   91.54    6.27   -4.57
3    0   20    0    0   73.09   69.78   63.43   86.89   12.42   -5.83
4    0   30    0    0   66.44   60.37   56.15   82.04   19.04   -6.90
5    0   40    0    0   60.10   51.55   48.94   77.01   26.20   -7.69
6    0   55    0    0   51.00   39.11   37.81   68.83   38.73   -7.94
7    0   70    0    0   43.21   28.85   27.82   60.65   52.23   -7.06
```

Adobe Profiles
The Adobe profile names refer directly to the characterization data that they represent

ECI Profiles
The ECI profile names include the term ISO to show the link to ISO 12647

Generic Symbols
These symbols appear in the book wherever Adobe or ECI profiles can be used

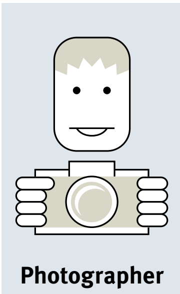


The Ugra/FOGRA Media Wedge CMYK

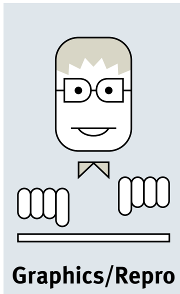
The media wedge CMYK serves the control of the digital proof with a spectrophotometer. It has become an integral part of more and more proofing systems, so it needn't be obtained separately. The target values for the proof are based on FOGRA characterization data and so are in accordance with the ISO profiles from the ECI.

Profiles from Adobe and ECI in the Production Process

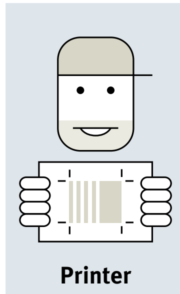
The profiles from Adobe or ECI are used in prepress. Before the finished document is composed for print it is important to clarify with the printers which type of paper will be printed. RGB image data is then separated with the correct Adobe/ECI profile for the type of paper. The same Adobe/ECI profile is used for the soft proof on the monitor to give a correct preview of the final result. Once the PDF data is created for print, the same profile is used for the proof for the printers. The proof contains a control bar in which the Adobe/ECI profile shows which color space is being simulated. The media wedge CMYK allows for a control of the proof at any time.



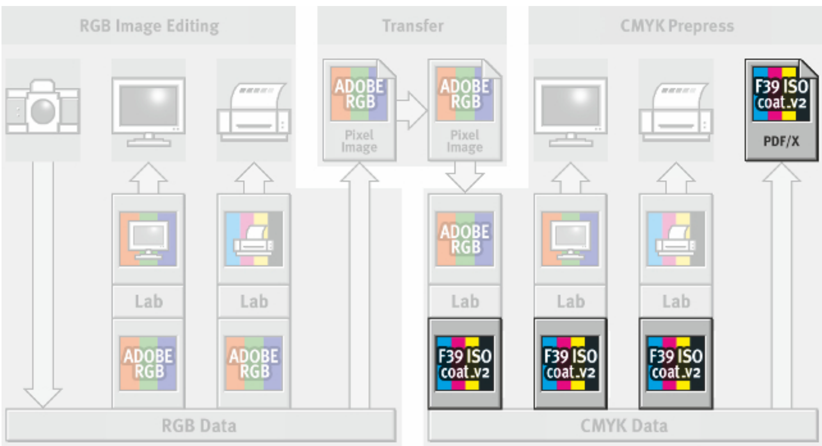
The photographer needn't be concerned with the color space of the print, but needs to be sure to embed the profile for his working RGB color space in his image files.

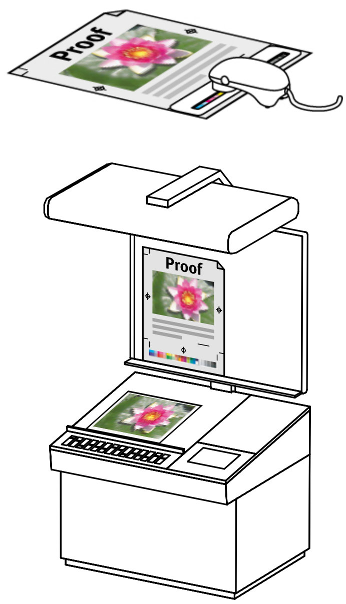


The Adobe/ECI profile is applied in prepress: in the separation, soft proof and digital proof (which includes an identification of the ISO standard and the media wedge CMYK).



The printer checks the incoming PDF data and measures the media wedge CMYK on the proof. Afterwards, he adjusts the print to match the proof.





In application programs for quality control in production and in thematic publications the following descriptions of ISO paper type, the numbers of the FOGRA characterization data or the names of ECI profiles are used alternately.

ISO paper type	**FOGRA-char. data**	**ICC profiles from the ECI**	**ICC profiles from Adobe (internal name shown in CS applications)**
1/2 – gloss and matt coated	FOGRA39	ISOcoated_v2_eci.icc ISOcoated_v2_300_eci.icc	Coated FOGRA39 ISO 12647-2
3 – LWC (thin rotary offset paper)	FOGRA28	ISOwebcoated.icc	Webcoated FOGRA28 ISO 12647-2
4 – uncoated	FOGRA29	ISOuncoated.icc	Uncoated FOGRA29 ISO 12647-2
5 – uncoated yellowish	FOGRA30	ISOuncoatedyelloish.icc	

The Media Wedge CMYK in the Production Process

The most important step for effective color management is the communication between prepress and printers about the proof standard of a print production. Efficient and safe work is only possible when a proof of the print data in prepress and a proof at the printers display the same results. Before the media wedge can be used to control the proof, the production manager at the agency and the customer advisor at the printers need to have agreed to work with proofs based on the Adobe/ECI profiles. If this is the case, then the Ugra/FOGRA media wedge CMYK serves both in prepress and the printers as a control for the proof.

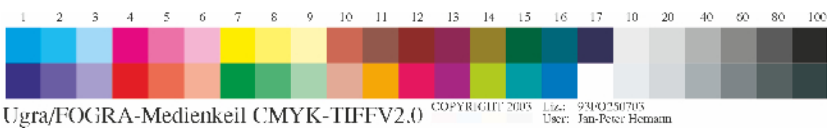
Color tolerances for the media wedge CMYK	Delta E Lab
Paper white Delta E	3
Mean difference Delta E	3
Max. difference Delta E	6
Primary colors Delta E	5
Primary colors Delta h	2.5
Primary colors Delta h	1.5

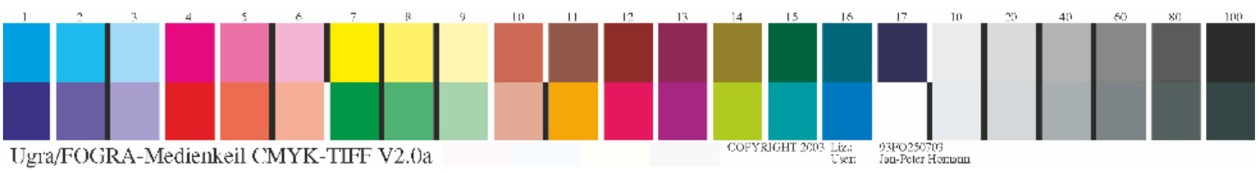
For the control, the media wedge on the proof is measured with a spectrophotometer. The measurement results are then compared in four categories with the parameters for the type of paper according to ISO 12647. For each of these categories there are different color tolerances, which are based on the ISO 12647-7.

With practically all current proofing solutions the media wedge CMYK can be output automatically for the final print. It is now an integral part of more and more proofing systems, so the user does not need to additionally obtain it.
For the evaluation of the media wedge there are a number of providers that automatically output the measurement result on a label printer. With a scanning spectrophotometer, the whole process, including printing the label, lasts about two minutes.
If the label is then attached to the proof, this will prevent an inaccurate proof being used on the printers presses. The reception control of incoming proofs is one of the most important stages if the printer wants to avoid unnecessary adjustment time on the printing machine and avoid reclamation where color is concerned.
The individually controlled and labeled proof is the safest method, if the prepress service wants to ensure that its proofs correspond contractually with the industry guidelines from FOGRA and other organizations.

The Ugra/FOGRA media wedge CMYK is available in various formats. With the smaller version, the fields are measured individually.

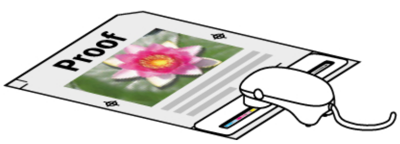
The larger version can be measured in one go with a scanning spectrophotometer.





The control of a proof can occur in prepress before the proof is delivered, as well as at the printers who receive proofs from various external sources.

Prepress



Printers

The Application of the Altona Test Suite

The application kit Altona Test Suite is one of the most important tools for optimizing production processes in prepress and at the printers. It consists of the three files Measure, Visual and Technical along with a set of reference prints for ISO 12647.

The Altona application kit contains reference prints for ISO 12647, which are compatible to Adobe/ECI profiles and proof control with the media wedge CMYK.

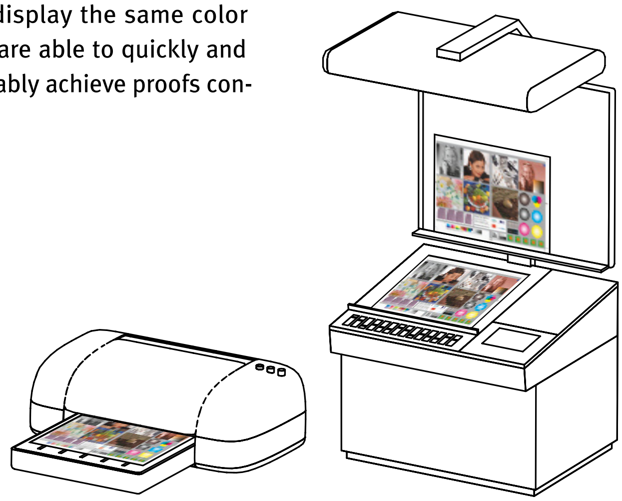
The Files Visual and Technical

With the files Visual and Technical all software can be tested in which PDF files are imported or further processed during the production of printed matter. In particular, graphic and layout programs, color printers, proofing systems, PDF workflow systems at the printers as well as RIPs from imagesetters.

The Reference Prints for the File Visual

The reference prints Visual serve the visual control of monitors, proofing systems and printing machines, when production corresponds to ISO 12647. In prepress, the color management with the Adobe/ECI profiles is functioning correctly when the monitor and proofing systems display the same color reproduction as the reference prints. If the printers are able to quickly and reliably reprint the reference prints, then they can reliably achieve proofs controlled with the media wedge CMYK.

If the monitor and proofing system display the same color reproduction as the Altona reference prints, then color management in prepress is set up correctly.

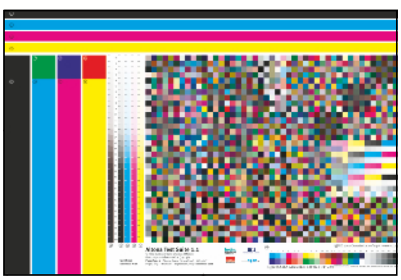


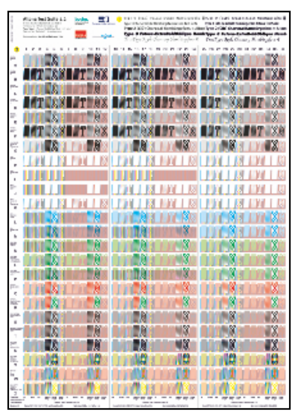
If the printers can reprint the Altona reference prints well, then they can achieve proofs that match the reference prints.

The File Measure including Reference Print

In this file, test charts are present for the inclusion of printing characteristics and for creating ICC profiles. Large fields in the Measure reference prints display CMYK full-tones with optimal coloration in accordance with ISO 12647.

From left to right: The Altona files Measure, Visual and Technical





The Color Reproduction of Different ISO Paper Types

Each paper type has its own characteristics when it comes to color reproduction. This concerns the intensity of the color reproduction as well as the paper's coloration. The highest intensity of color can be achieved on paper type 1/2 for gloss and matt coated paper. On paper type 3 LWC, the intensity of color is somewhat diminished and on paper types 4 and 5 the color reproduction is weaker still.

Furthermore, different paper colorations are predefined for the ISO paper types. Type 1/2 (coated) and type 4 (uncoated) are cold-white papers. Type 3 (LWC) particularly type 5 (uncoated yellowish) are considerably more yellow. The paper coloration has an influence on the reproduction of all colors and can only be partly compensated for with color management. The illustrations below show the reference prints from the Altona application kit. Before printing, the color photos were adjusted with the ECI-ISO profiles for the respective paper type. Hence, these prints display the possibilities as well as the limits of color management. The print on the uncoated papers of types 4 and 5 shows, even with color management, slightly paler colors. Please refer to page 101 for the history of FOGRA39 and its predecessor FOGRA27.

The color depiction on the reference prints from the Altona application kit

The photographic illustrations (except for the grayscale image) have been adjusted with color management for the respective paper type.

Paper type 1/2 coated – ISOcoated, FOGRA27

Paper type 3 LWC – ISOwebcoated, FOGRA28

Paper type 4 – ISOuncoated, FOGRA29

Paper type 5 uncoated yellowish – ISOuncoated yellowish, FOGRA30

Ink-layer and Solid Densities

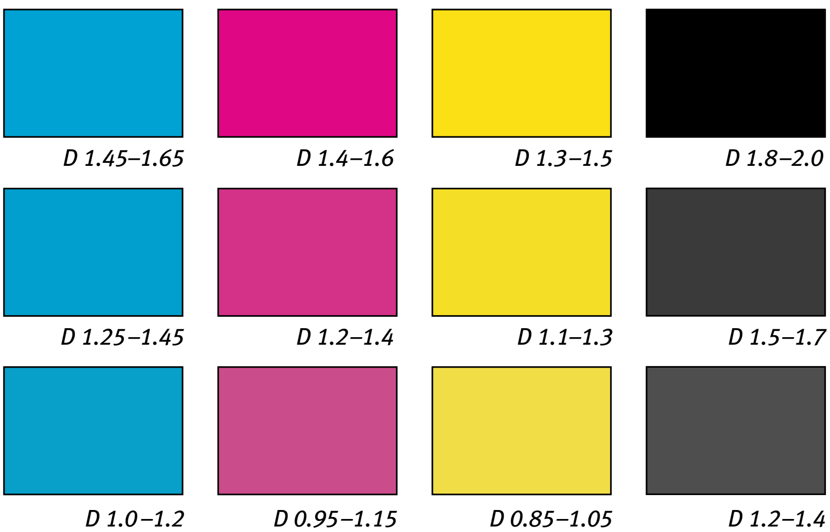
An important factor for color reproduction in offset printing is the ink-layer thickness. When the printer adjusts the colors at the start of a print contract to match the print of a proof, he does this mainly through the control of the ink-layer thickness.
A direct measurement of the ink-layer thickness is only possible under laboratory conditions. However, a good quality indicator is the thickness measured by a densitometer. The thickness of the pure printing colors (solids) is also known as the solid density. For the density measurement, a color field is illuminated and the relationship of the reflected light to the illumination is determined. The more light absorbed by the color sample, the higher its density. A lot of color in the print (high ink-layer thickness) produces a high density. Coated papers can be printed with higher ink-layer and solid densities than uncoated paper.

The printing color forms a layer on coated paper. High layer and solid densities can be achieved.

The printing color penetrates uncoated paper deeper.

Because offset printing uses a mixture of ink and water, the printing process is subject to unavoidable fluctuations. These are a result of the interaction between paper, printing color, water, additives, climatization, condition of machinery, etc. There are fluctuations within the respective print contract and differences between various print contracts. The latter are greater because a different color behavior is produced in the printing process depending on the paper used. Even at high-tech printers who, with great effort, maintain their printing processes consistently, the fluctuations are by far greater than with a proofing system that is regularly calibrated spectrophotometrically. The printer at the machine needs to compensate for these fluctuations so that his result matches that of the provided proof. He achieves this by slightly varying the ink-layer thickness (solid density) for each individual printing color.
For this reason, among others, there are no explicit target values in ISO 12647 for the solid density of individual paper types. The examples below illustrate different solid densities with which, as a rule, good matches to the proof can be achieved. Please note there are different regional methods (Status and Filter) for measuring densities. This leads to different values for the same samples.

Typical Densities (Status E, Polarization Filter) for Different Paper Types

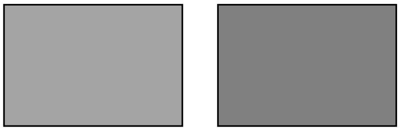


The basic colors on coated paper and the usual solid densities

The basic colors on uncoated paper and the usual solid densities

The basic colors on news print and the usual solid densities

Dot Gain / TVI of Paper Types



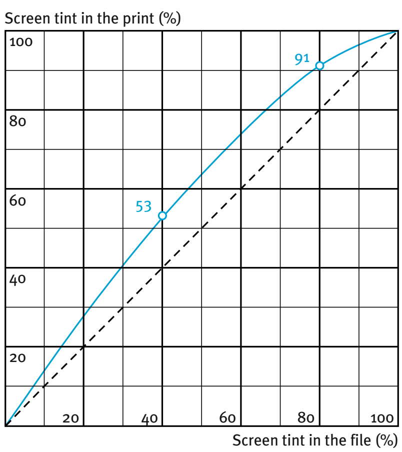
40% area coverage in the file (left) with a 16% dot gain results in 56% area coverage in print (right)

Next to the solid density, the dot gain is the second important factor that influences the color reproduction in print. The dot gain (also named Tonal Value Increase – TVI) specifies how much higher the area coverage is on the paper compared to the file. A 40% raster, for example, covers 40% of the surface with raster dots and leaves 60% free. With a dot gain of 16% the screen tint on the paper then covers 56% and leaves 44% free. The tone value has thus become darker. Dot gain can be described in different ways. Declared as a single figure, the gain for a tone of 50% is mostly specified internationally. In German-speaking countries it is often usual to specify the gain separately for the tone values 40% and 80%.

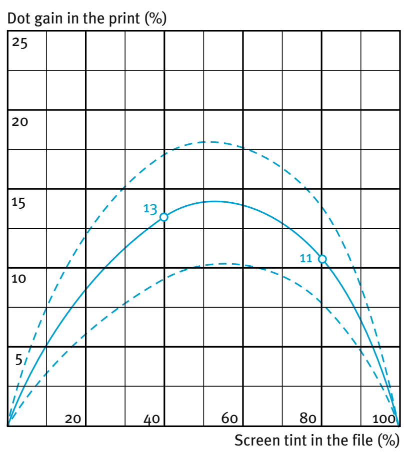
In actual print the dot gain is not only dependent on the paper, but also on the printing ink used, the manner in which the printing plates are produced and a great many other technical parameters. For this reason we speak not of dot gain in the printing machine, rather dot gain in the whole printing process, comprising machine, paper, color and further technical parameters.

The printers' role is to control its printing process and to ensure that the dot gain for printing on different types of paper remains within the limits predefined by ISO 12647. Only if it does this can it match a contract proof based on the Adobe/ECI profiles. Minor fluctuations in dot gain within these limits, however, are unavoidable in offset printing.
If the printer sets up a printing press to match a contract proof, then he can compensate for the unavoidable minor fluctuations in dot gain by printing a higher solid density for a dot gain that is too low, or a lower solid density for a dot gain too high.

The measurement of the dot gain is made with the densitometer. First, the measuring device is adjusted for the paper white, then the solid density is measured and then a rastered tone of, for example, 40% or 80%.



left:
The dashed black line shows the tonal values in the file, the blue line shows the tonal values of an ideal print on paper type 1/2, coated. The difference is the respective dot gain.



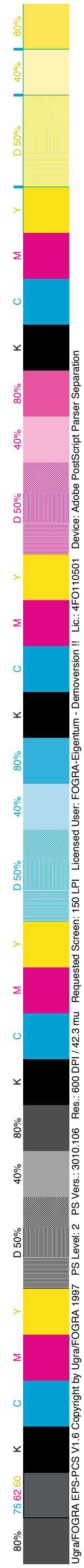
right:
The blue line shows the dot gain of an ideal print on paper type 1/2, coated. The dashed blue area is the range of tolerance according to ISO 12647-2.

Dot Gain / TVI of Paper Types According to ISO 12647-2

Because dot gain is dependent on a number of parameters, ideal dot gains and tolerances of ± 4% are predefined in ISO 12647-2 in the mid-tones. Generally, the rule applies that the dot gain of the colors cyan, magenta and yellow should be the same and black in the mid-tone should be 3% above the chromatic colors. The maximum spread further indicates that the dot gain of the different colors should not differ by more than 5%.

The Adobe/ECI profiles represent prints with ideal tonal value curves in accordance with ISO 12647-2. This ensures that a proof based on the Adobe/ECI profile can be achieved by the printers, if they control their dot gains in compliance with ISO 12647.

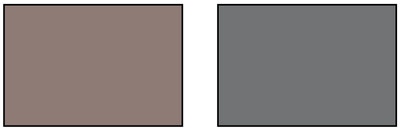
So that the printers can control their dot gains during production, a control wedge (an example is pictured right) is printed on every printed sheet. Should there be large deviations between the proof based on the ISO profile and the final run, the print control strips can be checked later to determine if the solid densities and dot gains lie within the tolerances of ISO 12647-2. Minor deviations between the contract proof and final run, however, are generally unavoidable.



The arrangement of production printing papers into three dot gain classes and the corresponding Adobe/ECI profiles

Type 1/2	**Type 3**	**Type 4/5**	
coated papers with a square measure of 70 g/m²	coated papers with a square measure under 70 g/m²	uncoated papers (including pigmented and calendered papers)	
Dot gain CMY in print (in %) with tolerance limits for 40% and 80%			**Tonal value F_R in the file**
9 – **13** – 17	12 – **16** – 20	15 – **19** – 23	40%
14	**17**	**20**	50%
15	**15**	**16**	70%
14	**13**	**14**	75%
8 – **11** – 14	8 – **11** – 14	9 – **12** – 15	80%

The Gray Balance



On the left is the brown tone that is made up of 50% cyan, magenta and yellow, respectively

In comparison, on the right, a neutral gray tone consisting of 62% cyan, and 50% of both magenta and yellow

The Gray Balance in the Print

The gray balance in the print denotes a well-balanced ratio of the print colors cyan, magenta and yellow, by which, in the combined printing of these colors, a neutral gray tone is produced. When printing in accordance with ISO 12647-2 this neutral gray is not produced with equal parts of each printing color. A neutral-appearing gray tone is only produced when cyan has a considerably larger percentage than magenta and yellow. The ISO norm itself has neither explicit target values nor tolerances for the gray balance. If the printers print, with regard to full-tone coloration and dot gains, in accordance to ISO then the gray balance adjusts itself. Furthermore, every FOGRA characterization data set has a predefined gray balance at its disposal, so that a defined gray balance is produced in print when adjusted in accordance with a proof based on FOGRA characterization data or Adobe/ECI profiles.

The Gray Balance in the Proof Print

The FOGRA characterization data clearly define the gray balance. Before the introduction of FOGRA characterization data there were many different proof standards, which could by all means differ to the FOGRA reference in their gray balance. For this reason a proof, based on the ISO proof standard, of older CMYK print data can differ from older proofs or prints.

Because the ISO paper types are based on different paper colorations, the gray balances in the FOGRA characterization data sets are not absolutely identical. Looking closer at the media wedge CMYK we see, on the far right, fields that, at the top, are built up with pure black and, below, with cyan, magenta and yellow. Like all the other fields in the media wedge CMYK, these CMY fields also emanate from the test chart ISO 12642. These CMY fields are not so constructed that they produce a perfect visual match to the fields of pure black in offset printing. If, for example, the darker CMY fields appear greener than those of pure black on a proof according to FOGRA39/ISOocatedv2, then this is correct.

The CMY fields on the media wedge CMYK appear bottom right. Depending on the ISO profile, they do not produce an exact match to the fields of pure black above them. This is particularly true of the darker CMY fields that, on a correct proof, appear slightly greener.

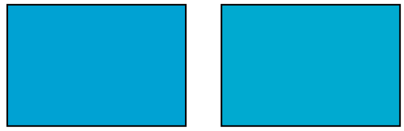
If the separation of RGB images occurs with an ECI-ISO profile, then the gray balance of the CMYK print data matches as best as possible a proof based on ECI-ISO profiles.

The Gray Balance in Reproduction

The prepress, in the reproduction of images, has to take into consideration the unequal ratio of the printing colors. Neutral gray tones in artwork to be scanned or in an RGB image should also appear neutral on the later proof. If a proof is made based on ECI-ISO profiles, then a correct gray balance can be produced in reproduction when separation occurs with ECI-ISO profiles. Print data, which has not been separated with ECI-ISO profiles, sometimes require a correction, so that they display the same gray balance on an ISO proof as on the earlier proofs or prints.

The Lab Coloration of Solids in ISO 12647

When the printer adjusts a print job to a proof, he controls the solid densities and dot gains with a densitometer. Thus, the densitometric measurement is the printer's best tool for control during the adjustment of a print to a proof. There are, however, cases where the colorimetric measurement of solids is more sensible. These are then cases when not only the ink-layer thickness, but also the full-tone's chromaticity co-ordinate is of importance. For example, it could very well be the case that a rather bluish cyan or rather greenish cyan have the same thickness in the measurement with a densitometer, although the color impressions of both colors differ from each other.



Although both these cyan tones are densitometrically no different, their coloration is. This only becomes apparent with a colorimetric measurement in the Lab color space.

If solids on a proof and a dried print are to be compared with each other then the rule is, in accordance ISO 12647, that a colorimetric measurement is to be made. A purely densitometric measurement from a proof does not allow for an unequivocal comparison of the colors on a print and proof.

The colorimetric measurement of solids is also necessary for test prints in the printers, when the whole printing process is optimized to come as close as possible to the ideal parameters of ISO 12647. Only in this way can it be controlled if the applied printing color matches as well as is possible to the ISO 12647 in its chromaticity (Lab) values.

Lab Measurements of Solids in the Context of Assessment

For many printers, the Lab measurement of solids has a scientific character that has nothing to do their normal practice. It should be borne in mind that an assessor, in the case of a dispute between the printer and client, colorimetrically evaluates the proof as well as the control strips on the printed sheet. For the printer to be on the safe side, it is determined with test prints which solid densities of the basic colors in print show the best match to the Lab parameters in ISO 12647. These are then the standard ink-film weights, or densities to use to match the standard

Paper type	**1/2**			**3**			**4**			**5**		
Color values for black bases												
	L*	**a***	**b***	**L***	**a***	**b***	**L***	**a***	**b***	**L***	**a***	**b***
Black	16	0	0	20	0	0	31	1	1	31	1	2
Cyan	54	–36	–49	55	–36	–44	58	–25	–43	59	–27	–36
Magenta	46	72	–5	46	70	–3	54	58	–2	52	57	2
Yellow	88	–6	90	84	–5	88	86	–4	75	86	–3	77
Color values for white bases												
Black	16	0	0	20	0	0	31	1	1	31	1	3
Cyan	55	–37	–50	58	–38	–44	60	–26	–44	60	–28	–36
Magenta	48	74	–3	49	75	0	56	61	–1	54	60	4
Yellow	91	–5	93	89	–4	94	89	–4	78	89	–3	81

The Lab target values in ISO 12647 apply in particular for the measurement by assessors and the printer's internal test prints to determine the optimal solid densities.

In practice the OK sheet can deviate from the parameters as far as Delta E 5. The black base applies to measurements of objects with a printed reverse side and the white base applies to single-sided objects and proofs.

The Offset Printing Process Standard provides details for measurements for assessors.

Guidelines, Manuals and Brochures Referring to ISO 12647

There are various organizations who have composed manuals and guidelines based on ISO 12647 for the print production. Some are only available to their members, while others are freely available. Also, more and more vendors are offering brochures about the implementation of ISO standards in their products. Some material is listed on this page.

ProcessStandard Offset Printing (German: ProzessStandard Offsetdruck)
The "ProzessStandard Offsetdruck" is the reference in Germany for the implementation of ISO 12647, from prepress to print. There are many comprehensive sections dealing with the quality control for proof and print. All German assessors for print production operate on the basis of this work. Distribution is carried out by the Regional Printing and Media Industries Federations as well as FOGRA for their members. An English version is planned for late 2008.

Documentation for the Altona Test Suite Application Kit
In the documentation for the Altona Test Suite application kit, which is available to everyone, comprehensive excerpts from the "ProzessStandard Offsetdruck" are provided. Apart from these, the details on creating and controlling reference prints are particularly useful for printers.

MediaStandard Print (German: MedienStandard Druck)
The "MediaStandard Print" is compiled from excerpts from the "ProcessStandard Offset Printing" that pertain to prepress and the proof. It is freely available via download from **www.bvdm-online.de**. Proofs based on ECI profiles with the media wedge CMYK are in Germany also often described as proofs according to MediaStandard Print. Going to press the Version 2006 is valid. An update may come in late 2008.

Pic4Press and Proof4Press
These guidelines for the UK magazine production are based on ISO 12647 and refer to ECI profiles for the seperation of images and proofing standards. They can be downloaded from **www.ppa.co.uk**.

Heidelberg Brochure "Standardization in Offset Printing"
This brochure explains the implementation of ISO 12647 with Heidelberg Prinect Color Solutions. It can be downloaded free from **www.heidelberg.com**.

"ProzessStandard Offsetdruck" (top), Altona Test Suite (centre) and "MediaStandard Print" (bottom)

Pic4Press (left) and the Heidelberg brochure (right)

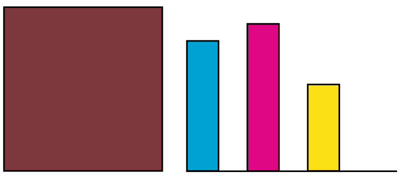
Standards in Reproduction

Because the same digital CMYK image is reproduced differently on different papers, prepress tries to compensate for this variation as best as possible. For this, the later dot gain is taken into consideration when scanning, likewise the color separation is adjusted to the different papers. In a color-management system, the profile for the printing standard alone determines all parameters of the separation.

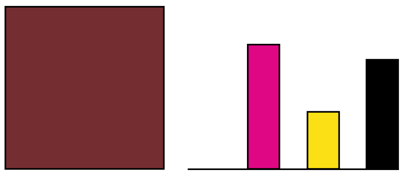
In separation, the relationship of black to the other three colors cyan, magenta and yellow, plays a deciding role. The same Lab-color tone can be reproduced on the same paper with different CMYK-values.

Because cyan, magenta and yellow in certain proportions combine as neutral color tones, they can be replaced in mixed colors to an extent with black. By replacing the cyan, magenta and yellow, the mixed color's total inking sinks.

By separation with a profile for a printing standard controls this profile the black generation according the paper type in printing.



A brown from 80% cyan, 90% magenta und 60% yellow gives a total inking of 230%.

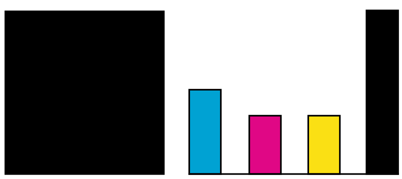


A brown from 77% magenta, 47% yellow and 62% black gives a total inking of 186%.

With uncoated paper, the printing ink soaks in. The total inking should therefore be kept as low as possible.

This process is ideal for uncoated paper and newsprint. Because papers of this class soak up the printing inks strongly, the filling-in of the darker areas in the motif is counteracted.

A pure black with 100% total inking



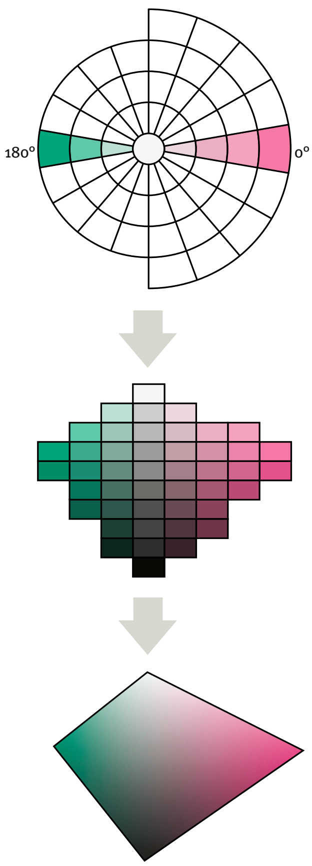
A black from 47% cyan, 33% magenta, 33% yellow and 100% black gives a total inking of 213%.

On coated paper the printing inks form a layer. To achieve a maximum contrast, high total inkings are worked with.

The counter process is the additional use of black in the dark, neutral areas of the motif, to achieve an increase in contrast with a fuller black. This process is used with good, coated papers that hardly soak up the printing inks and so allow for a greater total inking.

TAC and Black Generation

For better orientation, we have illustrated here once again the steps that lead to the sections through the LCH-color space from 0° to 180°. The only difference in the graphics to the previous ones is the highlighted segmentation.



Total inking is also referred to as TAC (total area coverage). The area coverage of each color in the darkest area of the motif is added together. The darkest tone in a CMYK image for newsprint in rotary offset printing has, for example, a TAC of only 240%. On art paper, an area coverage from 330% to 370% can be worked with, providing the scans are optimized for the image and print process by a repro professional. As opposed to print, there are no ISO references for the standardization of separation. The suggestions for separation in this book are only points of reference, gathered from ECI recommendations, personal experience, discussions with repro professionals and printers and also specialist literature.

Basic Concepts of the Black Generation

Black generation describes the method with which the black separation from Lab or RGB images is calculated in the conversion to CMYK. For a long time this process was the best kept secret of the manufacturers of drum scanners. Today, with the emergence of standard programmes such as Photoshop and color-management tools, low-cost solutions for color separation on the computer are available. Unfortunately, these tools often offer differing possibilities of usage and function, for similar processes, different terms. Consequently, the following technical terms are not to be found exactly in all programs.

A Summary of Terms for Black Generation

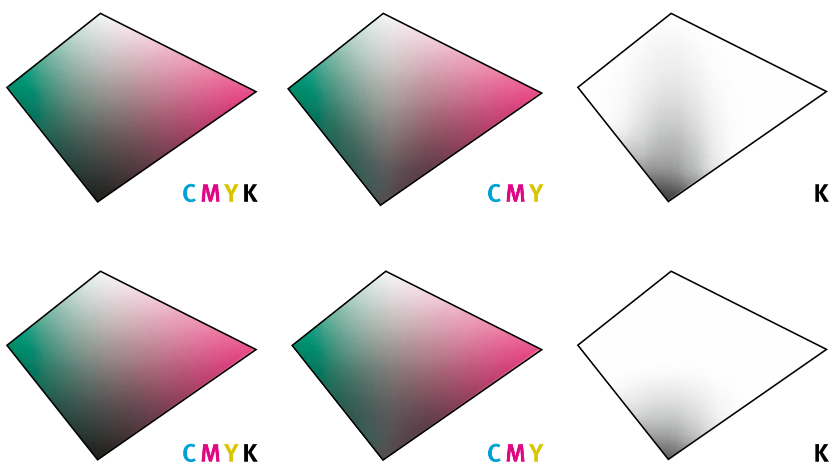
Long and Short Black

The length of the black indicates in which areas of lightness in the image the colors cyan, magenta and yellow are replaced or supplemented by black. A short black effects only the dark areas of the image, whereas a long black extends along the whole lightness axis.

The illustration on the right shows sections of the LCH-color space with different black generations:

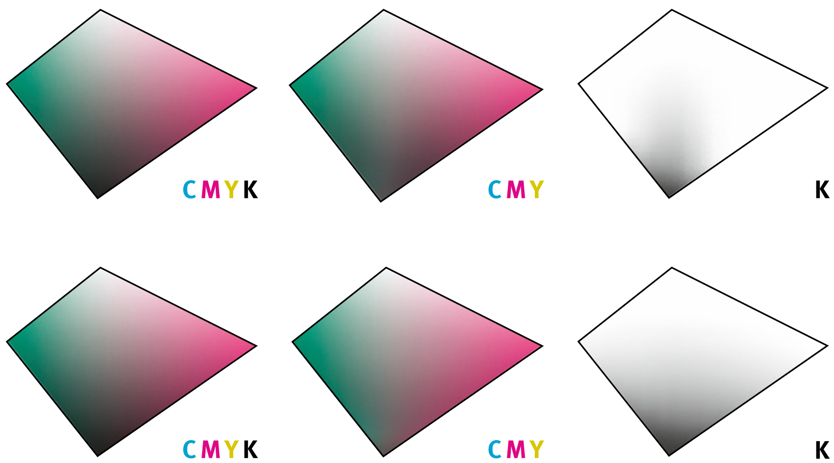
The top row demonstrates a long black, the bottom row a short one.

The combined print can be seen on the left, in the centre the chromatic colors and on the right the black.



Wide and Narrow Black

The width of the black describes to which degree the black replaces the colors cyan, magenta and yellow in the saturated areas. A narrow black only replaces the CMY-color values in the neutral areas. A wide black also effects the saturated areas. A wide black allows for a maximum reduction of the total inking, e.g. for newsprint. There is, however, the danger that the colors “gray-out”, which can have a negative effect, particularly in skin tones.



The top row in this illustration has been printed with a narrow black, as opposed to the bottom row with a wide one.

On the left the combined print can be seen, in the center the chromatic colors only and on the right the black separation.

In practice, many repro professionals prefer to work with a long, narrow black. In reproduction and printing this makes for a whole list of advantages:

Reliable Gray Balance in Print

Even if the full-tone densities for cyan, magenta and yellow fluctuate slightly in the edition print, the neutral tones in print remain reliable with a long black as they are made up mostly of black.

No “Graying-out” of Skin Tones

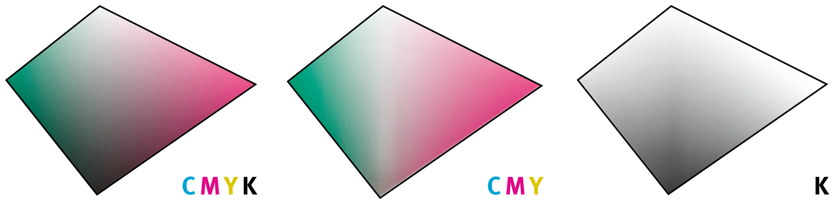
With the narrow black the “graying-out” of skin tones is prevented.

Application in all Paper Classes

Because the highest area coverage lies in the neutral, dark areas of a motif, a long, narrow black can be realized with a different maximum area coverage according to the different paper classes. For very low area coverages under 280%, the width of the black can be increased.

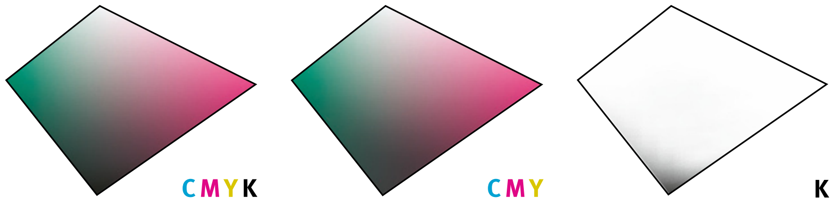
The Relationship of Black to Cyan, Magenta and Yellow

Next to the length and width of the black, its relationship to the other three colors plays an important role in the optimizing of the black generation for different sorts of paper.



The top row shows a long, wide black. In the neutral and unsaturated color tones, the black replaces the CMY portions.

Because black, in order of printing, is printed before cyan, magenta and yellow, this type of black generation is also called Under Color Removal (UCR).



The bottom row shows a short, narrow black that only affects the shadow areas in addition to the CMY portions. This kind of black generation is called Under Color Addition (UCA).

In many programs for controlling the black generation are diagrams that display the build-up of the gray axis with the printing ink black in relationship to the printing inks cyan, magenta and yellow. The following graphics illustrate the different black generations of a gray axis: the top strip shows the combined print of all colors, the middle strip shows black only and the bottom strip the colors CMY only. In the diagrams the tonal value curves for the black and the other three color separations can be seen.

The graphic above shows a black that evolves along the whole gray axis. This is expressed in the diagram on the left as a steep, climbing curve for black. The curves for the colors CMY are somewhat flatter. The tonal values in the strip for CMY are also clearly lighter in combined print than the black separation.

This graphic shows a black that develops gradually while the CMY-color values increase much more rapidly. The color strip of the CMY separations is consequently darker in the light and mid-tones than the black separation.

UCR and GCR

Maximum Black

This indicates how great the maximum area coverage is in the black separation. Because the black generation is important for a rich contrast in the depiction of motifs, the maximum black should, as a rule, lie in the region of 95%.

UCA (Under Color Addition)

This traditional repro term describes the addition of cyan, magenta and yellow in the neutral and dark areas of a motif. In this way, a saturated and good contrasting black is attained.

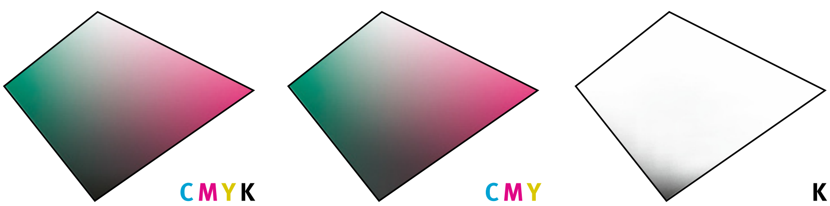
Black generation with UCR and a maximum area coverage of 330%. Because the area coverage lies well above 300%, only a light UCR occurs in the mid-tones, and in the dark tones a light UCA.

UCR (Under Color Removal)

UCR is a traditional repro-term that describes a narrow black. The length of the black is usually calculated by programs automatically. With a low-set area coverage, UCR only replaces cyan, magenta and yellow with black in the areas of neutral color. If the user sets a UCR with a high area coverage well over 300%, then most programs automatically generate an Under Color Addition in the dark areas of the motif.

Skeleton Black (or Ghost Key)

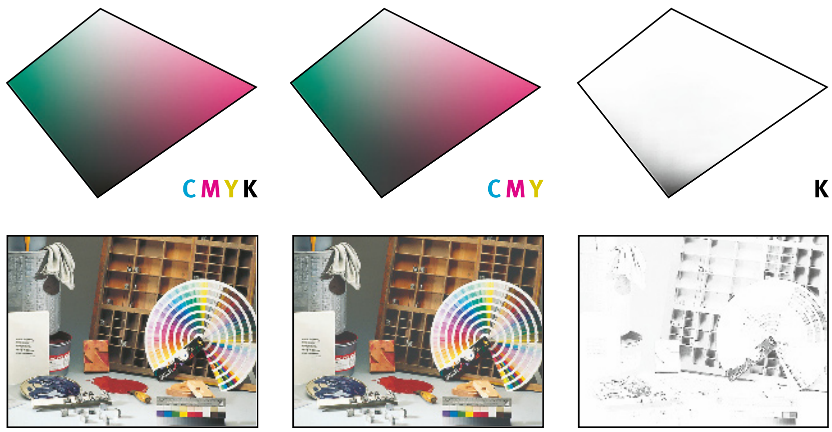
This term is used for a short, narrow black with a high area coverage and Under Color Addition. The black forms a “skeleton” in the dark and neutral areas of the motif to achieve a maximum contrast.



The illustration, left, shows the composition of a print with skeleton black.

UCR and GCR: the Significance of Paper Color

This sequence of images shows a strong GCR with an area coverage of 240%. In the neutral and unsaturated colors, an extensive UCR occurs. This setting is typical for newsprinting.



In this example a weak GCR and a high area coverage (360%) produce a skeleton black.

GCR (Gray Component Replacement)

GCR, also a traditional repro term, is in comparison to UCR a wide black and, thus, also replaces the portions of cyan, magenta and yellow with black in the more saturated colors. Most separation programs have global settings for a strong or weak GCR. A strong GCR is a long, wide black. With a strong GCR and a low area coverage, the highest possible reduction of inking in print can be achieved. This combination is consequently preferred for uncoated paper, particularly newsprint. A strong GCR can, however, also lead to a “graying out” in skin tones if the printer uses more black than intended in the separation program. A weak GCR is often a short and relatively narrow black (see above).

An individual press profile contains all the information about the color behavior of a paper type.

The separation of even yellowish or recycling paper is thereby automatically optimized.

The Significance of Paper Color

If colored paper is printed on then this will naturally influence the color impression of reproduced images. In classical reproduction an experienced scanner operator had to compensate for the paper tone with color adjustments to the scan. Separation with an appropriate ICC profile greatly reduces the time and effort spent on correction and, furthermore, allows a preview of the later printed result during the correction.

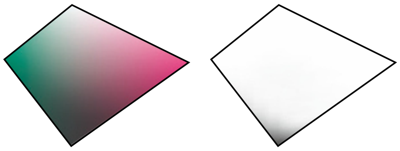

The set of images above is built up with a long, wide black (GCR). In the image on the right, the printer used more black then intended. Due to the GCR, this grayness occurs throughout the whole motif.


This set of images is built up with a long, narrow black (UCR). With too much black in the print (right), the grayness caused by the UCR, occurs mainly in the neutral color tones.


The images above show an RGB scan, which has been separated with individual profiles for a very bluish paper (left) and a very yellowish paper (right).

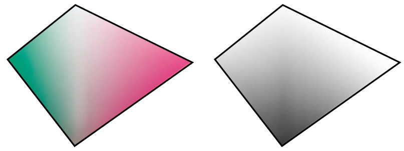
UCR and GCR in Different Programs

In programs for calculating ICC profiles there are, different manufacturers use different terminology, dialogue boxes and calculation processes when referring to the subjects UCR and GCR. Here are a few examples from the programs most prevalent in Germany, PrintOpen and ProfileMaker.

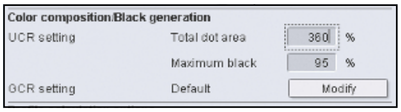


The left column for a short, narrow black with max. area coverage of 360%

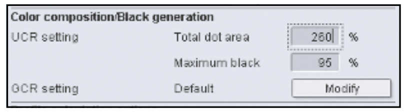
The right column for a strong GCR with a max. area coverage of 260%

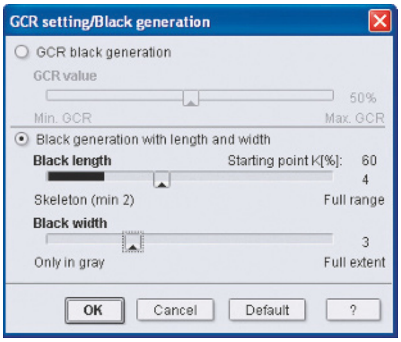


Prinect Profile Editor/PrintOpen from Heidelberg:



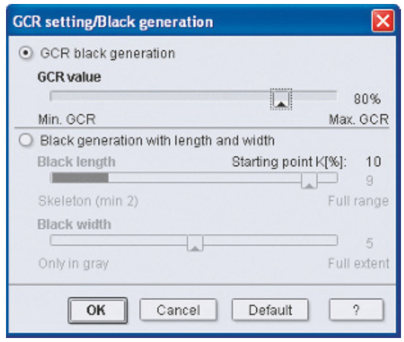
In PrintOpen the user must decide either a UCR or GCR setting





left:
For UCR, the width and length of the black are individually adjustable.
The strength of the CMY replacement with black is predefined.

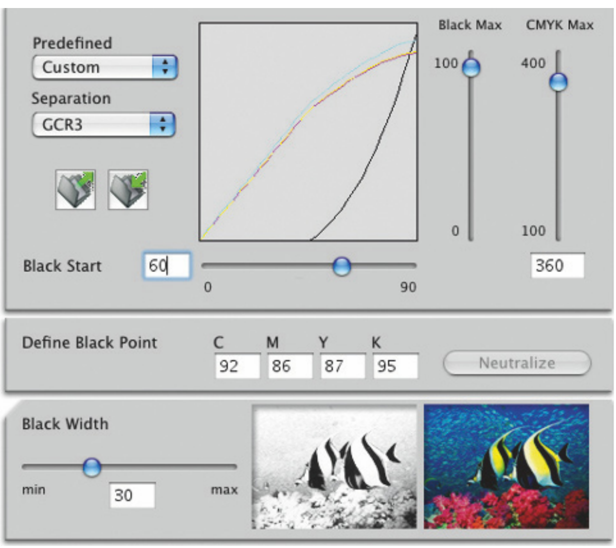
right:
Under the GCR label in PrintOpen, a black with maximum width and length is predefined.
The user can control how strongly the CMY segments are replaced with black.

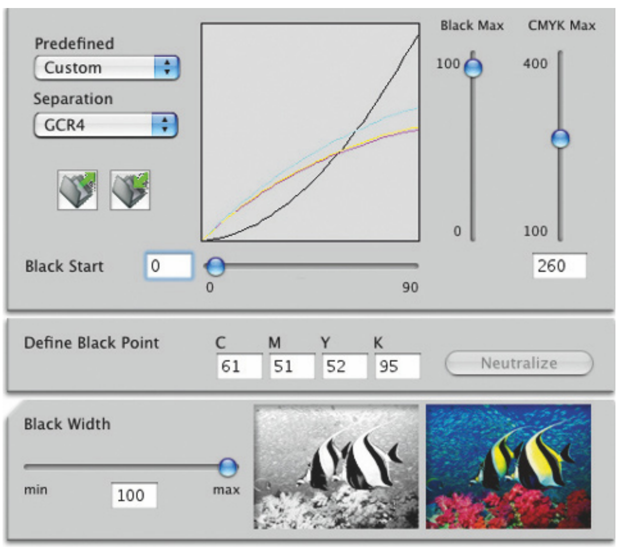


ProfileMaker Pro from X-Rite/GretagMacbeth:

In ProfileMaker the length and width of black and the strength of CMY replacement can be adjusted separately

For the classic GCR setting, you should start very early with black, extend to the full width and select a strong CMY replacement with black under "Separation"

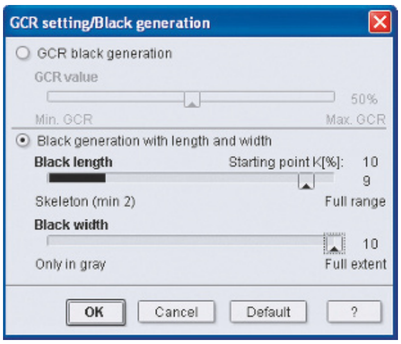


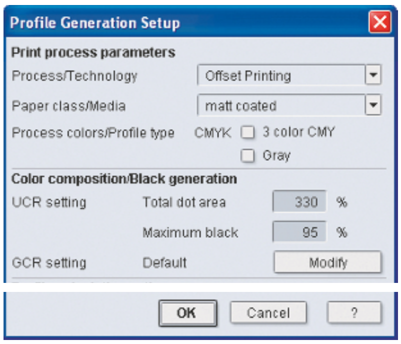


Black Generation in the ECI Profiles

The illustrations on this page show the settings for the black generation in ECI profiles, which have each been generated with the software PrintOpen 4 from Heidelberg. At the time of going to press the current version of the program is version 5, which in the meantime has been renamed "Prinect Profile Toolbox". All the profiles were calculated with a long black. ISOcoated_v2 has a black width of 9 and a max. black of 330%. ISOcoated_v2_300 has a similar black generation but a max. black of 300%. ISOwebcoated and ISOuncoated have a comparable black generation with a black width of 5 (narrow).

Both screenshots show the basic settings in the software. The diagrams below illustrate the separation of neutral colors from white to rich black. The small differences between the chromatic colors are accounted, for the most part, by the characterization data FOGRA27–29, which represent the test prints from the Altona Test Suite.



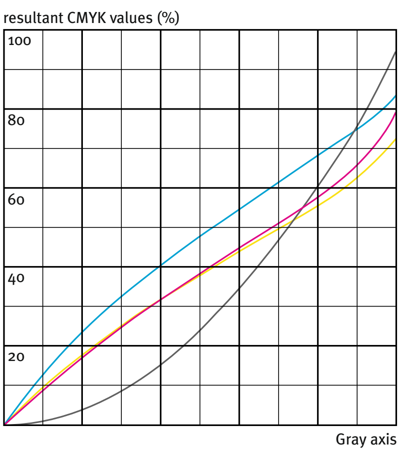


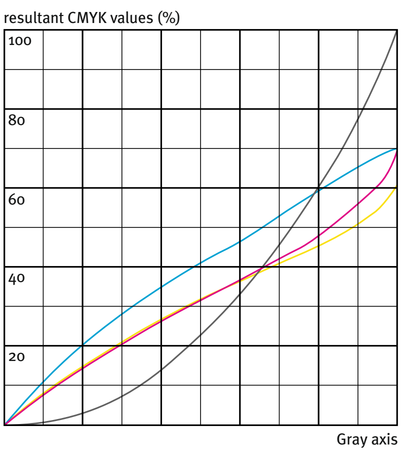
Settings for the black generation of ECI-ISO profiles in PrintOpen

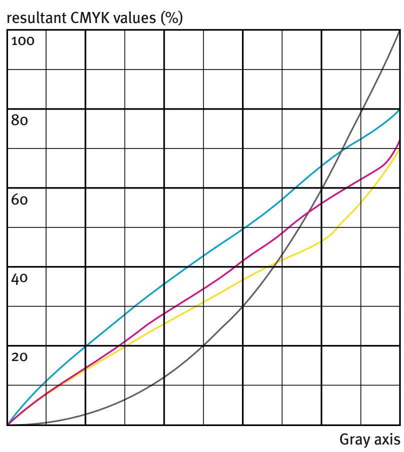
ISOcoated_v2/FOGRA39:
Separation of the gray axis with a maximum area coverage of 350%.

ISOwebcoated/FOGRA28:
The settings for the black generation correspond largely with ISOcoated. Only the maximum area coverage has been reduced to 300%.

ISOuncoated/FOGRA29:
For this and for ISOuncoated yellowish, the same settings apply as for ISOcoated, but with a maximum area coverage of 320%.







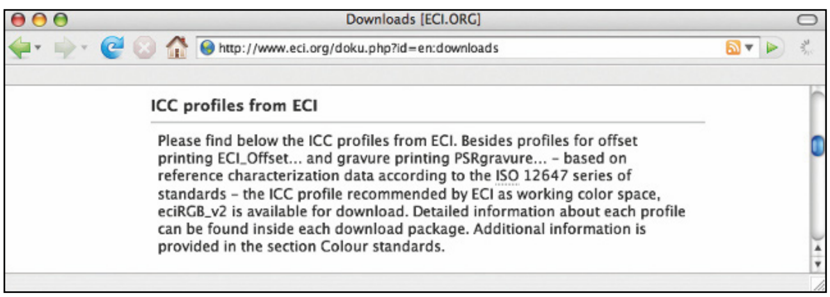
Standard Profiles for Gravure, Continuous Form and Newsprint

Along with the ECI-ISO profiles for offset printing according to ISO 12647-2, there are now also standard profiles for other printing processes and parameters for the media wedge CMYK. Once the operating principle of ECI-ISO profiles for offset printing is understood, then the separation and proof for gravure, continuous or newsprinting no longer remains just a secret kept by repro specialists. The available characterization data and standard profiles are geared to subsections of ISO 12647.

Quality Initiative in Newsprint (QUIZ) According to ISO 12647-3
The organization IFRA runs the QUIZ (Quality Initiative in Newsprint) with many newspaper printers and publishers. Here, test charts are printed according to ISO 12647-3 and characterization data is created. The best results are averaged and made available to users as ISOnewspaper26v4.icc on the website **www.ifra.com.** At the time of going to press, there are no reference prints available.

ProcessStandard Rotogravure (PSR) According to ISO 12647-4
Under the abbreviation PSR, various gravure printers have developed standard profiles together that, at the time of going to press, represent four different paper types. These are LWC paper, which corresponds to type 3 in offset printing, SC paper and upgraded newsprint. The latter two are thin, uncoated papers. At the time of going to press, there are no reference prints available.
The standard profiles
– PSRgravureWC.icc
– PSRgravureLWC.icc,
– PSRgravureSC.icc and
– PSRgravureMF.icc
can be downloaded from the website **www.eci.org.**

Continuous Forms According to ISO 12647-2
Continuous form, or tractor-feed, is a special variation of offset printing, which is mainly used for forms (checks, invoices, etc.). The dot gains are somewhat higher than with sheet-fed or rotary offset, which are represented by ECI-ISO profiles. Reference prints are available in the Altona Test Suite. The standard profiles
– ISOcofcoated.icc und
– ISOcofuncoated.icc
can be downloaded from **www.eci.org.**



*Along with the ECI-ISO profiles for offset printing, profiles for gravure and continuous-form printing can be downloaded from **www.eci.org**.*

For newsprinting there is a link to the QUIZ profiles from IFRA.

The History of FOGRA39

The standard characterization data FOGRA39 and the FOGRA39/ISOcoated_v2 profiles from Adobe/ECI had a predecessor. The FOGRA27 characterization data and the ECI ISOcoated profile are based on the production run of the Altona Test Suite in winter 2003/2004. In the following two years FOGRA, along with several large printers and vendors, such as Heidelberger Printing Machines, made a number of comparisons between ISO conform print runs with FOGRA27.

Averaging the best print runs showed some very slight differences from FOGRA27. For example, the cyan of FOGRA27 was within the ISO 12647-2 tolerances, but on the greenish side. Most available cyan was within the ISO 12647-2 tolerances but on the bluish side.

Also, the ISO technical committee 130, which maintains the ISO 12647 standards, carried out some international research on the secondary colors in ISO conform print runs, which showed that the ISO standard itself needed some slight enhancements. This led, in 2006, to a so-called ammendment to ISO 12647-2.

Proofing the same images, both with FOGRA27/ISOcoated and FOGRA39/ISOcoated_v2 led to very similar results, as can be seen in the images at the foot of this page. Small differences are in the bluish area, where FOGRA39 is slightly more reddish/violet. So, the update from FOGRA27 to FOGRA39 is a detail optimization of an established working method.

Conversions from FOGRA27/ISOcoated to FOGRA39/ISOcoated_v2 are often not necessary. However, where they are necessary, they should be made with DeviceLink profiles, as described in Chapter 6.

Proof according to FOGRA27/ISOcoated

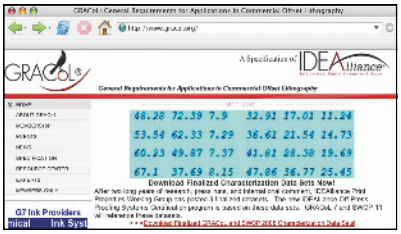
Proof according to FOGRA39

The Latest from the USA: GRACoL, SWOP and G7

At the time of this third edition going to press, the American market in regard to standards for separation, proof and print is gathering a lot of momentum. In some points there are very similar developments to the implementations of ISO 12647 in Germany and Europe, in others very different trends are emerging.

The Organizations GRACoL, SWOP and IDEAlliance

The best-known abbreviation in the USA is SWOP for Standard Web Offset Printing. SWOP is an organization of industry enterprises concerned with specifications for data, proof and print control for weboffset printing. GRACoL stands for General Requirement for Applications in Commercial offset Lithography. These are mainly guidelines and specifications for data, proofs and print control in sheet-fed offset printing. The IDEAlliance is an umbrella organization under which the further development of SWOP and GRACol, among others, is co-ordinated.



*The American characterization data can be freely downloaded at **www.gracol.org***

Standard Characterization Data for Sheet-fed and Weboffset Printing

For a long time there was no standard characterization data in the USA for different paper types. There merely existed the TR001 characterization data for weboffset printing on yellowish paper, on which the SWOP profile is based, which, for example, has been rolled out with Adobe applications since the year 2000. Since October 2006 there are now three different sets of standard characterization data in the USA: one for coated paper, which is predominantly used in sheet-fed offset, and two for paper types mainly used in weboffset printing. The new characterization data is available at **www.gracol.org** as a free download. The following table shows a comparison of the characterization data and profiles from FOGRA/ECI with the American data.

The table shows the FOGRA characterization data and its American equivalents

Paper type according to ISO 12647-2	FOGRA characterization data	ECI profiles	GRACoL/SWOP characterization data
Type 1/2 coated	FOGRA27/39	ISOcoated_v2	GRACoL2006_coated1
Type 3 LWC	FOGRA28	ISOwebcoated	SWOP2006_coated3
			SWOP2006_coated5

The common division of paper types in the USA differs from that in Europe. The key descriptions are grade #1, grade #2, grade #3, etc., where a lower number indicates a higher paper quality. Grade #1, with the corresponding characterization data GRACoL2006_coated1, is equivalent to coated papers in Europe. Grade #3 papers equate to the LWC papers in web offset printing, although the paper white is considerably cooler than in ISO 12647-2 and somewhat cooler than in the FOGRA28 data (which just about equates to ISO 12647-2). The most used LWC papers in weboffset printing worldwide lie, in terms of paper white, in the area of SWOP2006_coated3 data and are less yellowish than FOGRA28 data. Grade #5 papers have no exact equivalent in ISO 12647-2. These are very yellowish weboffset papers with a very simple coating. The attainable color space is smaller than with SWOP2006_coated3 or FOGRA28 and is almost exactly equivalent to the FOGRA40/eciSC color space.

Digital Proofing According to GRACoL and SWOP

With the introduction of the new characterization data in the USA, the guidelines for the certification of digital proofing systems in accordance with GRACoL and SWOP were adjusted in November 2006. They are based now on ISO 12647-7 and contain the guidelines that certified proofing solutions should reproduce the GRACoL and SWOP characterization data as colorimetrically exactly as possible.

Information on the certification of proofing systems on the basis of the new characterization data for GRACoL and SWOP can be found on the website ***www.swop.org***

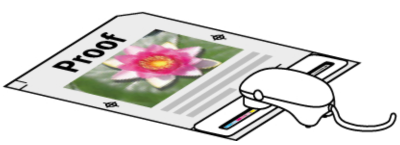
The IDEAlliance ISO 12647-7 Color Control Strip

IDEAlliance published a control strip in November 2007, also based on ISO 12647-7, which all producers of digital proofs should output in addition to the proofed motif. This is an American equivalent to the UGRA/FOGRA media wedge CMYK that can be used freely by end users as well as the manufacturers of proofing systems.

The evaluation is carried out, like the media wedge, with a spectrophotometer and the comparison of the measured values with the target values of the characterization data corresponding to the printed material (GRACoL and SWOP). At the time of going to print there are no obligatory tolerances for the evaluation of the IDEAlliance ISO 12647-7 color control strip, IDEAlliance recommends that prepress and printer agree on their own tolerances, based on the level of quality for the production. A good starting point are the tolerances of ISO 12647-7, which are also used for the FOGRA media wedge in Europe.

Color tolerances in ISO 12647-7	Delta E Lab
Paper white Delta E	3
Mean difference Delta E	3
Max. difference Delta E	6
Primary colors Delta E	5
Primary colors Delta h	2.5
CMY Gray Delta h	1.5

Prepress

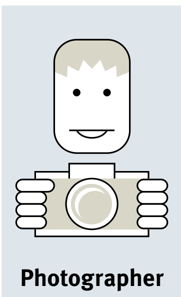


Printers

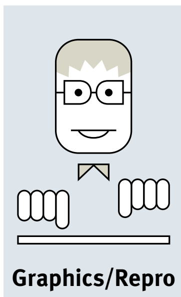
The control of a proof can occur in prepress before the proof is delivered, as well as at the printers who receive proofs from various external sources

The GRACoL/SWOP Profiles in the Production Workflow

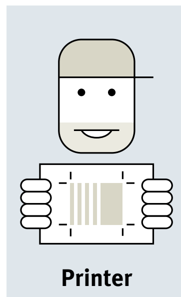
The GRACoL/SWOP profiles are used in prepress. Before the finished document is prepared for print it is important to clarify with the printers which type of paper will be used. RGB image data is then separated with the correct GRACoL/SWOP profile for the type of paper. The same GRACoL/SWOP profile is used for the soft proof on the monitor to give a correct preview of the final result. Once the PDF data is created for print, the same profile is used for the proof for the printers. The proof contains a control bar in which the GRACoL/SWOP profile shows which color space is being simulated. The IDEAlliance Color Control Strip allows for a control of the proof at any time.



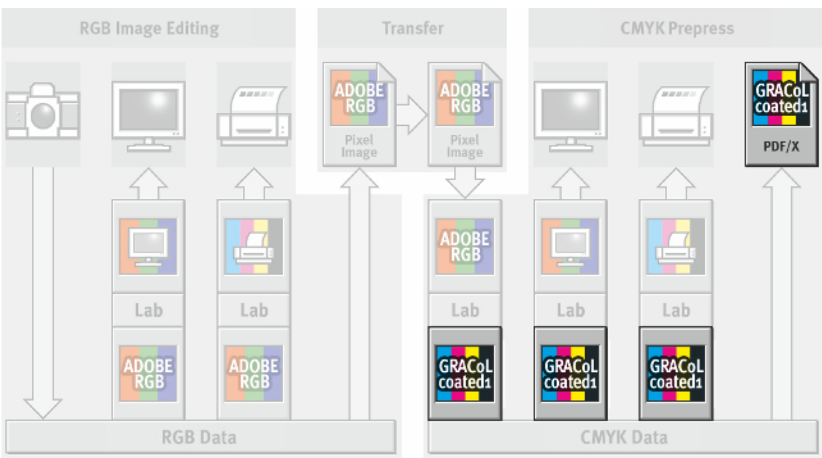
The photographer needn't be concerned with the color space of the print, but needs to be sure to embed the profile for his working RGB color space in his image files.

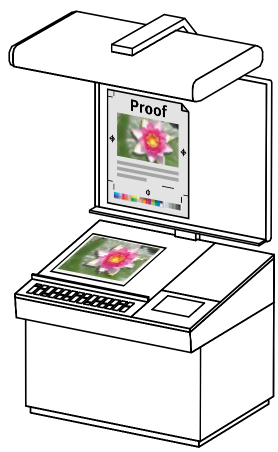


The GRACoL/SWOP profile is applied in prepress: in the separation, soft and digital proof (which includes an identification of the GRACoL/SWOP reference and the IDEAlliance Color Control Strip).



The printer checks the incoming PDF data and measures the IDEAlliance Color Control Strip on the proof. Afterwards he adjusts the print to match the proof.





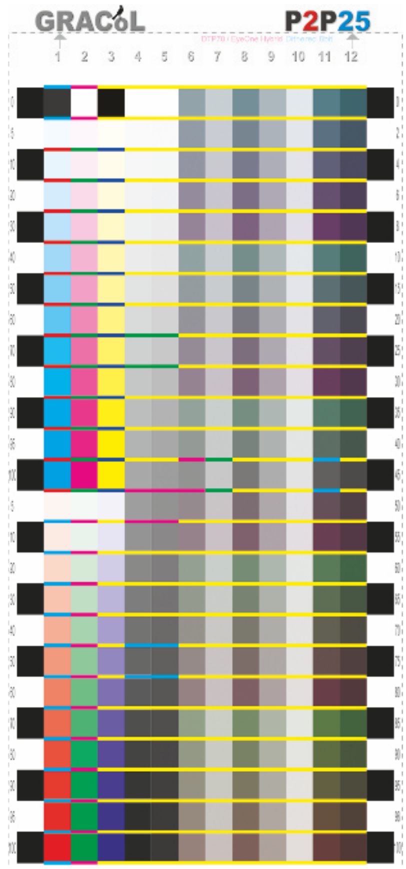
G7 Calibration of Printing Processes

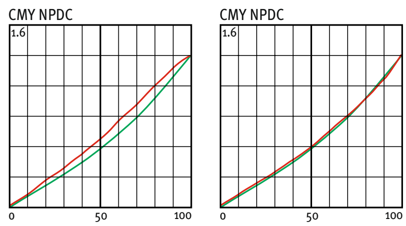
IDEAlliance and other organizations in the USA recommend the G7 method for the calibration of printing processes, which, at the time of printing this English edition of this book, is not based on ISO 12647-2. The aim of the G7 methodology is to achieve the most visually similar result possible, in terms of gradation and gray balance, with the most different of printing processes and paper types. The basis of the G7 method is a K and a CMY scales called "Neutral Print Density Curves" or NPDC, which, measured in print in respect of the gray balance in the CIE Lab color space and the gradation in density, should fulfil certain specifications.

The detailed procedure can be read in "G7 How To Guide", available as a free download. Additionally, there is the software "IDEALink Curve" from IDEAlliance, available for a fee, which facilitates the creation of G7-compatible correction curves for PostScript RIPs. PostScript RIPs are special programs that convert the print data to screen dots. In offset printing the RIP drives the CtP system, in digital printing it is connected directly to the printing machine and in gravure printing with the cylinder engraver.

The GRACoL and SWOP characterization data correspond to the offset print calibrated in accordance with the G7 methodology. A comparison of this characterization data with that of FOGRA, which at the time of going to press describes most exactly the implementation of offset printing in accordance with ISO 12647-2, shows that the European and American data for coated paper are very close to each other.

IDEAlink Curve

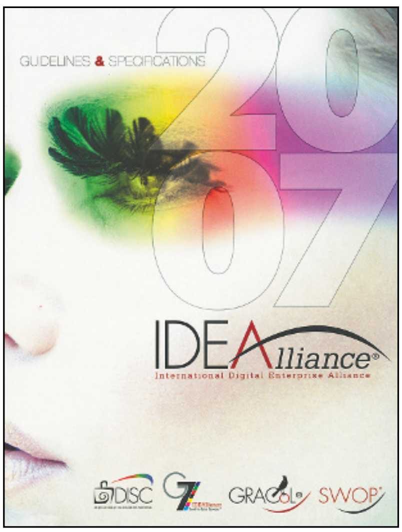




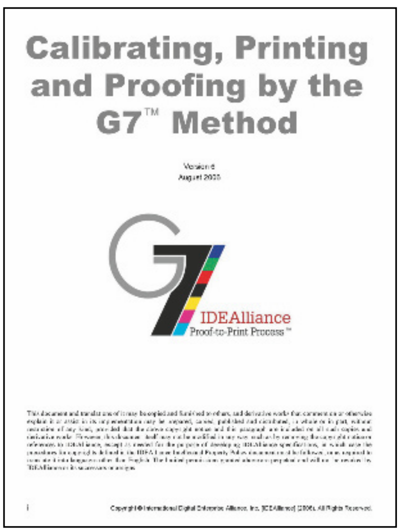
The reference method for the creation of G7 correction curves for the RIP is implemented in the software "IDEAlink Curve".

The P2P chart (above) is printed and measured with a spectrophotometer.

The software then calculates the G7 correction curves for reaching the optimal neutral print density curves NPDC.



The printed IDEAlliance brochure "Guidelines and Specifications" acts as a reference for GRACoL, SWOP and G7



*The free downloadable pdf "G7 How to Guide" from **www.gracol.org** describes the G7 procedures in detail*

FOGRA/ISO 12647-2 versus G7

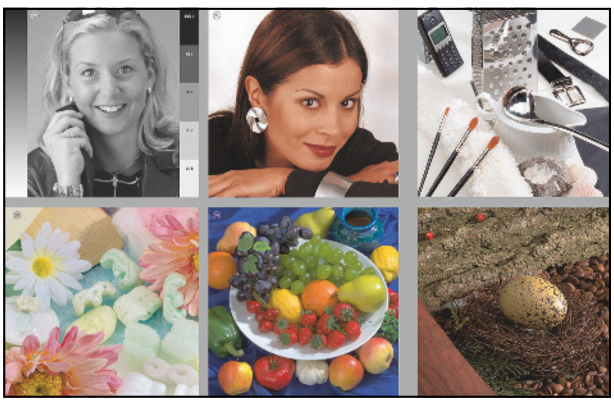
A comparison between the methods of FOGRA/ISO 12647-2 and G7 for calibration and process control of offset printing to match the standardized digital proof shows that there are fundamental differences. The aim of the FOGRA method is to achieve the best possible dot gains in ISO 12647-2. The dot gains in offset printing fluctuate according to the paper used, the printing ink used, the condition of the printing machine and other factors. The CtP calibration to optimal dot gains in accordance with ISO 12647 is a good starting point with which to determine, in the ongoing print production, if the dot gain fluctuations still lie within ISO 12647-2, or if measures are necessary to tame the out-of-control dot gains. The strength of this dot-gain-based method for print process calibration is the optimal link to the dot-gain-based process control according to the ISO 12647 target values.
At the time of going to press, dot gains only play a very marginal role in G7 for offset printing. For the CtP calibration they are ineffectual and, with regard to control in the ongoing production, it is recommended to observe dot gains after the G7 calibration has been made without defining guidelines and tolerances for intervention.

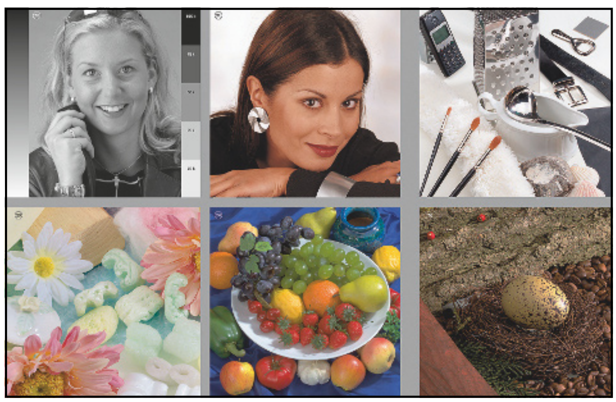
On the other hand, G7 contains a manufacturer-independent method for measuring the gray balance as well as lightness in the mid-tones in the ongoing production. At the time of going to press, the methodology of FOGRA/ISO 12647-2 needs to catch up in this area.

The G7 process can also be applied to every type of printing process to reach a similar visual appearance to offset printing or proofs based on GRACoL/SWOP. At the time of going to press, FOGRA had not published a recommendation on how any printing processes can be optimized to match FOGRA39/ISOcoated_v2 proofs optimally.

But, even if the calibration methods are quite different, the results can be quite similar, as the images below show.

Different methods for print process calibration can lead to similar results: on the left a proof according to FOGRA39, on the right for GRACoL2006_coated1, each from the same data.





Discussions in ISO TC 130 about G7

The Technical Committee 130 is the ISO's international workgroup that, with the long-standing co-operation of the Americans, develops the ISO standards for the graphics industry and adapts them for the latest technical status. Within the ISO TC 130 the American activities concerning G7 are evaluated very differently. Many European representatives regard the G7 methodology as competition for the ISO standardization, because the Americans certify printers as G7 Master Printers on an international level when they want to work for large American print buyers.

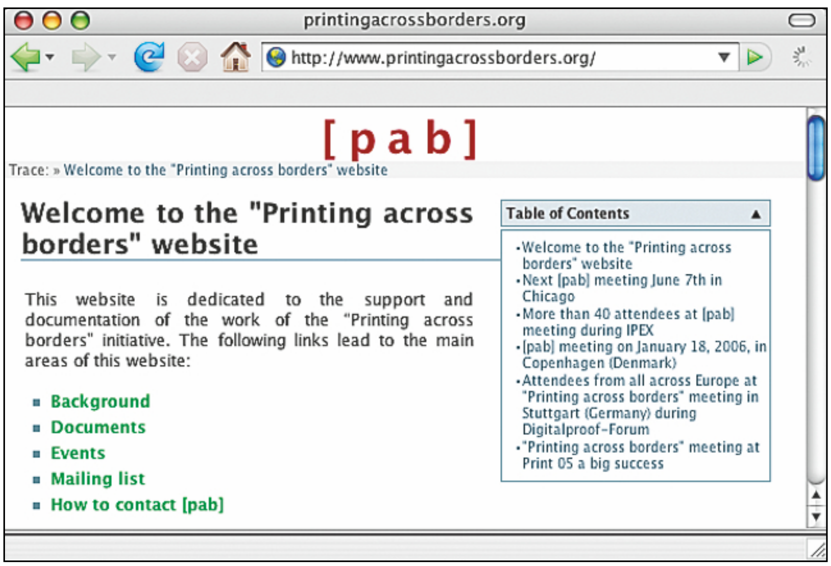
The Americans, on the other hand, see G7 as an American interpretation of ISO 12647-2, because it complements in important criteria such as a more exact metrological definition of the gray balance in production printing.

Maybe a revision of ISO 12647 and the ISO technical speficication ISO/TS 10128 (under development) will be the basis for global unified characterization data and global seperation and proofing standards.

Following Further Developments

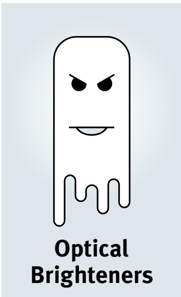
The specifications and tools surrounding G7, GRACoL and SWOP, at the time of going to press, are in a stage of constant further development. On the websites for IDEAlliance, GRACoL and SWOP there are regularly new documents, describing tasks of work in further detail. Subjects anticipated to be described closer after the press deadline for this book are dealing with tolerances in the evaluation of proofs, detailed procedures for the implementation of G7 in the printers or the metrological evaluation of prints in comparison to GRACoL or SWOP characterization data.

Print buyers, prepress or printers working in accordance with G7/GRACol or SWOP, should regularly read up on the news and updates on the mentioned websites.



For print buyers, prepress and printers needing to work in both worlds, the mailing list from Printing Across Borders offers the best solution for an exchange of thoughts with users as well as with standardization experts around the whole world.

Optical Brighteners in Production According to Print Standards



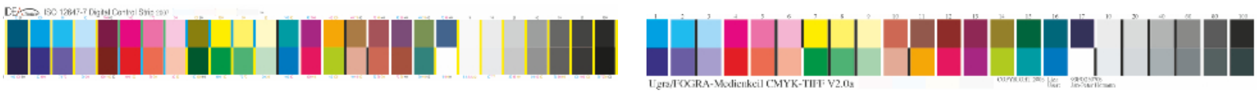
At the time of going to press, the subject of optical brighteners has been completely suppressed in ISO 12647-2, GRACoL, SWOP and the resources that have been developed for it. However, for print production this subject is extremely relevant in many aspects.

Limits of the Proof Evaluation with the Media Wedge or Color Control Strip

If the evaluation of a proof control wedge shows correct values, then the user has worked with the correct profile for the proof medium and the standard being simulated.

The proof control with the FOGRA media wedge or IDEAlliance Color Control Strip does not, however, guarantee the visual consistency of metrologically correct proofs on different media. If the proof medium contains considerably more optical brighteners than the print standard being simulated, a metrologically correct proof result will be visually too yellow, e.g. when a typical photo paper for inkjet printers has been used for the proof.

Proofs on media with different amounts of optical brighteners have clear visual differences, even if, according to the media wedge or color control strip, they are correct.



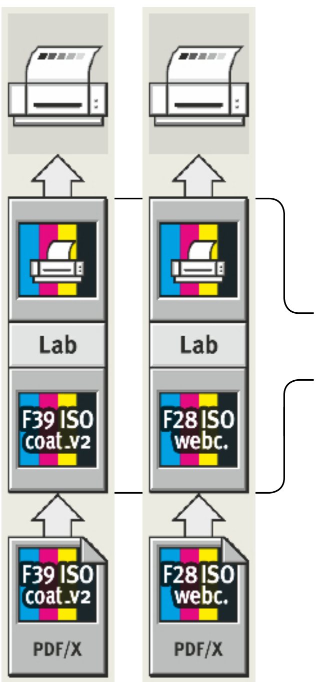
However, sometimes the opposite also occurs: if the proof medium contains far less optical brighteners than the print standard being simulated, a metrologically correct proof will be visually too blue. This occurs, for example, when an attempt is made to simulate the color space ISOcoated, on a proof medium without optical brighteners, with a b* value of 1 or more. It would be ideal to use a proof medium, for each FOGRA/ISO, SWOP or GRACoL standard, whose paper white has the same Lab values and gloss as the standard being simulated.

Simulating Different Print Standards with one Proof Medium

The FOGRA, GRACoL and SWOP characterization data and the corresponding profiles represent papers with varying degrees of optical brighteners. FOGRA39/ISOcoated_v2, GRAColcoated and FOGRA29/ISOuncoated, have a moderate amount of optical brighteners, whereas SWOPcoated3, FOGRA28/ISOwebcoated and SWOPcoated5 are largely free of them.

To proof effectively it is useful to output all ISO standards on a semi-matt proof medium. If the system is regularly calibrated for the medium used, then the profiles ensure a metrologically correct simulation of the different standards. So that metrologically correct proofs, under these basic conditions, also correspond well to reference prints, there should be two prerequisites:

1. The paper white of the proof medium in use should lie between –3 and –1 in the b* value and above 95 in the L* value. These are the ideal conditions to depict FOGRA39/ISOcoated_v2, GRACoLcoated and FOGRA29/ISOuncoated, all which have a paperwhite with b* –2. SWOP3, SWOP5 and FOGRA28/ISOwebcoated can be simulated with a slightly yellowish papertone simulation.
2. For highest quality, every combination of standard print profile and profile for the proof medium in use must be optimized based on visual aspects. Ideally the manufacturer of the proofing solution should already have carried this out. If a high-quality calibration is available here, then the user can fall back on the optimized profile combination from the manufacturer.



If different ISO standards are to be simulated on one proof medium, each profile combination must be optmized individually.

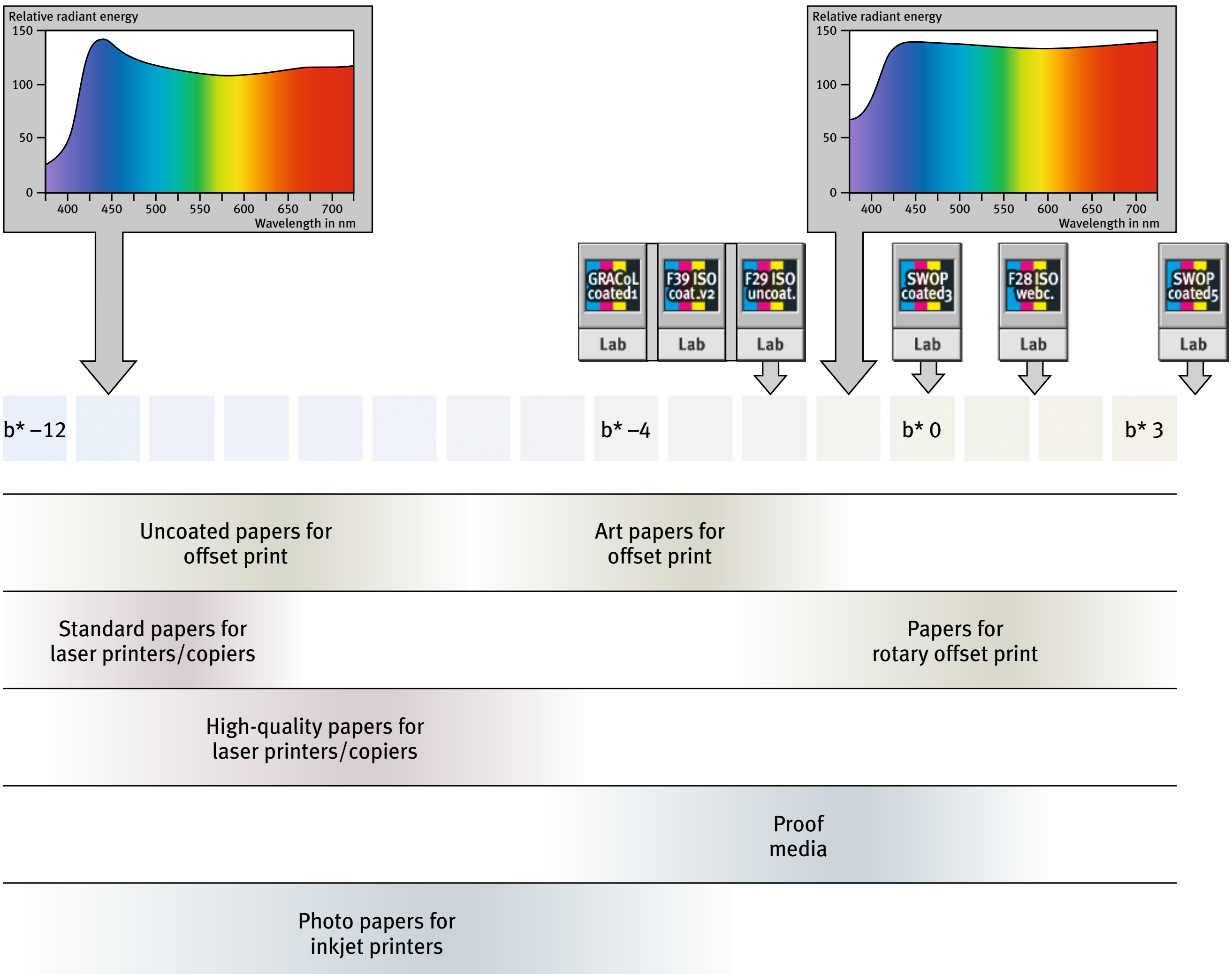
Problem Zone: Color Laser Printers and Color Copiers

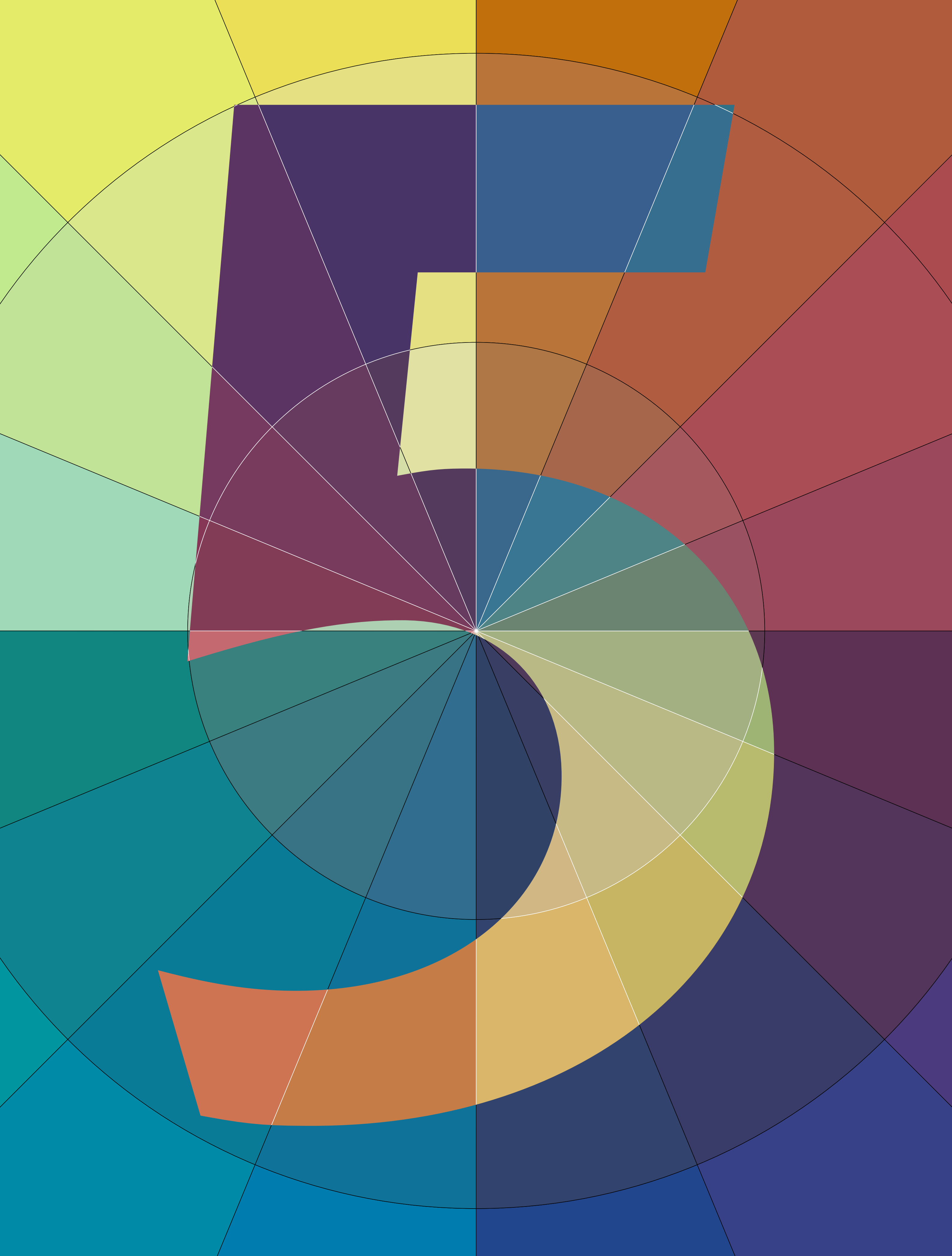
The b* values of typical papers for color laser printers and copiers, compared with the FOGRA/ISO, GRACoL and SWOP specifications for offset print, are practically consistently bluer. Here the rule also applies: if you want to achieve a visually good result on such papers with the correct use of color profiles, it is always necessary to optimize the combination of print standard profile and the profile for the color print/paper.

Uncoated Papers for Offset Printing

Almost all prevalent uncoated papers for offset print contain large amounts of optical brighteners. The characterization data FOGRA29 and the corresponding profile ISOuncoated, however, are based of a seldom used paper with clearly fewer brighteners – which is clearly an advantage for the simulation of this standard. Self-made profiles for uncoated papers require manual reworking, otherwise they would lead to a definite bluish cast on the monitor and proof.

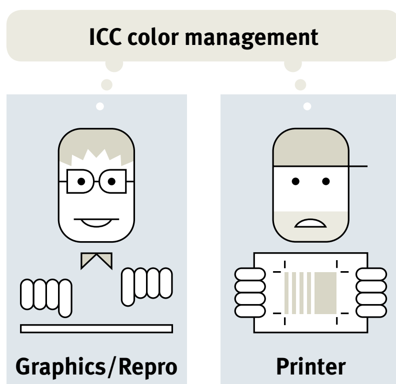
The illustration shows the chromaticity co-ordinate of the Adobe/ECI, GRACoL and SWOP profiles in comparison to typical papers in the color management environment.





Using ICC Strengths and Avoiding ICC Problems

Color management with ICC profiles can be very useful in many aspects and in other areas cause much trouble. This chapter goes deeper into the technical details and shows ways to use the ICC strengths and to avoid ICC problems as best as possible.

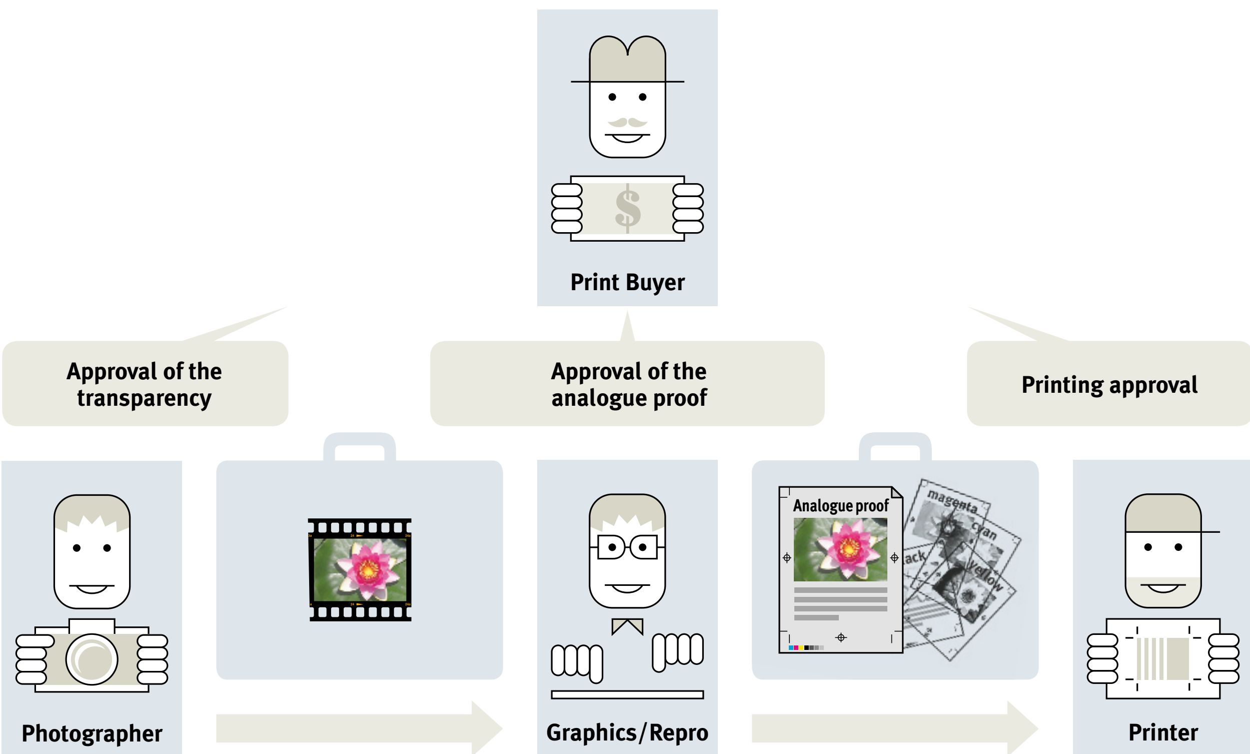


In the Past: Hard Facts about Data Transfer

In the days before color management the transfer of printing copy and its approval were associated with some hard facts:

The Transparency, Approved by the Print Buyer
The photographer delivered a transparency to the print buyer or repro house. If the print buyer accepted the colors as they were, then it wasn't down to the photographer if the reproduction or print did not meet the print buyer's requirement.

The Analogue Proof, Approved by the Print Buyer
Far into the 1990s it was usual, when delivering printing copy, to hand over imageset films and an analogue proof to the printers. There were a list of advantages for the printers' intake control: one could be certain that the raster dots on the film would be transferred to the printing plate exactly as they were – a light table and a trained eye sufficed for the control. With an accompanying analogue proof the printers could be certain that the proof and films corresponded with each other.



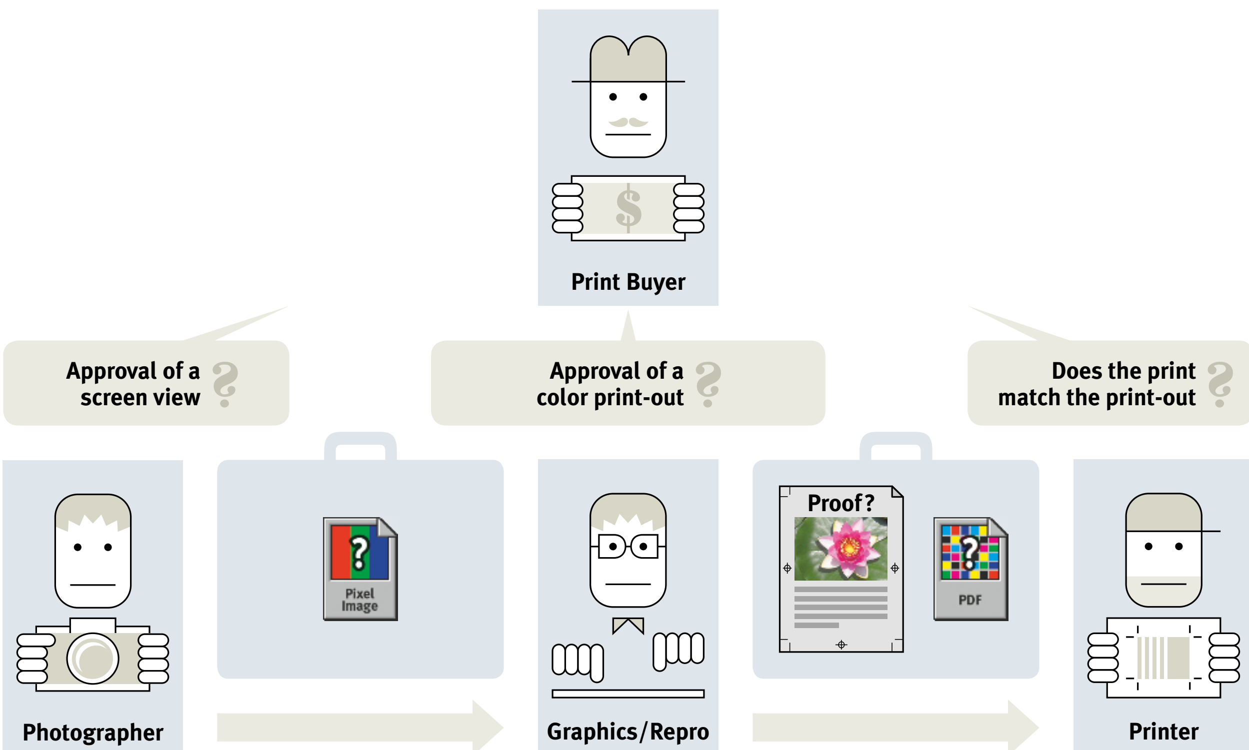
Today: Uncertainty and Unclear Responsibilities

These days, the whole production process is much more virtual and the responsibility for a correct reproduction in terms of color is much more unclear. It starts with how digital photos are presented to the print buyer and then passed on to the graphic designer or repro house: with the transfer of RGB data it is a question of which color depiction is contractual – the one on the photographer's monitor, the one on the print buyer's monitor or the one at the repro house? If the photographer delivers a color print with his image data there is still no guarantee that the same colors will be displayed when opened at the repro house.

When the print data is ready the print buyer should give his approval based on a digital proof. But not all prints claiming to be proofs are suitable for the job.

After all, it can so happen that individual images, graphics or text sections in the data prepared for the printers contain individual profiles. Should these profiles then be used or ignored? Who is ultimately responsible for the color balance in the printed result?

Without color management, absolutely no consistent reliability of color is possible in the chain of production. The existence of ICC profiles alone does not, however, lead to reliable and predictable color results. Compared with delivering transparencies, films and analogue proofs, a completely digital way of working is, at the time of going to press, still much more unreliable.



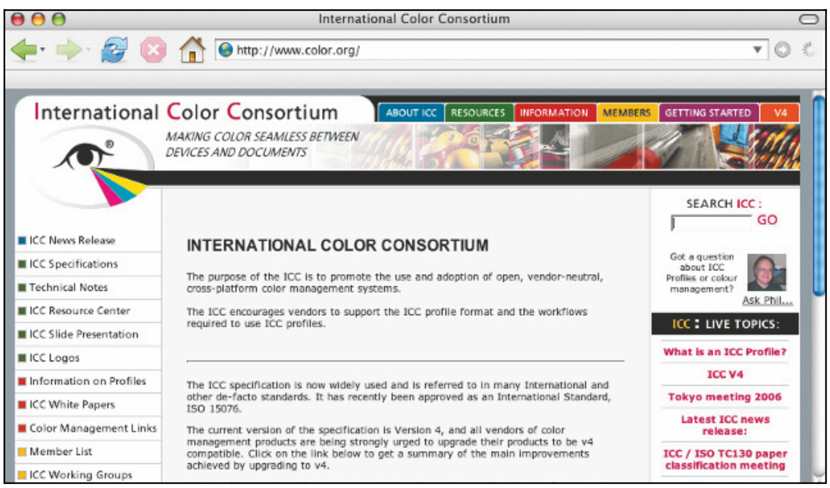
ICC Standard, the Trouble Maker

Color management is a Janus-faced technology. On the one hand, color management is the prerequisite for achieving a color quality with affordable standard programs, from input through processing to output, that was unimaginable 20 years ago. On the other hand, color management can lead to undesired color transformations at different stages in the chain of production, which in the worst case can make a complete reprint necessary. The reasons for these problems are essentially not(!) that the application programs insufficiently support color management. Even the user's possibly deficient knowledge of color management only plays a secondary role. The main cause for the simultaneity of success and the greatly present problems with color management lies in the ICC specifications.

They define in great detail how color profiles must be constructed and formulate some rough principles for how they are used. The ICC specifications do not, however, describe any detailed workflows in color publishing or what ICC-compatible application programs need to be capable of so that such workflows function reliably. Apart from this, the ICC specifications lack references to processes and stages of control for quality assurance in production with ICC profiles. For this reason, the conscious use of the advantages of color management with ICC profiles must be expanded with strategies to avoid the ICC-based faults. This subject will be discussed in detail at many points in this book.

But back now to the ICC specifications: these are written and maintained by the International Color Consortium, ICC for short. This industry organization represents practically all the companies that develop products either for creating color profiles or ones that are used in the daily production. The ICC specifications, which can be downloaded free as a PDF file from **www.color.org**, are known colloquially as the ICC standard.

*The official website for the ICC specifications is **www.color.org***



A Short Look Back at the Development of the ICC Standard

The idea of colorimetrically describing the color spaces of different media in an independent color space is much older than the phrase “color management”. The large manufacturers of photographic materials, above all Kodak, have been carrying out research in this area for decades. The color television standards PAL and NTSC have been colorimetrically defined since their formation, and for offset printing, in Germany, there was the forerunner to ink standard ISO 2846-1, DIN 16539. Even the large repro houses began in the 1980s to work with colorimetrically predefined references for their drum scanners, EIP and digital proofing systems. At the beginning of the 1990s the first systems for standardized color transformation with personal computers came on the market.

What all the PC systems had in common was their own incompatibility to all the other systems: A user who calibrated his device with system A could not swap his calibrated data with a user of system B. In the publishing industry, orientated towards collaboration, this situation was more than annoying. For this reason the International Color Consortium was founded in 1992 under the auspices of the German research institute FOGRA.

On board from the beginning were operating system manufacturers (Apple, SUN and Silicon Graphics), AGFA and Kodak with traditional knowledge of color and the PostScript inventor from Adobe. The large repro vendors Crosfield, Linotype-Hell, Scitex and Screen were not involved at this point in time. Microsoft maintained an equally low profile, only to join the ICC later under pressure from the competition. The official specifications for the ICC standard were published in 1993. The four big repro vendors still showed no interest – for them an opening up towards ICC would have meant that their decades of know-how in color transformation would suddenly have become freely available with the operating system for every small software developer. Every Taiwanese scanner manufacturer could have competed with them, without year-long research and development. The reluctance of the repro industry is all too understandable. Microsoft, SUN and Silicon Graphics announced a licensing of the ICC-compatible color management from Kodak. Apple continued to work apparently independently.

Then in March 1995 there was a surprising turning point: Apple and Linotype-Hell announced together the ICC-conformal implementation of Linotype-Hell’s color technology as ColorSync 2.0. This step was quite astonishing for a large repro vendor. However, aware of the problem that their knowledge of color would now be available to the competition around the world, Linotype-Hell made provisions: instead of waiting for the clever Taiwanese to build this technology into their scanners, Linotype-Hell had their own flatbed scanners built in Taiwan and adapted the corresponding software, LinoColor, for ColorSync 2.0. LinoColor became the first repro software to enable a standard operation from flatbed scanners to high-end drum scanners. At the time the first edition of this book went to press, Linotype-Hell was the only one of the four large repro vendors to open itself consequentially to the desktop world. But this is now also history, since the purchase of Linotype-Hell by Heidelberger Druckmaschinen: just as Heidelberg – in its own right – was beginning to make a name for itself among graphic designers and photographers with its own flatbed scanners, from one day to the next it had the whole market covered. With this, Heidelberg created a unique chance for itself as the only manufacturer worldwide to occupy the subject of color from the input and creation through prepress to print.

After this short interlude from Heidelberg there are no longer any other manufacturers within the ICC who covers the subject of color management in respect of the production processes throughout the whole chain of production – all of the represented companies only support one section with their products. Therefore, the application of color management in accordance with the ICC standard works well where it can be narrowed down to precisely defined stages. The problems occur in the production chain where data is transferred and users process this data with programs from various manufacturers.

If software providers implement color management in accordance with the ICC parameters, then users do things that are described on the next page under "The successes of the ICC standard". However, there are giant gaping holes in the ICC specification when it comes to definitions of production processes with ICC profiles and how the interaction of ICC profiles with different application programs, operating systems, printer drivers, color printers and imagesetters should work. So, after the "successes of the ICC standard" there are three sections about the breaking points of ICC workflows.

The Successes of the ICC Standard

The application of ICC profiles is very successful when it comes to definitive tasks that are well covered by the ICC specifications. These are the following points in particular:

1. Color fidelity in scanning
Five years before the publication of this book's first edition, high-quality color scanners still costs hundreds of thousands of euros. Nowadays, thanks to ICC profiles, the color fidelity of scanners in the price range of 600 to 3000 euros achieve the quality of these "repro dinosaurs." The resolution of detail in the shadows is also of a high standard thanks to continuously improved CCD cells.

2. Separation of RGB images at a high standard
Ten years ago the high-quality conversion of RGB images to CMYK for offset printing was only possible with special equipment and training over many years in artwork preparation. Today, with an integrated color management workflow, this is a simple press of the button for graphic designers and photographers.

3. Soft proof of RGB and CMYK images
The correct color display of RGB and CMYK images on monitors is these days no longer a problem, thanks to the ICC standard. The quality achievable with a color-measuring device for profiling a monitor has reached a standard that, ten years ago, was only possible with incredibly expensive special solutions.

4. Digital proof of CMYK documents
Nowadays, the production of high-quality proof is also possible with inexpensive inkjet printers to such a standard that was unimaginable ten years ago. Here, color management with ICC profiles has caused a revolution in quality and price.

5. Universal color standards
Because the ICC standard is defined for all manufacturers and is freely available it enables universal color standards. Only through this can the same CMYK profile be used for the separation of RGB data, the soft proof on the monitor and for the print simulation with the digital proof.

The ICC standard is therefore the main driving factor for the fall in price of equipment for the manufacture of color artwork. Ten to fifteen years ago the founding of a company producing digital artwork would have meant an investment of some 300,000 euros. This can be done today for a fraction of that money. The learning curve to produce a good quality with this equipment is much shorter than before. Prepress is no longer a secret for graphic designers and photographers when educating themselves further.

Alongside these great successes there is still some homework left for the ICC to do.

Missing ICC Definitions for Processes and Test Files

If you look at the construction of other standards for the processing of complex digital data, there are predefined workflows as well as clearly defined test files and procedures. Programers of software based on these standards are able to test if their programs apply the standard's parameters correctly.

No Explicitly described Production Flows on the Part of the ICC
If this approach is applied to color management, then the ICC should define explicit and clear processes of how ICC profiles are applied in individual stages of work. This means processes in the terms of production, for example image capture, image processing, graphic and layout design, color transformation of complete documents and the proof.

No Minimum Requirements and Test Procedures for Application Programs, Operating Systems and Printer Drivers on the Part of the ICC
Defined workflows are the prerequisite for describing the minimum requirements for image processing, graphic and layout programs, printer drivers and operating systems. In particular, the definition of clear interfaces would be important, for example how operating systems, application programs and printer drivers work seamlessly together in terms of color management. If these minimum requirements are described then test files and procedures can be predefined in order to test, for example, individual application programs, functions in the operating system or printer drivers, on their own or working together.

No Parameters and Tests for the Approval of Profiles on the Side of the ICC
Only if the individual components are tested for functionality can a complete color-management process, including the appropriate profile, be optimized. Also, only when complex test documents can be cleanly converted should the ICC profile be approved for the production.

Summary: the ICC has a Mountain of Homework
As to the parameters for the functionality and interaction of application programs, operating systems, printer drivers, etc., there is practically nothing in either the ICC specification or supplementary documents – not to mention corresponding test files. Because none of this exists, the programmers of operating systems, application programs, printer drivers and other applications implement color management as they see fit, which is often a catastrophe for the user: how these programs function internally and interact can often only be found out through thorough individual tests or the exchange through mailing lists and internet forums.
Only the ICC can provide clarity with defined processes, test files and procedures. However, there is no sign of this at the time of this third edition going to print. And because all this does not exist it is very difficult to determine in which areas the ICC specifications are themselves the cause of problems.

No ICC Parameters for the Proof of RGB Data

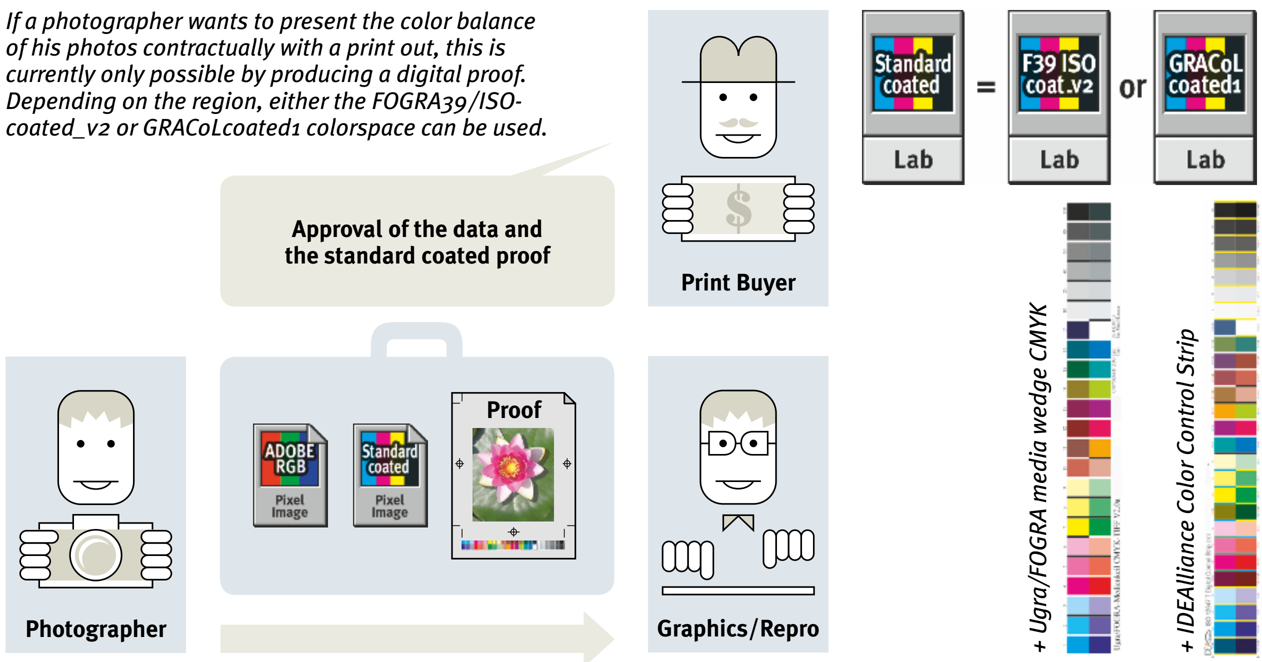
With the demise of transparencies there is a great problem with quality assurance in the transfer of digital imagery from the photographer to the print buyer or prepress. With the availability of the ICC specifications at the beginning of the 1990s, it was also preached that RGB data should be delivered to the printers so that they could undertake the separation and proof. For both these cases, however, a parameter is missing on the part of the ICC for a central building block in the workflow: **a proof of RGB data that works, regardless of how it will later be separated and proofed by the printers.**

This RGB proof would have two functions. Firstly, the photographer can present his print buyer a contractual color print. Should different colors come out later in repro or at the printers then this would definitely not be the photographer's problem. If we should strive to deliver RGB data to the printers then the proof of the RGB data should likewise be independent of the profile used at the printers for separation and proofing. Only then does it make any sense to give the printers RGB data. Unfortunately, we are still far from such a universal proof of RGB data.

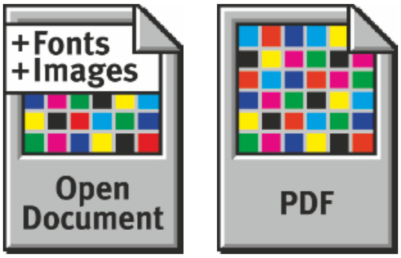
From RGB Data to the Proof in a Standard Coated Color Space

For photographers a color print for the approval of their RGB data is a central tool in the communication with print buyers, graphic designers and repro houses. This book therefore describes a method that is applied in practice by leading photographic studios: to convert the RGB data by a clearly defined method to a standard coated color space and then to produce a proof with a control wedge. The print buyer receives the RGB data with a proof for the standard coated color space or, if desired, standard coated CMYK data.

If a photographer wants to present the color balance of his photos contractually with a print out, this is currently only possible by producing a digital proof. Depending on the region, either the FOGRA39/ISO-coated_v2 or GRACoLcoated1 colorspace can be used.



The Myth of Mixed-color Documents



Mixed-color files and PDFs

Depending on the intended use of a file, it is usual to construct this in one consistent color space.

However, the ICC standard, as well as current application programs and the PDF format allow mixed-color documents.

One of the founding myths of the ICC is functioning workflows with mixed-color documents. On paper the concept is impressively simple: every image, every graphic and every text section of a document could be present in any color space, as long as this is defined by an ICC profile. The components of the document would then be converted to a target color space that is likewise defined by an ICC profile. In this way the document could be automatically optimized for different printing processes or other output processes. The idea is, as mentioned, impressively simple. Unfortunately, during its entire existence, the ICC have carried out no systematic tests as to whether the ICC specifications are capable of realizing this in practice.

ICC Breaking Points: Grayscale Images and Technical Shades

The ICC specifications with regard to the conversion of grayscale images and technical shades in images and vector graphics is totally insufficient. If complete documents are to be converted to different target color spaces then problems can be expected. Likewise, the ICC specifications only rudimentally describe under which preconditions CMYK images can be cleanly converted to another CMYK standard.

Programmers Love Mixed-color Documents

While the proposal of mixed-color documents was received with scepticism by users, it was met with great approval by programmers. The idea that each image, graphic and text section in one document could have an individual profile has, meanwhile, been implemented in current graphic and layout programs as well as in the PDF and PostScript standards for print.

The Abyss of Digital Color Hell

When a user takes the trouble to test if it is possible to convert mixed-color documents to any output color space, the abyss of digital color hell opens up: in practice, complex mixed-color documents and PDF files can practically never be converted to other color spaces by the push of a button. There is, however, a second much more dangerous effect: through the integration of these functions in all data formats and programs for creating and processing print data, it is more and more the case that undesired color transformations are triggered on individual images, graphics or text sections.

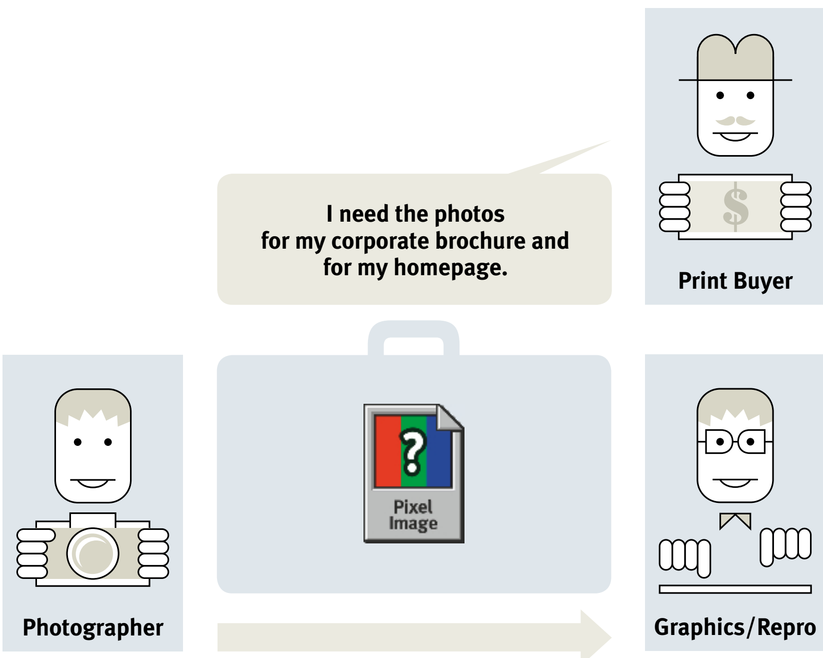
The conscious use of color profiles in graphic and layout programs and in the creation of PDFs has become something like a dangerous balancing act. Activated color management for the soft proof can, in some situations, lead to the conversion of images, graphics or text objects. This can happen in the DTP program itself, in the creation of the PDF or in the processing of PDF data at the printers. Sometimes this can be detected on the proof in time, sometimes it can't …

Consequences for the Following Sections

The workflows described here in the book concentrate on using the strengths of ICC technology and avoiding the potential problems as best as possible. In doing so, reliability in production takes clear precedence over a broad use of all color-management functions in application programs. Technological explanations of how the ICC standard works and where specifically problems lie are largely orientated around the stages of production described in each section.

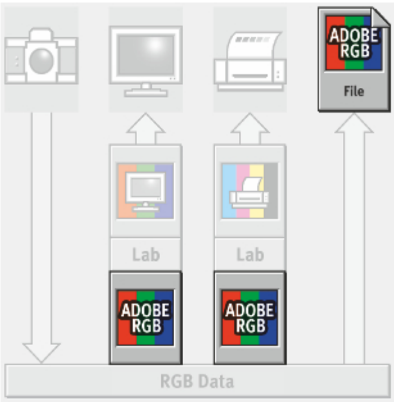
About the Role of the RGB Working Color Space

Before we go into further detail about the ICC specifications, it is necessary to deal more intensively with the role of the RGB working color space. This is particularly important when RGB data is to be used for ICC-based color management as well as for the internet or in office programs. Furthermore, it is wise to adapt the parameters for calibrating the monitor to the actual RGB working color space in use.



The exchange and approval of RGB data between the photographer, print buyer and prepress is a sensitive area. This is particularly true when the RGB data should be used both for print production and in office programs or internet pages.

The Role of the RGB Working Color Space



A complete color-management workflow requires a consistent RGB working color space – from the export of camera data through the display on the monitor and the output on the printer to the embedding of the working color space profile in the finished file.

As already explained in Chapter 3, the RGB working color space is the basis for processing RGB images and documents as well as the exchange with other users. Both areas of application make certain demands of the RGB working color space.

Image Editing

In image editing it is necessary for equal RGB values to produce a neutral gray. Only then can the user orientate himself to numerical values and carry out selective color corrections. Furthermore, the RGB working color space should cover the color space of a possible later application. If an RGB working color space is chosen that does not cover the particular color space of a later application, then the color saturation for some images will be unnecessarily limited.

File Exchange with Other Users

For the file exchange with other users, the profile for the RGB working color space should have as small a file size as possible, so that the size of the image file hardly changes after embedding the profile. Furthermore, it is advantageous if the users who exchange digital image data agree if possible on one single RGB working color space.

No Parameters or References from the ICC for RGB Working Color Spaces

Many users embed profiles in RGB images as a matter of course and also apply them when opening. Despite this, there is still a lot of RGB data in circulation without a profile, mainly for office and internet applications.

In the ICC specifications there are no references for RGB working color spaces or even parameters for which color space to use if no profile is embedded. Accordingly, there is an uncontrolled growth of references from various organizations and a wide range of settings in application programs. This results in difficult situations, as the next sections show, where even many color-management professionals are left in the dark.

DQ-Tool from the German Photographic Industry Association, on the right the test image for skin tones

sRGB

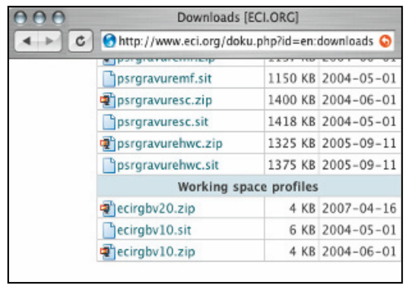
Fault Tolerance

It can always occur that in a color-management workflow the RGB working color space has not been embedded in the files, or that the receiver does not extract the embedded working color space. In both cases a color shift occurs when the files are opened. The more different the working color spaces are between the sender and receiver of the data, the greater the resulting color shift is. If the sender and receiver coincidentally work in the same or a very similar working color space, the effect will be less dramatic.

To avoid such problems from the start, it is imperative in the use of RGB data to embed ICC profiles in the image data when saving. And the application programs must be so configured that embedded profiles in RGB images are automatically extracted.
In the area of office and internet applications, many application programs and browsers are, however, not able to incorporate embedded profiles correctly.

sRGB, AdobeRGB, ECI-RGB

According to the references of branch organizations, as well as the defaults in application programs, the most prevalent RGB working color spaces are sRGB, AdobeRGB and ECI-RGB. The particular quirks of these color spaces will be looked at later in further detail. A common attribute of these color spaces is, however, that they greatly differ from each other.



If RGB images are passed on without embedded profiles, considerable color shifts can occur if the sender and receiver have set different RGB working color spaces in their application programs. Left, the sender's display working in sRGB. Right, the receiver's display, set for AdobeRGB or ECI-RGB.

*The profile ECI-RGB can be downloaded from **www.eci.org**, which, in Germany, is particularly well established in repro houses.*

AdobeRGB

ECI-RGB

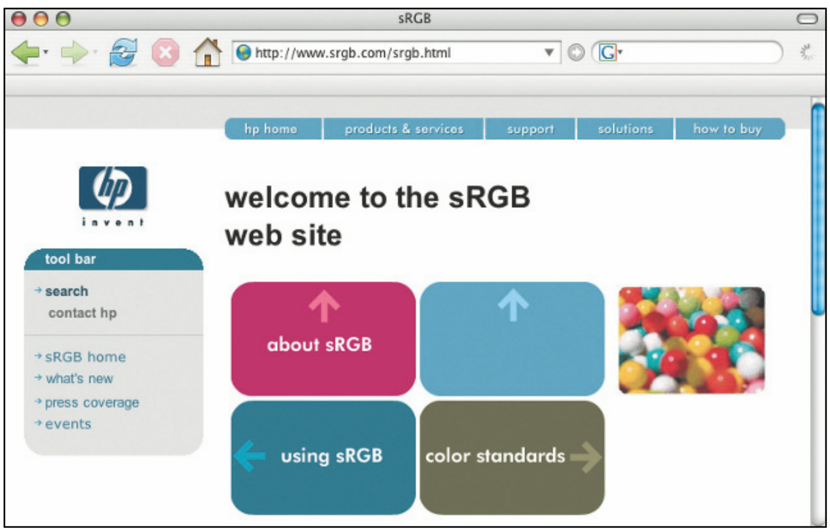
ICC-based Workflows and the World of sRGB

In color management there are two vastly different philosophies and strategies with ICC-based workflows and the world of sRGB. For successful color management it is indispensable to be familiar with both areas.

The Simple but Inflexible World of sRGB

The sRGB approach is aimed at making color management as simple and fault tolerant as possible. To this end only sRGB is allowed as the working color space for the exchange and archiving of RGB data. All devices that create RGB data – such as scanners or digital cameras – must deliver sRGB data. All devices that output RGB data – such as monitors, color printers or the photo service around the corner – must correctly convert sRGB data to their corresponding output color space. This is a tremendous relief for users in color management. They do not need to worry about the color settings in their programs as long as they use devices that create and output sRGB colors.

sRGB is an open standard for which there is no license fee whatsoever. The corresponding profile is freely available on the internet at **www.srgb.com** and is described in the international standard IEC 61699 for multimedia applications. The World Wide Web Consortium (W3C) prescribes sRGB as the standard working color space and in the realm of consumer photography sRGB is widespread in digital cameras as well as in the output in photo labs. Microsoft has integrated sRGB into the Windows operating system and have anchored it in their certification process for input devices and printers. If a manufacturer of cameras, scanners or printers wants to promote his product with a Windows logo, he must be able to prove that this device (including its driver) can deliver or correctly output data in the sRGB color space. And so sRGB has asserted itself in every respect in the area of office applications, on the internet and in digital consumer photography.



The website from HP ***www.srgb.com*** *provides extensive information about the sRGB color space*

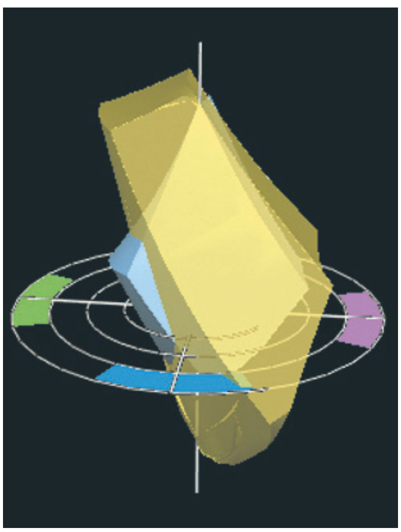
As impressive as the sRGB approach with its simplicity might be – it also has its darkside. In the areas of cyan and green tones there are colors missing in sRGB that can still be reproduced in offset printing on coated paper. However, for 95% of normal applications in the graphics business, this is not of concern. For this reason sRGB can generally still be used as the color working space for print production. For any graphic designer wanting to build up a simple as possible color-management workflow for print, internet and office applications, sRGB can be used as the working color space without any problems.

However, for a photographer or anyone in prepress wanting to get the best out of his image data, sRGB should not be used as the color working space. Although he should be aware that he must convert his RGB data explicitly to sRGB if they are also to be used for office or internet applications. If he does not do this for such areas of application, then he cannot deliver correct data.

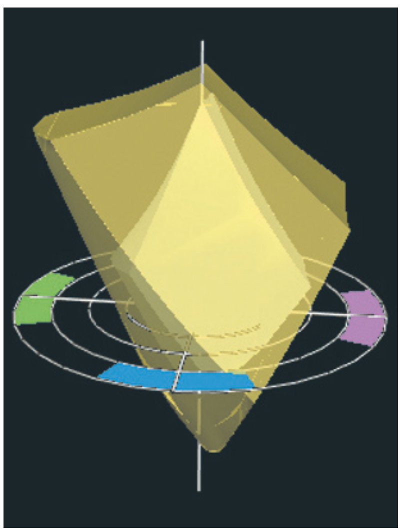
The slight weakness in the cyan/green areas, however, is not the only one in the sRGB philosophy. To make it as simple as possible for the user, in most sRGB-based applications, no optimization of color transformations can be carried out. This means if a printer's sRGB conversion is unsatisfactory, hardly anything can be done to change it. Furthermore, it would be helpful in some cases if another RGB working color space could be selected at a central point rather than sRGB so that different input and output solutions could work with this alternative color space instead.

The simplicity of the sRGB philosophy also means then an inflexibility and a lack of possibilities for optimization.

sRGB



ECI-RGB



The screenshots from the program ProfileEditor from GretagMacbeth/ X-Rite show the color spaces sRGB and ECI-RGB (yellow) in comparison to ISOcoated_v2 (blue).

In the picture on the left, the sRGB color space does not completely envelop the ISOcoated color space in the green-cyan area, while in ECI-RGB it is completely covered (right).

PhotoGamut as the RGB Working Color Space

An ideal RGB working color space for media-independent work should, on the one hand, completely cover the various output color spaces in print but, on the other hand, also be fault tolerant when images and documents are applied in the sRGB world. At first glance this might seem contradictory. If images are edited in a large color space then the colors change quite drastically when such an image is wrongly allocated the sRGB profile. It has been shown on page 70 what happens when images in the ECI-RGB color space are allocated the sRGB profile and vice versa.

*The PhotoGamut profile can be downloaded at **www.photogamut.org***

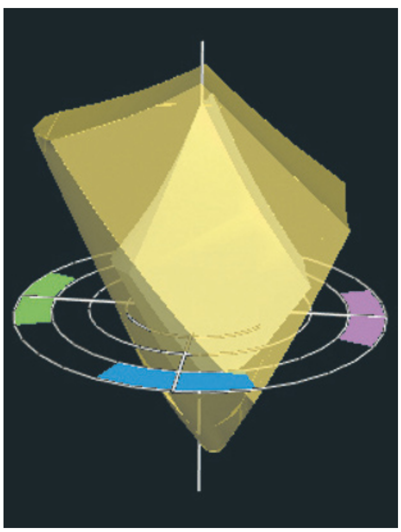
But this doesn't necessarily have to be so. These days it is possible to construct RGB working color spaces that behave, for a large part of the colors (e.g. skin tones), exactly like sRGB but are still able to display more saturated colors. An example of such a color space is PhotoGamut from **www.photogamut.org**. This color space has been so constructed that it can be used as an RGB working color space in ICC-based production environments and does not result in any unpleasant color shifts when embedded profiles in the sRGB-based environment no longer have any effect. A desired side effect is, furthermore, the good accord with photo printers in photo laboratories for the mass market, which are adjusted for sRGB data. Some repro houses also use PhotoGamut to process images from digital consumer cameras for offset printing. First, the image is allocated the PhotoGamut profile and then a profile conversion for offset printing takes place.

The illustrations opposite show identical RGB data that have been allocated the PhotoGamut, sRGB and ECI-RGB profiles respectively.

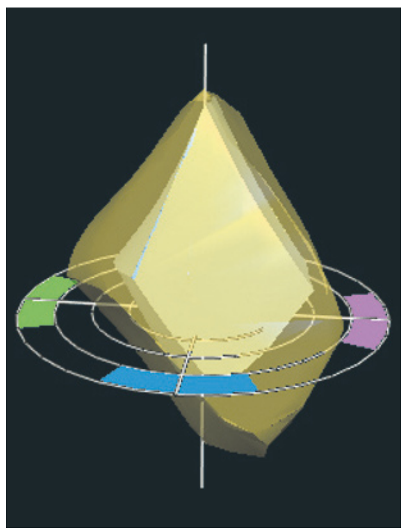
The screenshots from the program ProfileEditor from GretagMacbeth/X-Rite show the ECI-RGB and PhotoGamut color spaces in comparison to ISOcoated_v2.

In both instances the ISOcoated color space is completely enveloped. The shape of PhotoGamut, however, corresponds more to that of ISOcoated_v2.

ECI-RGB



PhotoGamut



The same RGB image data, allocated different RGB profiles.

In the skin areas and gradation, PhotoGamut and sRGB show practically identical results. ECI-RGB displays all color areas constantly more saturated and the mid-tones lighter.

PhotoGamut

sRGB

ECI-RGB

The Dilemma of ECI-RGB Color Settings

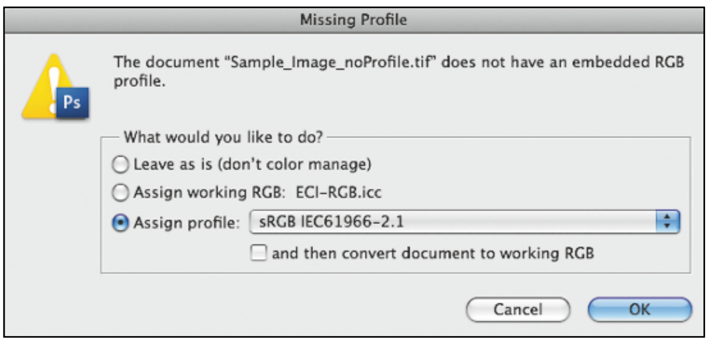
Above: original image in the sRGB color space, no embedded profile

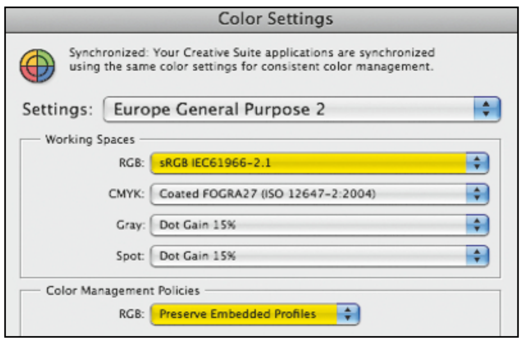
This is how the image looks in a program with ECI-RGB set as the RGB working color space. If the image is then converted to CMYK, the display error will be carried through to the proof and even on to the final print (image source: DQ-Tool from the German Photographic Industry Association).

In the German-speaking color-management scene, the leading repro houses have agreed upon using ECI-RGB as the working color space for the exchange of RGB images. At the same time, it has been agreed that the producer of image data embeds the ECI-RGB profile and the receiver allows for this embedded profile. Many repro houses have been working very successfully in this way for years and in practically all German language text books, industry references and professional articles on color management you'll find the recommendation to set ECI-RGB as the RGB working color space in application programs. For repro houses who cover everything from image capture to separation to the print-ready data, this is a very sensible approach. There are, however, a number of occasions where ECI-RGB in the color settings leads to a disappointment in image data.

The Role of Standard Profile in the RGB Color Settings

In all programs that allow a choice of profile for the RGB color space, this profile determines which color space will be applied to unprofiled RGB data. However, in daily practice, RGB data that contain no profile are generally not ECI-RGB data. The only color space designated in the international standards for unprofiled RGB data is sRGB. Because many unprofiled RGB data originate from consumer digital cameras, internet applications or office programs, sRGB, in practice, is the best setting for unprofiled RGB data. For application programs in which RGB data is opened or imported it makes little sense to use ECI-RGB as the color space for unprofiled RGB data. It makes more sense to use sRGB for this and to correctly allow for RGB data with embedded profiles.





If ECI-RGB is used as the working color space, RGB images with no embedded profile should be allocated the sRGB profile when being opened.

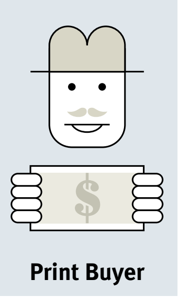
The image on the right shows a program setting that does this automatically and uses the embedded profile for ECI-RGB data. The mistaken allocation of the ECI-RGB profile is therefore avoided.

Profile Dialogue Windows when Opening Images

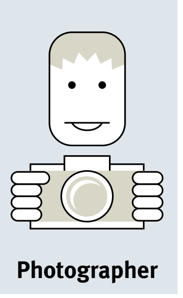
Some programs (e.g. Photoshop) allow a dialogue window to be displayed when opening to select profiles. For users using ECI-RGB as the RGB working color space it is essential to activate this option. This gives the possibility to allocate the sRGB profile when opening an RGB image without a profile. This is the second possibility to avoid wrongly applying ECI-RGB. Not all programs, however, offer such a dialogue in all situations – for example, neither QuarkXPress nor InDesign have such warning dialogues when importing RGB images to the layout.

Summary for Different Users

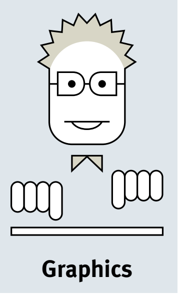
Print Buyer
If you compile an image library in-house, high-end RGB data and RGB data for the internet and office applications should be clearly separated to avoid any confusion. You should clearly prescribe that photographers and repro houses contracted by you should work with embedded profiles.



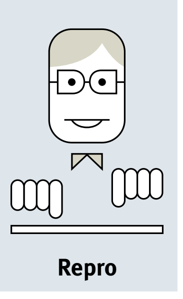
Photographer
Clarify in the briefing if your photos are required for internet and office applications. If this is the case then offer to deliver two RGB versions to your print buyer: high-end data (high resolution, possibly 16-bit color depth, in AdobeRGB or ECI-RGB) and data for internet and office applications (lower resolution, 8-bit color depth, in sRGB). Also embed the profile for the respective RGB working color space in the files. You should always enclose a short description of the color spaces you've used with the delivery.



Graphic Designer
Check in the application program that sRGB is set for unprofiled RGB data. This should be the rule. If not, then it is essential to activate the profile dialogue window for opening data. Always deliver RGB data for internet and office applications in sRGB with embedded profile.



Repro
ECI-RGB should only ever be chosen as the working color space when high-end image editing takes place. It is essential to activate profile dialogue windows. When unprofiled RGB data is opened these should be allocated the sRGB color space. If our print buyers deliver RGB data with an embedded profile **other than** ECI-RGB, this profile should be maintained for the further stages of processing – a conversion to ECI-RGB has no advantage but can lead to banding in critical images. If print buyers require RGB data for internet and office applications then these should be converted to sRGB. Communicate clearly to your print buyers the differences between ECI-RGB and sRGB.



If you stick to these basic rules then most common problems can be avoided when working with image data from or intended for the high-end world of ICC and the sRGB-based internet and office environment. The following pages deal with the subject of monitor profiling, as this also needs to be adjusted for the chosen RGB working in color space in some areas.

Monitor Setting for Color Temperature and Light Density

To achieve a good match between the monitor display and the proof in the light booth next to the monitor it is important to set the monitor to the correct white point.

The monitor's white can tend towards warm or cold. For color assessment it is necessary to settle on a consistent white for the monitor as well as for light booths used for the color matching of proofs and artwork. For the graphics industry this is a white of D50 or 5000 Kelvin.

The measured value, by the way, is derived from a reference light source that, depending on temperature in Kelvin, produces a warm or cold light. Along with D50 (5000 Kelvin), D65 (6500 Kelvin) is also common. This somewhat colder white is recommended for use in television production as well as straightforward office and internet applications.

The most important demand made on color-calibrated monitors, however, is the corresponding display with reference prints or proofs in the light booth next to the monitor. It is at this juncture that the phenomenon occurs that the monitor, metrologically calibrated to exactly D50, appears too yellowish. This is dependent to a great degree on the light intensity of monitor white and the ambient light. The light density given in the measurement Candela describes how bright a pure white is displayed on the monitor. CRT displays can reach a maximum of 70 to 110 Candela, depending on make and age. TFT displays can easily reach a maximum of 200 Candela and more, depending on make. The brighter the ambient light and the lower the light density of the monitor, the stronger the visually perceived yellow cast is at a color temperature of 5000 Kelvin for the monitor.

For this reason, many professionals in prepress calibrate their monitors to D55 or 5500 Kelvin to achieve the best possible match with the light booth. With a light density of circa 90 Candela this little trick produces nearly always the optically better result. CRT displays that can only reach 80 Candela or less because of their age should be taken out of service in image editing. An accept-

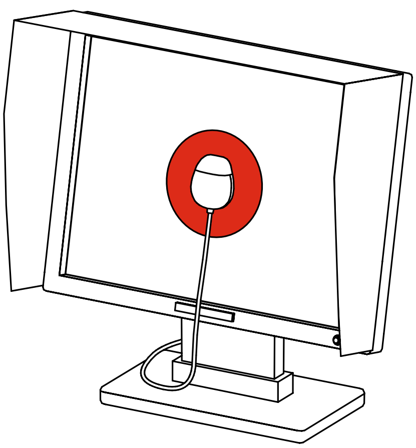
The optimal color temperature for a monitor is the one that gives the best correspondence to the proof in a dimmable light booth next to the workstation.
For TFT displays this is generally around 5000–5500 Kelvin, for CRT displays mostly 5500–6000 Kelvin.

able match with a reference proof is often only achieved with such monitors from 6000 Kelvin. If a TFT display is set to a light density of 120 to 140 Candela, then the visual perception at 5000 Kelvin normally corresponds better to the theory and the standards.

If you are calibrating a monitor for the first time, there comes the moment of retuning: if you've worked for a long time on a monitor with a white between 6500 and 9500 Kelvin, it can be quite irritating at first how yellow the monitor is, calibrated to 5000 or 5500 Kelvin. But if you work with the monitor for about 30 minutes and then switch to 9300 Kelvin, you'll find the opposite is true – suddenly the monitor appears unnaturally cold and bluish. The effect is particularly strong if you do not have a light booth next to the monitor to compare the color reproduction on the monitor with a reference.

6500 Kelvin for Straightforward Internet Applications
The only exception to the rule of 5000–5500 Kelvin is for monitors on which colors are assessed explicitly for the internet. In this case the monitor should be set to 6500 Kelvin. The color reproduction is then somewhat cooler in comparison to monitors with 5000–5500 Kelvin.

D65 in AdobeRGB and sRGB
If you take a look at the definitions for the RGB profiles AdobeRGB and sRGB, you'll find a reference to D65 or 6500 Kelvin. This does not mean that monitors, when using these color spaces, need also to be set to 6500 Kelvin. The optimal color temperature for the monitor is dependent on the intended later use and not the applied color space. Photographers and graphic designers who work with AdobeRGB and also doing prepress tasks should therefore set their monitors to 5000–5500 Kelvin.



A monitor measuring device is invaluable for the optimal setting of color temperature and light density. The conditions for consistent color reproduction can only be met when all the monitors in a company are set to the same color temperature and light density.

The Gamma for the Monitor and RGB Working Color Space

The gamma or gamma curve describes the brightness gradient from dark to light on the monitor or within an RGB color space. The greater the gamma, the darker the mid-tones on the computer. Usually, a gamma of 1.8, which was introduced in the primitive times of the Macintosh for black and white monitors and the Apple Laserwriter, is prescribed in the graphics industry and a gamma of 2.2 for Windows, office programs and internet browsers.

If you browse through archives of mailing lists on the subject of color management, you'll see that, since many years, there have been regular heated discussions as to which gamma is the best.

The question of the right gamma can be asked for the target value of the monitor calibration as well as for the choice of RGB working color space. Ideally, the RGB working color space and the monitor calibration should both be based on the same gamma. In the practice of color management, however, this is less important than most users assume. As long as the monitor has a high-quality profile available and an application program such as Photoshop supports ICC profiles, then it is only relevant for absolute high-end demands which gammas the RGB working color space and monitor have. The differences are canceled out with color management.

It's a different story when RGB images are transferred from programs in a color-management workflow to office programs or internet applications. At the time of this third edition going to press, a correct color display in office programs and internet applications is still based on the assumption that RGB working color space of the images as well as the monitor itself are attuned to a gamma of 2.2.

The row of images below simulates the differences in display when the same image, without color management, is reproduced on monitors with different gamma settings.

Gamma 1.4

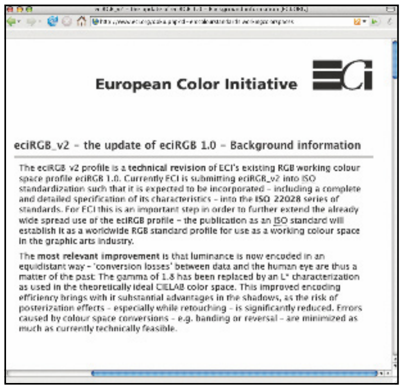
Gamma 1.8

Furthermore, many drivers for digital cameras can only deliver images in color spaces with a gamma of 2.2. These are, for example, the color spaces sRGB or AdobeRGB. For a color-correct transfer of such camera images in Photoshop, the same RGB working color space needs to be set. Users who want to work as uncomplicated as possible in Photoshop as well as office programs and internet browsers should calibrate their monitors to a gamma of 2.2. Inexpensive monitors are generally constructed innately to work optimally with a gamma of 2.2.

A gamma of 1.8 for the monitor is only recommended for repro-oriented working environments where suppliers and receivers of RGB image data all work essentially with a gamma of 1.8 and where a proper color display in office programs or internet browsers is not of importance. The corresponding RGB working color space is ECI-RGB. For a high-quality monitor display, a monitor calibrated with hardware should be used, whereby the color-measuring device and monitor communicate directly with each other.

The Linear Gamma L*

The linear gamma, also known as L* or L-Star, is a new approach in color management. Here, there is not just one measured value that describes the brightness of the mid-tones. Instead, a linear gamma ensures that equal distances in RGB gray values also yield equal distances in the L value of the Lab color space. Consequently, an RGB working color space with linear gamma is also required. Together they provide an optimal utilization of the brightness levels in the RGB working color space and on the monitor. The users of the linear gamma are mostly found in the areas of high-end photography and post-production. The version 2 of the ECI-RGB – called eciRGBv2 is also based on a linear gamma.

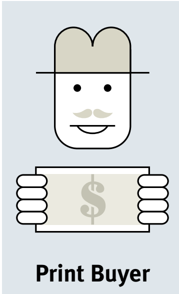


*The eciRGBv2 workingspace can be downloaded from **www.eci.org***

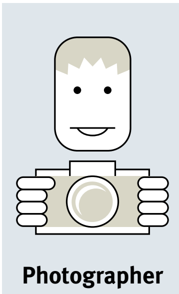
Gamma 2.2

Gamma 2.6

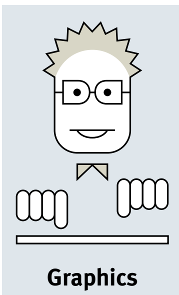
Summary of the RGB Working Color Space and Monitor



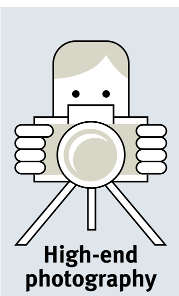
Print Buyer
Your monitor should be set to a gamma of 2.2 and, if possible, have an individually created monitor profile. If you, as the contracting body, also use DTP programs then “sRGB” should be set in the RGB settings for unprofiled data, furthermore, embedded profiles in RGB data should always be maintained. If you compile an image library with RGB data then it should be clearly indicated for each image if it is high-end data in a working color space such as AdobeRGB.

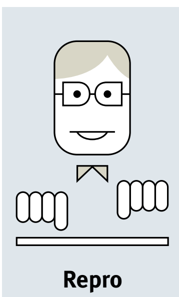


All-round Photographer
Your monitor should be set to a gamma of 2.2 and you should select “AdobeRGB” as your RGB working color space. When delivering image data you should embed this working color space in your image files. If the print buyers are not graphic designers or repro houses then it is to be recommended that, in addition to AdobeRGB data, you also send an office or internet folder containing low-resolution data that you have converted from AdobeRGB to sRGB.



Graphic Designer
Your monitor should be set to a gamma of 2.2 and have, at all costs, an individually created monitor profile. “sRGB” should be selected in the RGB settings of DTP programs for unprofiled data. Furthermore, embedded profiles in RGB data should always be maintained. If you capture images yourself then AdobeRGB is to be recommended as the working color space. In layouts for internet and office applications you should always check that RGB data also exists in the sRGB color space.





High-end Photography, Post-production, Repro Houses
The monitor gamma should correspond to the gamma of the RGB working color space. If work is carried out in ECI-RGB then this means a gamma of 1.8. If work is done in eciRGBv2 then the monitor must also be calibarted to L*. When delivering RGB data for office and internet applications care should be taken to ensure that the data is firstly converted to sRGB.

After this short excursion into the world of RGB working color spaces and monitor settings, the next sections cover further details pertaining to the ICC standard. In particular the various options for the conversion of data from a source color space to a target color space are discussed.

Construction of an ICC Profile

The most important components of an ICC-conformal color-management system are the color profiles. These contain, among other things, different rendering intents that – depending on purpose – can be coupled with the rendering intents in other profiles.

The color field in the profile symbol represents the color-conversion tables, also known as ***rendering intents,*** *which will be looked at now in closer detail.*

What is a Rendering Intent?

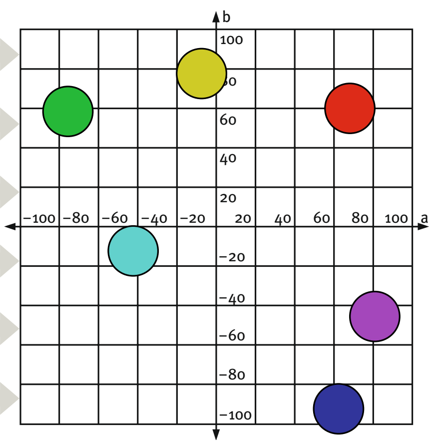
Put simply, rendering intents are large tables that translate all a color profile's RGB or CMYK color values to the Lab color space. However, with an 8-bit color depth per RGB color value, such a table would have 16.7 million entries. Because this would be too unmanageable, only a selection of color values is saved in the table. The values in between are interpolated from the neighboring values. Because the table contains an individual dimension for the values of R, G and B and L, a and b, respectively, tables of this type are known as *3d-lookup-tables*.

Characteristics of the Rendering Intents for CMYK Colors

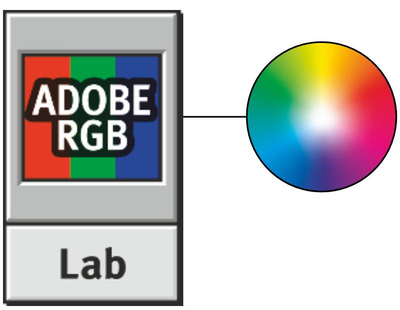
In the conversion between CMYK and Lab there are, theoretically, with 4 x 8-Bit color depth, 43 billion possible combinations of the colors cyan, magenta, yellow and black. In order to work with a reduced number of combinations, an ICC profile has, from the offset, a predefined black generation. This color generation cannot be changed later. Programs for creating ICC profiles therefore mostly have an internal base format from which different black generations can be produced.

A section of a color profile's rendering intent. In reality, the number of recorded color values lies between 27 and 32,000, depending on the profile's accuracy.

R	G	B	L	a	b
0	191	191	75	−44	−14
191	0	191	54	81	−46
191	191	0	80	−17	75
191	0	0	48	68	60
0	191	0	71	−78	63
0	0	191	30	64	−92



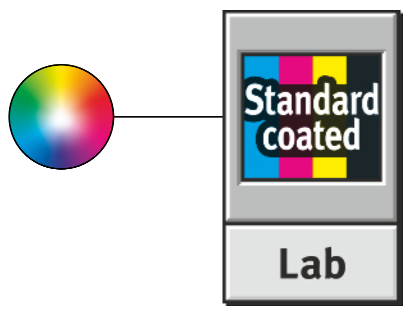
RGB: larger displayable color gamut



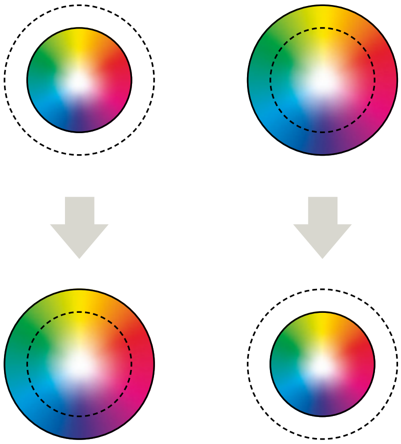
A monitor, with its additive mixture of colors from the components red, green and blue, is able to reproduce more saturated colors than possible in print with a subtractive mixture of cyan, magenta and yellow.

The range of LCH/Lab colors mixable from RGB is therefore ***larger*** *and is* ***reduced*** *in print. The conversion between both color systems is done with the* ***rendering intents****. There are two possibilities that are explained in detail on the following pages.*

CMYK: fewer displayable colors



The Colorimetric Rendering Intent



The colorimetric rendering intent transfers all reproducible colors 1:1 to the target color space and clips all the non-reproducible colors.

A rendering intent converts any colors from one color system to another. The description "colorimetric" stands for a conversion that displays any input color value optically the same in the target color space, provided the target color space is large enough. For example, if you want to display CMYK color values for offset printing on the monitor, these are converted to Lab with the offset profile. These Lab values are then converted to monitor colors using the colorimetric rendering intent in the monitor profile. This is unproblematic because the monitor's color gamut is larger than that of offset print. The same is true for the digital proof of offset colors: the data is translated to Lab with the offset profile and then converted with the colorimetric rendering intent in the proof profile. It becomes more difficult when, for example, monitor colors are converted for print. All monitor colors that cannot be printed are simply reduced to the next printable color by the colorimetric rendering intent. The larger monitor color space is "clipped" to the limits of the printable area.

Each profile contains two versions of the colorimetric rendering intent: "absolute" simulates, by means of inking on a lighter proof medium, the white tone of a darker paper in print. "Relative" cannot simulate paper color through inking.

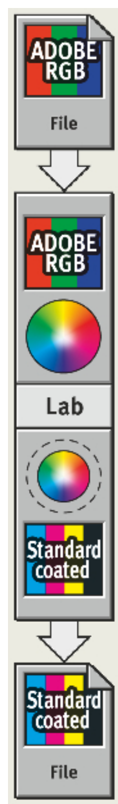
In these blue bands, the background color and the three left boxes are too saturated to be reproduced in print. The colorimetric rendering intent reduces them to most saturated printable color tone, while the other boxes are translated 1:1.

Above is the simulation of the monitor display with the band after adjustment to CMYK below it.

CMYK to RGB with the colorimetric rendering intent

The data, converted to Lab, passes through the monitor profile with the colorimetric rendering intent that translates the colors 1:1.
This is unproblematic as the smaller CMYK color space is contained in the RGB color space.

The CMYK data passes through the offset profile. The small color wheel symbolizes the reduced color space of offset printing.



RGB to CMYK with the colorimetric rendering intent

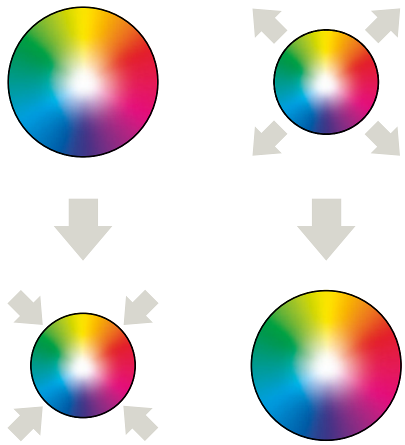
An AdobeRGB image with a large color gamut is converted to Lab values with the AdobeRGB profile.

In the reduction of the color gamut, the colorimetric rendering intent in the offset profile clips all the non-printable colors to the maximum reproducible value (see the blue bands, left).
All printable colors are translated 1:1 to the target color space.

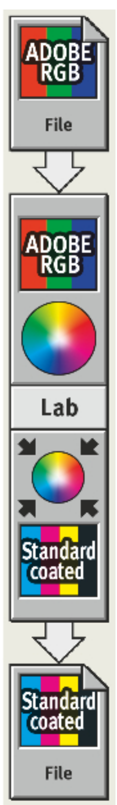
The Perceptual Rendering Intent

ICC profiles contain a further table for the conversion of a large color space to a smaller one: the perceptual rendering intent, often also described as the photographic rendering intent. This translates the most saturated colors of the monitor image to printable colors with the greatest possible saturation. In this way, a monitor image is converted as best as possible to the smaller print color space. However, this image-based color conversion does have a disadvantage: not all the printable monitor colors are reproduced 1:1. The smaller range of saturated print colors has to reproduce the many saturated monitor colors. In order to do this, some of the printable monitor colors have to be reproduced less saturated so that the color distance in the image is maintained. In other words, the whole color space is compressed.

The perceptual rendering intent table is standard in most programs for the conversion of monitor colors to the CMYK color range. Throughout the operation this table cannot be changed. Regardless of how the inbound image is constructed, it always runs through exactly the same table with always the same color compression. Very good results can be achieved with most applications. In a few cases, however, problems can occur. These will be explained in greater detail on page 140.



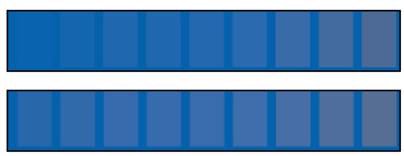
The perceptual rendering intent compresses the whole color space so that color distance is maintained.
A reverse operation is usually only possible with limitations.



RGB to CMYK with the perceptual rendering intent

An AdobeRGB image with a larger color gamut is converted to Lab values with the AdobeRGB profile.

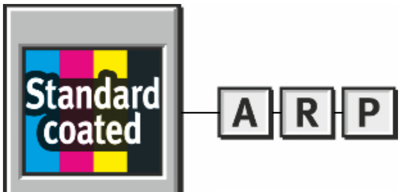
In the reduction of the color gamut, the perceptual rendering intent in the offset profile compresses it to a printable color gamut. This compression alters all colors.



The same blue bands as on the opposite page: the perceptual rendering intent compresses the whole color space so that the color distances in the image are maintained.

The simulation of the monitor display is illustrated above with the band after adjustment to CMYK below it.

Rendering Intents and their Application in Separation



Every profile contains three main types of conversion table.

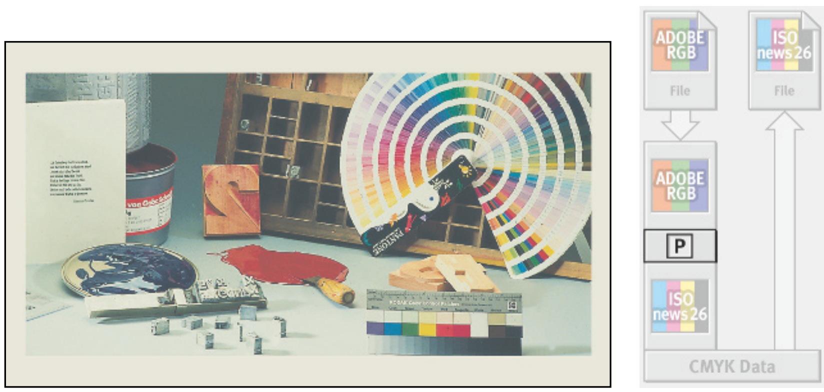
The letter in the Lab interface field between the profile symbols indicates which pair of tables is being used for the conversion.

Every ICC profile contains three different main types of conversion table: the absolute colorimetric, the relative colorimetric and the perceptual rendering intent. In the conversion with two profiles, the appropriate rendering intents of *both* profiles are used. Thus, both of the absolute, relative or perceptual tables are averaged.

The choice of the right rendering intent plays a large role in configuring application programs for a consistent color reproduction. The road to this goal is often a rocky one because many programs have rendering intents predefined for certain tasks and do not describe *which* intents are being used. Many manufacturers also use their own descriptions for rendering intents.

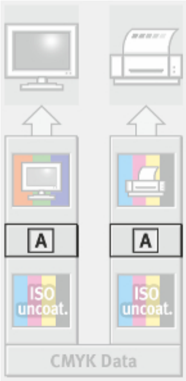
Because of the importance of rendering intents for color transformation with profiles, the abbreviations A, R and P are used in the profile symbols in subsequent graphics to indicate the rendering intent being used.
A stands for “absolute colorimetric”. Its main purposes are for the digital proof and the soft proof on the monitor with the simulation of the subsequent paper tone. **R** means “relative colorimetric”. Its main purposes are for the digital proof and soft proof on the monitor without a simulation of the paper tone. To achieve the best possible color values in the media wedge on the proof it is essential to use the absolute colorimetric rendering intent. **P** stands for “perceptual”, also know as “photographic”. Its main purpose is for the separation of RGB image data for printing.

*This illustration shows the separation of an RGB file for newsprinting. With the **perceptual rendering intent,** all component parts of the image compressed visually correctly to the smaller color gamut of newsprinting.*



*The same RGB file, converted with the **absolute colorimetric renedering intent.** A loss in detail occurs (clipping) because the light, dark and saturated tones in the artwork cannot be reproduced 1:1 on newsprint.*

Rendering Intents for Soft and Digital Proofs

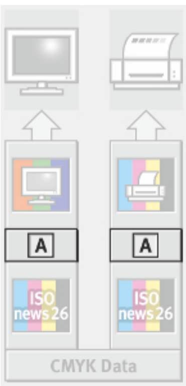


A

This illustration shows the simulation of a printed result on uncoated paper, which is somewhat darker and bluer than the proof medium. By using the ***absolute colorimetric rendering intent*** *the color tone of the paper is simulated on the monitor or proof printer.*

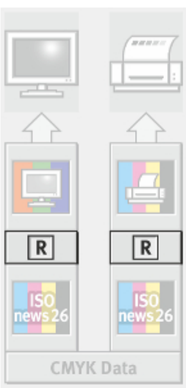
R

If the ***relative colorimetric rendering intent*** *is used instead then the paper tone is not simulated – the white of the proof medium (monitor or proof material) is shown. This has no bearing if there is only a slight difference from the paper tone.*



A

This illustration shows the print simulation for news printing on a monitor or proof printer. By using the ***absolute colorimetric rendering intent,*** *the paper tone of the newsprint is shown.*



R

If the ***relative colorimetric rendering intent*** *is used then there is no reproduction of the newsprints' paper tone. Instead, the white of the monitor or proof material is shown. The newsprint paper tone and all bright colors are reproduced too lightly as the difference from the white of the medium is too great.*

Black-point Compensation

Relative colorimetric rendering intent with black-point compensation

In Adobe programs there is a checkbox “Black Point Compensation” next to the choice of rendering intents in the menu items for the application of color profiles. At the time of going to press this is not a component part of the ICC standard, although there have been preparations within the ICC since 2005 to introduce this.

What does Black-point Compensation do?
Black-point compensation is basically an extension for the relative colorimetric rendering intent. As explained on the previous page, the relative colorimetric rendering intent converts the pure white of the source color space to the pure white of the target color space. An RGB white of R 255, G 255, B 255 produces a CMYK white of C 0, M 0, Y 0, K 0 and vice versa.

The relative colorimetric conversion behaves differently, however, in very dark tones: if dark tones are present in the source color space that cannot be reproduced in the target color space, then these are clipped by the relative colorimetric conversion. This occurs particularly in the conversion of RGB data to printing color spaces that cannot produce a very dark black. If rich black CMYK values are converted relative colorimetrically to the RGB color space, then an RGB dark gray of, for example, R 18, G 19, B 17 is produced instead of R 0, G 0, B 0.

Black-point compensation ensures that the darkest rich black in the source color space is always converted to the appropriate rich black in the target color space. Source and target can exist as RGB as well as CMYK.

Perceptual versus Relative Colorimetric Intent with Black-point Compensation
The perceptual rendering intent makes sense when the colors in an image are clearly more saturated and higher in contrast than can be reproduced in the target color space. If there is only a small difference between the colors in the image and target color space, or if all the colors in the image can be reproduced 1:1 in the target color space, then the relative colorimetric rendering intent with black-point compensation is the better choice – the use of the perceptual intent in this instance would desaturate the image slightly or reduce the contrast somewhat. For production on coated paper, with 80–90% of images, the relative colorimetric with the black-point compensation method produces the better results.

Relative Colorimetric with Black-point Compensation Produces a Consistent Result
In the calculation of the perceptual intent, the ICC specifications give the manufacturers of profiling software great freedom. If an RGB image is separated with profiles originating from different profiling software, this can lead to visibly different results. The ICC specifications give manufacturers exact parameters for the relative colorimetric intent. The basic conversion of images with the relative colorimetric intent and black-point compensation produces more consistent results across various profiling software. There is more about this on the next double-page.

Separation and Monitor Display with Black-point Compensation

Specifically in Adobe applications the black-point compensation is used in two main areas. It is preset in the provided color settings for the mode change between RGB and CMYK. It is also preset for the monitor display.

This means that, in Adobe applications without special configurations, CMYK color spaces with different dynamic ranges are always “inflated” to the monitor’s dynamic range. The image on the far right shows, in comparison to the image in the middle, the effect this has on the display of ISOuncoated images, for example, on the monitor.

Sections from the DQ-Tool from the German Photographic Industry Association

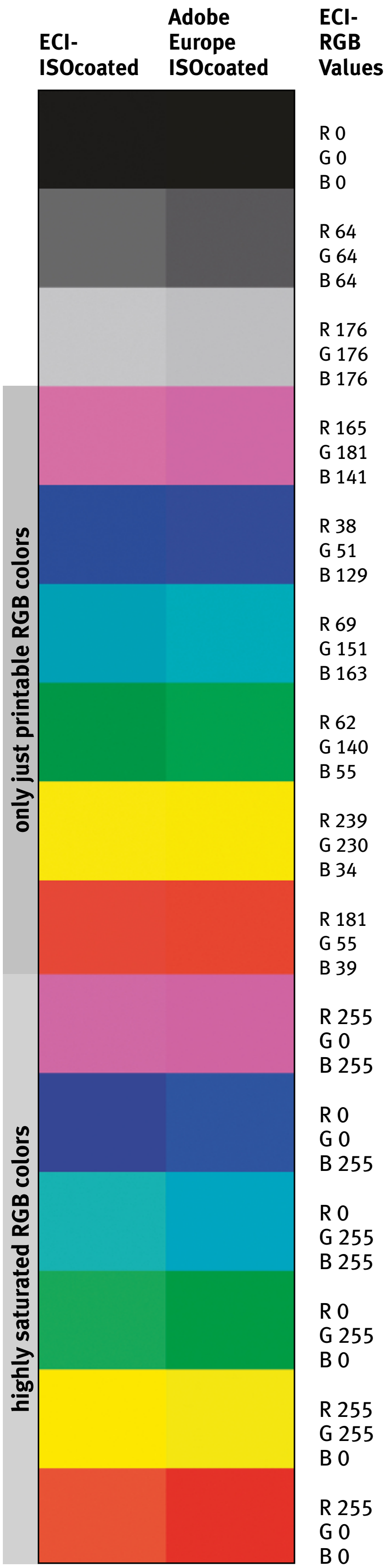
This example shows the use of the relative colorimetric rendering intent in the conversion of AdobeRGB to FOGRA29/ISOuncoated. Because AdobeRGB has a higher dynamic range than FOGRA29/ISOuncoated, details in the shadows are lost.

If black-point compensation is used in the separation, details are maintained in the dark areas.
The reproduced colors and contrasts simulate the proof and print in the FOGRA29/ISOuncoated color space.

If black-point compensation is used for the display on the monitor then the display appears much richer in contrast to what is later the case on the proof or in print.

Black-point Compensation Compresses and Expands Dynamically
Normal rendering intents in ICC profiles are static, precalculated tables. The black-point compensation analyses the differences in the maximum attainable depth for the source and target and, from that, dynamically calculates a compression or expansion in the color conversion. In doing so, it not only refers to the dark areas of an image (as the name might suggest) but to the conversion of all color ranges in the image. This often leads to a better-adjusted color compression from the source to the target color space than with the use of the static tables in the perceptual rendering intent.

Perceptual Conversion in Comparison



These illustrations show the perceptual conversion of RGB data with the profile variations “ISOcoated.icc” from the ECI and “EuropeISOcoatedFOGRA27.icc” from Adobe. The colored bars consist of neutral ECI-RGB colors, colors that are only just printable 1:1 in the ISOcoated color space, and the primary colors from ECI-RGB. It is noticeable in the comparison that the differences apply to all color ranges. With regard to the gradation of mid-tones, the ECI-ISOcoated produces a visibly lighter separation than the Adobe variation. This can be seen in the gray tones of the colored bar as well as in the photo below. In dealing with highly saturated RGB colors, both profiles display deviant conversions. With the exception of blue, the ECI profile produces lighter CMYK color values than the Adobe profile. This characteristic changes with the colors that are only just printable. Here, the ECI profile produces, in parts, darker CMYK tones.

For the user then, it is a matter of record that the perceptual conversion of RGB data with profiles from different manufacturers for the same printing standard can lead to visibly different results. This not only concerns highly saturated colors, but also less saturated tones right up to the gradation of neutral tones. The result, then, of a conversion from RGB to CMYK is, in many areas, dependent on the profiling software used.

Problems in the Media-neutral Production with RGB Data

For production processes in which RGB image data is automatically converted to different CMYK target color spaces, this means a huge constraint. An automation is practically only possible when the profiles being used have been generated with the same software, for all the CMYK target color spaces. If users exchange RGB data and work with different profiling software then no automation is possible when the demands for quality are high. The same constraint applies when different printing service providers supply their profiles to repro houses and these have been created with different profiling software.

ISOcoated, perceptual

Europe ISOcoated FOGRA27, perceptual

Relative Colorimetric with Black-point Compensation in Comparison

Compare then the conversion of the RGB test images with the relative colorimetric intent and black-point compensation and the problematic is greatly reduced: both profiles produce very good results in the photo as well as the neutral and only just printable RGB colors. It's a different story with the highly saturated RGB colors – as before, clear differences can be recognized here between both profiles. This behavior corresponds exactly to the ICC specifications. When it comes to the perceptual intent, they allow the provider of profiling software great freedom as to how it controls gradation and color compression. However, for the relative colorimetric intent it is prescribed that the results of profiles from different manufacturers must correspond, provided that the colors to be converted can be reproduced 1:1 in the target color space. The ICC specifications do not set any particular parameters for the conversion of highly saturated colors with the relative colorimetric intent. Large differences in these color ranges are also quite normal for the relative colorimetric intent between profiles of different manufacturers.

Because the black-point compensation also comprises a dynamic color compression, it can not only balance out different dynamic ranges but also different gamuts from source to target. Because this special color compression is based on the relative colorimetric tables, the differences between various profiling software hardly has any bearing as long as the image in the source color space does not contain any extreme saturated colors.

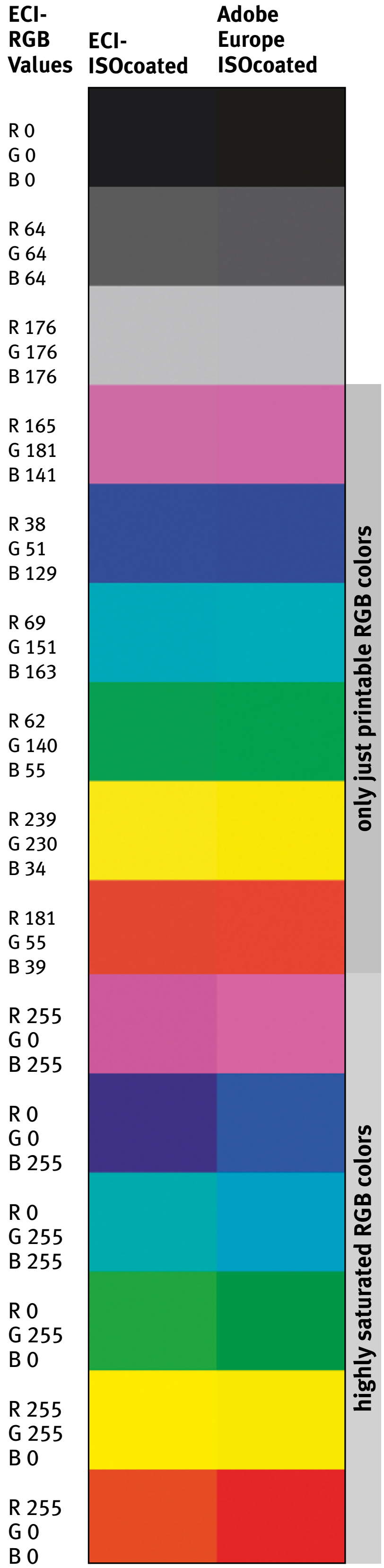
Converting RGB Data with Profiles from Different Manufacturers as Reliably as Possible

If you want to convert RGB data with profiles from different manufacturers as similarly as possible, there are two conditions:

1. A relative colorimetric conversion with black-point compensation,
2. Colors in the image should not be much more saturated than is possible in the target color space.

ISOcoated, relative colorimetric with black-point compensation

Europe ISOcoated FOGRA27, relative colorimetric with black-point compensation



RGB Image Optimization for Automatic ICC Conversion

The top image shows the CMYK conversion of a very highly saturated image with the relative colorimetric rendering intent and black-point compensation.

Below that the result after some color ranges have been manually desaturated under an activated soft proof. Now there is, for example, more detail in the red blade on the windmill.

This optimized RGB image can be archived and is ready for automatic production processes.
(Source: DQ-Tool from the German Photographic Industry Association)

As the previous examples have shown, the relative colorimetric conversion with black-point compensation is currently the best method to achieve as consistent a conversion as possible across different profiling software. The requirement for this is, however, that no extremely saturated colors are present in the image. With real photos, extremely saturated colors, in a relative colorimetric conversion with black-point compensation, would lead to clipping and a loss in detail. In the author's experience and according to articles on various mailing lists this effects circa 0–10% of the images to be separated. In order to correctly convert such images, there are two different approaches:

Archiving with Complete Color Gamut and Manual Separation
In an extensively manual production process each RGB image is archived with its complete color gamut. The final separation occurs in an image-editing program and the viewer decides whether conversion will be done relative colorimetrically with black-point compensation or perceptually. In the case of the latter it should be taken into account that conversions with profiles from different sources will produce different results. Furthermore, and at the time of going to press, there is no solution for deciding by means of automatic image analysis which method of conversion is best for the image in question.

Archiving with Limited Color Gamut and Automatic Separation
In this production process each RGB image is controlled prior to archiving with a soft proof for a standard coated profile. For the 0–10% of images where clipping becomes visible, manual image editing is carried out until sufficient detail is present in the critical image areas. For a practiced image retoucher this is quickly done with a program such as Photoshop.

This method has four advantages over the previous one:

1. After archiving, the images can be fully automatically separated.
2. The problem with the different perceptual conversions of different profiles is safely avoided.
3. A proof for the standard coated color space can be automatically created from the images. This makes approval of RGB images easier and establishes a reliability in the data transfer from photographers to prepress.
4. The determining of a conversion method is a prerequisite for working numerically in the RGB color space. For example, RGB target values can be defined for product colors in a catalog. They can be controlled at an early stage with the pipette in Photoshop and serve as a template for RGB color corrections.

These are the basic reasons why, in the color strategy at the end of this volume and, the second method takes preference.

RGB Image Editing with CMYK Soft Proof

Up until now, in all the illustrated production processes two profiles have been linked together for a color transformation. In principle, with the ICC technology, color transformations can be carried out three or more profiles linked together. In the case of RGB image editing this is very useful and is indeed used in practice. The graphic on the right shows a process in which the AdobeRGB data, during processing, is converted to the standard coated color space with the relative colorimetric intent with black-point compensation and from there converted relative colorimetrically to the monitor's color space.

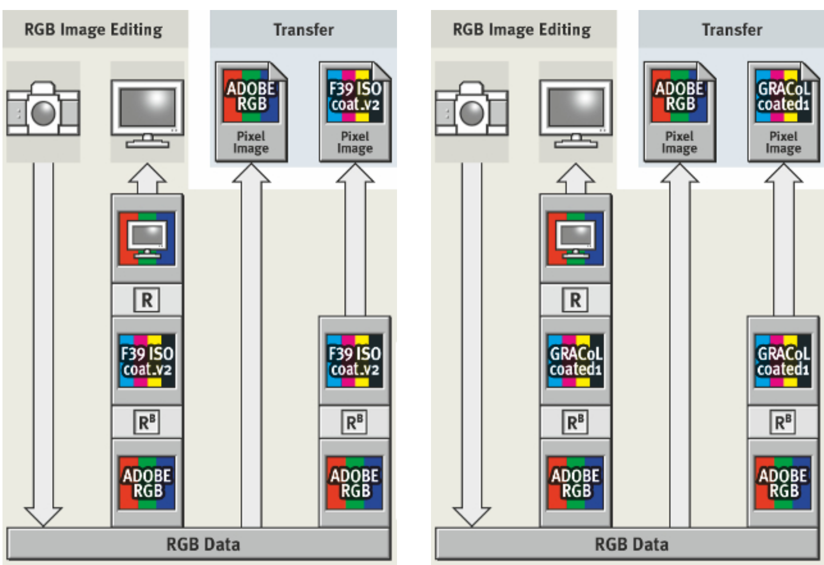
Color-management process with the standard coated soft proof of an RGB file

In this way, it can be checked, in a suitable image-editing program such as Photoshop, if images can be smoothly converted to the standard coated color space with the relative colorimetric intent and black-point compensation. In a few cases, however, a relative colorimetric conversion with black-point compensation can lead to loss of detail in image areas with a high saturation.

RGB image editing with an active soft proof for standard coated allows such cases to be manually optimized until there is no more loss in detail and the saturation is maintained as best as possible. The image, prepared and controlled in this manner, can be subsequently archived and is ready for production processes in which RGB data is universally converted with the relative colorimetric method and black-point compensation. The process diagram below shows the direct transfer of AdobeRGB images from the camera, editing with a standard coated soft proof and the output of image files in the AdobeRGB and standard coated color spaces.

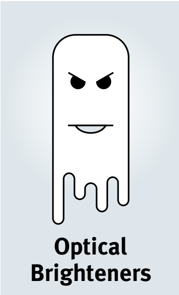
Before we now come to more complex production processes with rendering intents, an old acquaintance is knocking at the door: that nuisance, the optical brightener.

ISO/FOGRA **US/GRACoL**

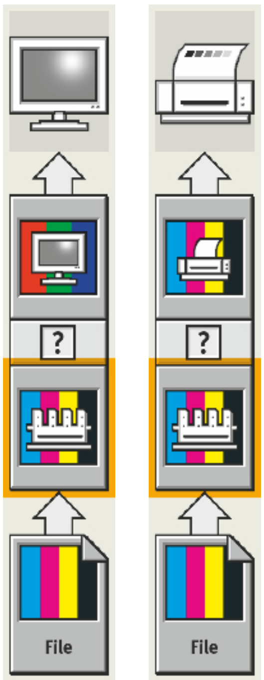


Using rendering intents for image editing in the photographic environment with FOGRA39/ISOcoated_v2 (left) and GRACoLcoated1 (right)

Rendering Intents and Optical Brighteners



As already shown, the basic problems with optical brighteners is the lack of reference between measured values and visual perception. If measuring devices delivered perfect measured values then the absolute colorimetric proof and the soft proof would produce visually perfect results. With nearly all solutions that provide functionality for the soft proof and/or proof, the user can choose between the rendering intents “absolute colorimetric” and “relative colorimetric” or between active and inactive paper tone simulation. Where optical brighteners are involved, the different rendering intents double the chances of reproducing visually incorrect colors on the proof or monitor.



Optical brighteners in the reference for the offset printing profile cause visually incorrect reproductions in the soft proof and proof, depending on rendering intent.

Optical Brighteners in the Profile for Production Print

If the reference for the offset printing profile contains high optical brighteners then the reproduction with the absolute colorimetric intent, on a normal proof medium or monitor, is clearly too blue. If the relative colorimetric intent is used for the reproduction instead, the reproduction of the paper tone is much closer to the original. However, as a rule, the gray axis leans heavily towards yellow. Without interferring heavily with the characterization data or the profile for offset printing, papers with a lot of optical brighteners cannot be incorporated sensibly into color management.

Image reproduction when the reference for the printing standard to be simulated contains more optical brighteners than the proof medium (center: the original).

Proof for ISOcoated and ISOuncoated on Media without Optical Brighteners

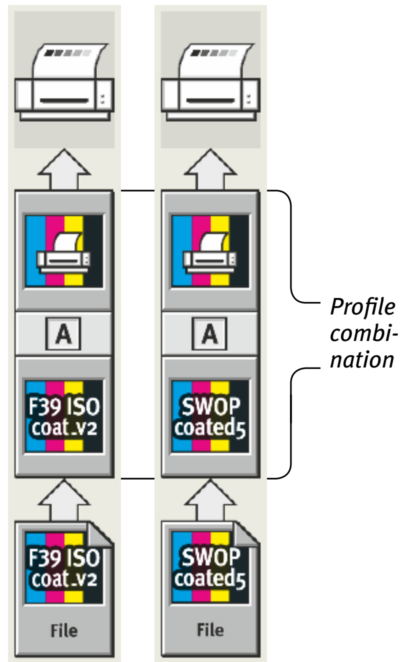
The profiles ISOcoated and ISOuncoated represent production papers with a moderate proportion of optical brighteners. If a medium, wholly without optical brighteners, with a b* value of circa 1 is used for proof of this printing standard, the same phenomenon occurs as in the images above: the metrologically correct proof with the absolute colorimetric reproduction displays a visually too bluish paper tone. The reproduction with the relative colorimetric intent produces a better paper white, a generally too yellowish display and more inferior values in the media wedge.

Image impression when the proof medium contains more optical brighteners than the printing standard being simulated (center: the original).

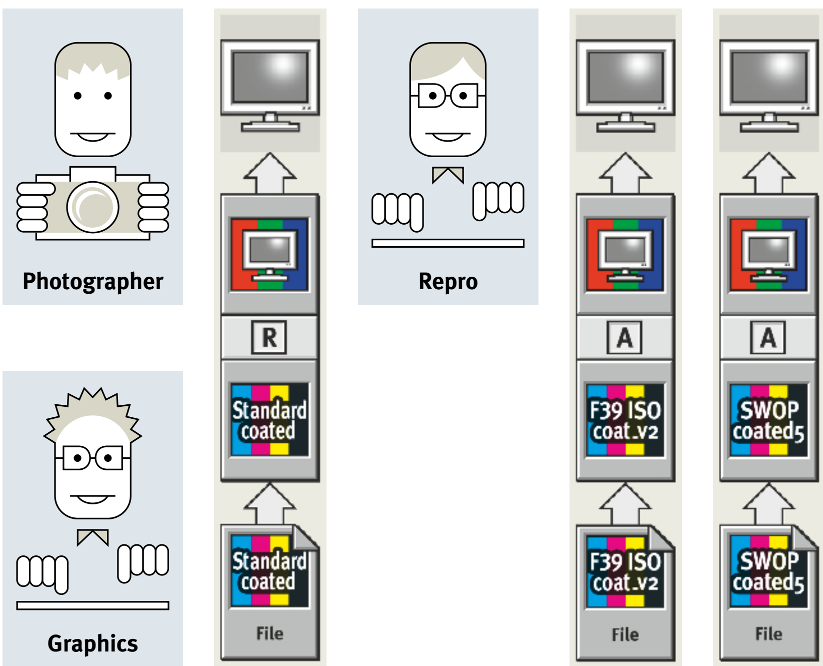
Proof on Media with many Optical Brighteners
A photo paper with many optical brighteners used in the proof medium has the opposite effect: the metrologically correct proof with the absolute colorimetric rendering intent shows visually a definite yellow cast. The relative colorimetric intent prevents the yellow cast but reproduces the gray axis much cooler than in the original.

Optimization of Individual Profile Combinations Including Rendering Intent
If various printing standards are to be simulated on one proof medium it is usual to optimize each profile combination of printing standard and proof medium individually. The basis for this is the absolute colorimetric conversion.

Which Rendering Intent for a Standard Coated Soft Proof?
The standard coated profiles (FOGRA/GRACoL) are based on a reference with a moderate proportion of optical brighteners. The soft proof with the absolute colorimetric intent produces a slightly bluish display. If standard coated is the only CMYK color space, the user should therefore use the relative colorimetric intent for the soft proof; high-end repro houses who regularly prepare data for different printing standards should use the absolute colorimetric intent.

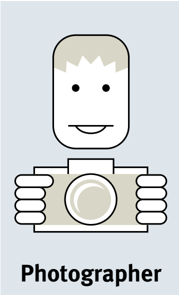


For optimal visual proof quality it is usual to optimize individually each profile combination of ISO standard and proof medium based on the absolute colorimetric intent (above).



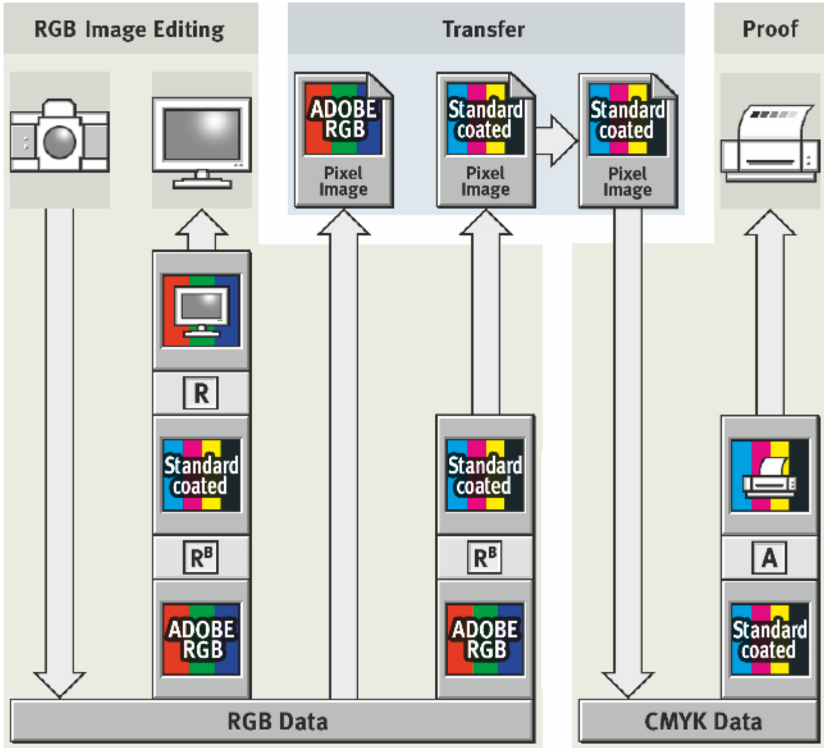
Photographers and graphic designers prefer, as a rule, the relative colorimetric soft proof for ISOcoated. Repro houses should work with the absolute colorimetric intent to be able to correctly judge the influence of different paper colorations.

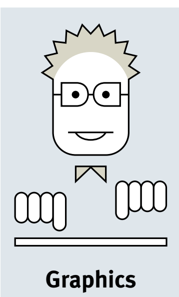
Production Process with Rendering Intents and Transfers

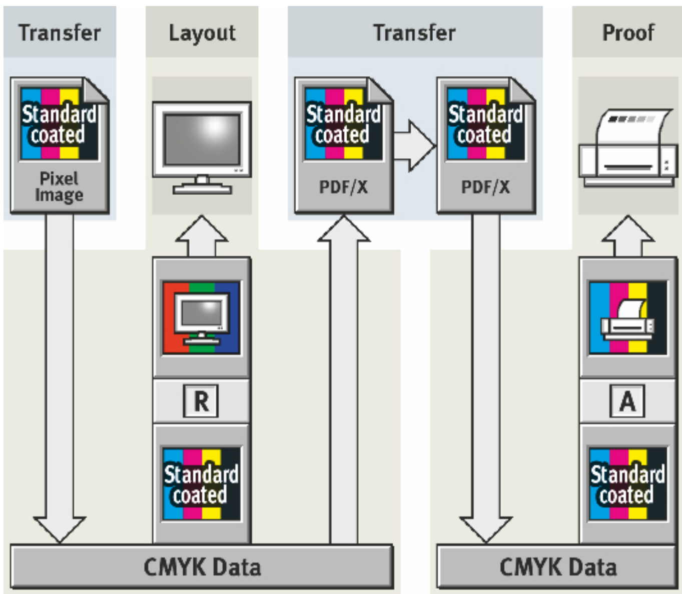


The photographer transfers AdobeRGB data from his camera. The soft proof for standard coated is activated for image optimization. The conversion from the working color space to the offset profile is carried out with the relative colorimetric intent and black-point compensation, the soft proof on the monitor is relative colorimetric. After editing, the images are saved as AdobeRGB and standard coated files with embedded profiles.

A standard coated proof is produced with a professional proofing solution from the standard coated images (conversion between offset profile and proof profile is absolute colorimetric). On this basis, the print buyer approves the proof and data. The photographer hands provides the graphic designer/ repro house with RGB and CMYK data along with the proof, with which he can verifiably communicate the original color balance of his photos.

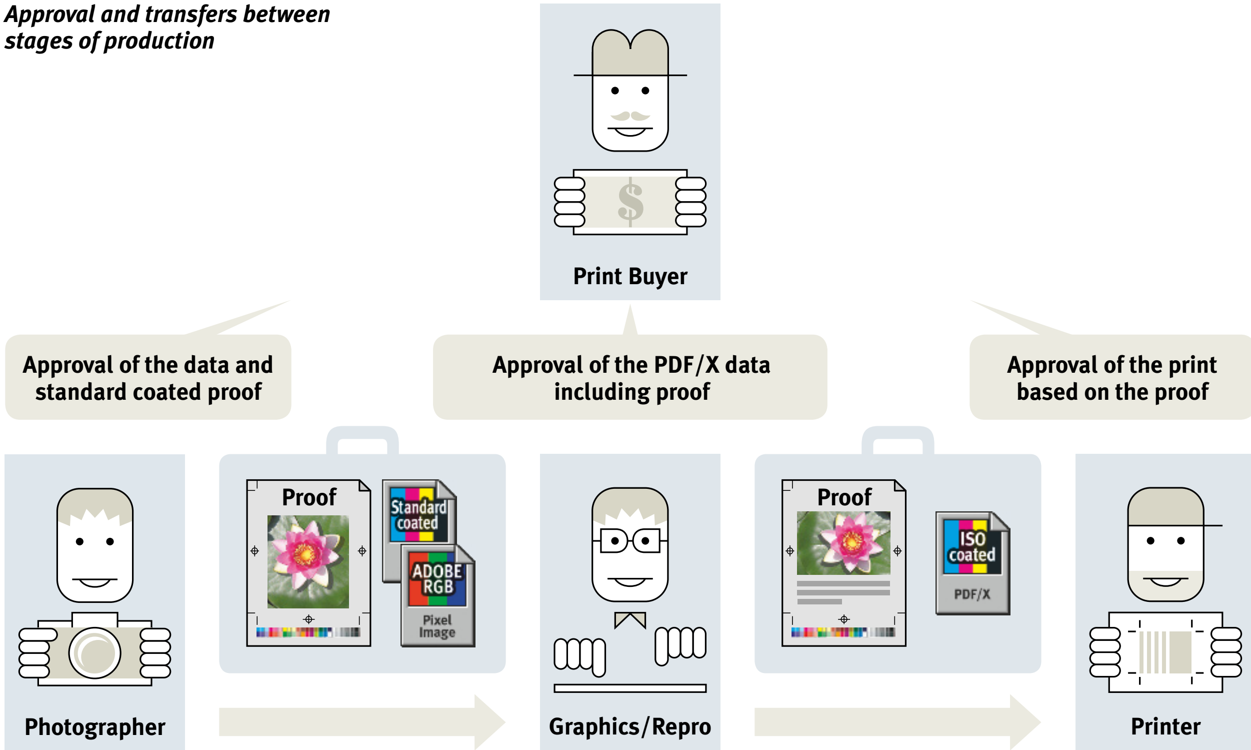


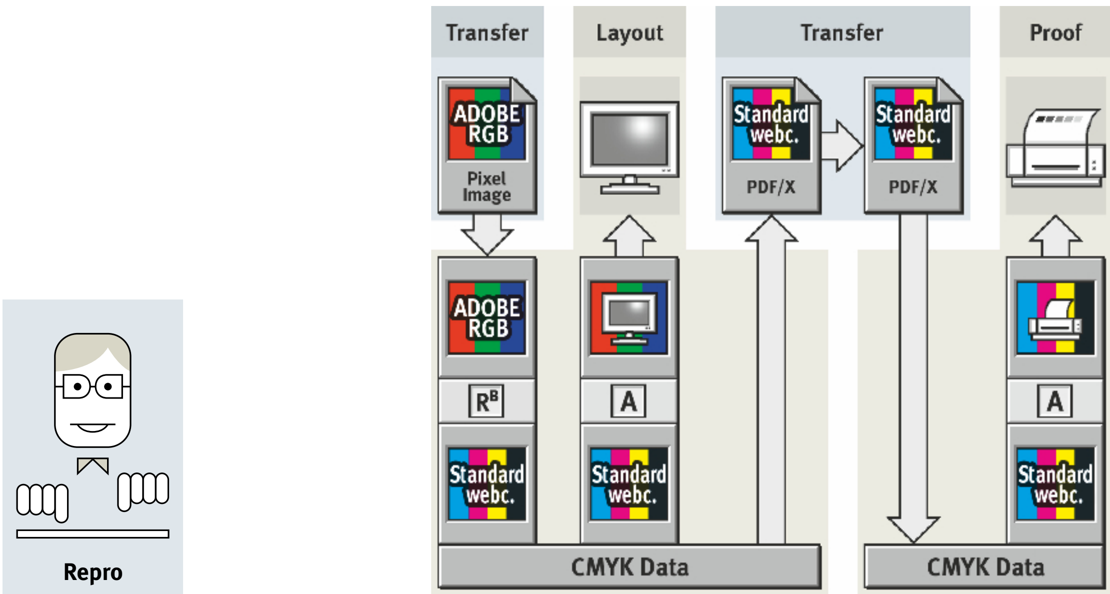




If the graphic designer constructs his layout for offset printing on coated paper, he can make immediate use of the standard coated images provided by the photographer. The profile embedded in the image files indicates a standard coated file. The proof supplied by the photographer serves for the control. All component parts of the document are saved in the standard coated color space, which is simulated on the monitor with the relative colorimetric intent. A PDF/X file for standard coated is created from the finished document, which is subsequently proofed (the absolute colorimetric intent is used here).
After the print buyer's approval of the proof, the standard coated PDF/X file and proof are passed on to the printers.

Approval and transfers between stages of production



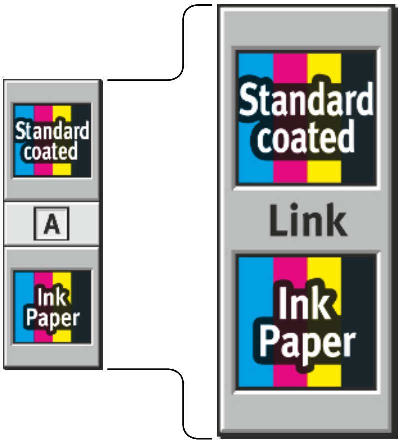


If the complete document is required for a printing standard other than standard coated (e.g. standard web-coated) or if it is to be adjusted for several printing standards (e.g. for an advertising campaign), then a professional repro house is the best choice for this purpose. These work with the AdobeRGB data from the photographer, which are converted to the respective printing standard through the embedded profile mostly with the relative colorimetric intent and black-point compensation.

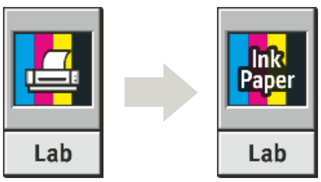
The soft proof on the monitor is done absolute colorimetrically. A PDF/X file is proofed (absolute colorimetric intent). This file and the proof are passed on to the printers.

Optimal Proofing of Print Standards with DeviceLink Profiles

DeviceLink profile



When a particular profile combination for the transformation from an ISO standard to the color space of a proof printer is optimized, it makes sense to save both profiles as a DeviceLink profile.



The proof printer's color space is always a result of the ink used and the proof medium.
This is alternatively represented by the symbol on the right.

Calibration file

Correction based on manufacturer's values for a combination of ink and proof medium.

At various points in this book it has been demonstrated that, due to the influence of optical brighteners, a purely metrological creation of color profiles for proof media and the printing standards to be simulated does not lead to visually optimal results – particularly when always the same proof medium is used in a proofing system for the simulation of different print standards. In order to achieve, in this case, a high quality of proof for all simulated print standards, each combination of proof and press profile must be optimized individually.

In high-quality proofing solutions it is usual to save such an optimized profile combination in a special profile format known as a DeviceLink profile. DeviceLink profiles always produce a complete color transformation from a source to a target and can only be used for this very color transformation.

While normal ICC profiles for different purposes can be linked with each other as desired, DeviceLink profiles are only suitable for optimizing a particular frequently recurring color transformation. The optimized simulation of different print standards on one proof medium is a typical use case for DeviceLink profiles. The targeted optimization of a particular profile combination is, however, only useful if the proofing system has a powerful calibration system.

The Difference between Calibrating and Profiling

In calibration, the user of a proofing system produces a calibration file at regular intervals with the calibration software – the process is similar to profiling. This file is a special profile format that brings a proofing system's current color reproduction into line with the target values as defined by the manufacturer. A good proofing system should have a high-quality calibration that functions completely separately from the application of profiles. The calibration is always based on the combination of the ink used and the proof medium. A powerful calibration ensures that exactly corresponding results are achieved with identical proof printers at different locations, using the same ink and the same proof medium.

If the provider of a proofing solution with a powerful calibration offers a standard profile for a proof medium, then there is no need for the user to create his own proof profile – he only needs to calibrate his proofing system at regular intervals.

Optimized Profile Combinations from the Provider of a Proofing System

For the provider of a proofing system to make the proof of print standards as simple as possible, he provides suitable DeviceLink profiles for selected combinations of ink and proof medium. The DeviceLink profiles are optimized so that, on the one hand, they produce good values in the proof control wedge and, on the other, achieve a good visual correspondence between the proof and official reference prints, particularly for the simulated paper tone. The user, in this case, need only be able to use his proofing system's calibration assistant to create good standard proofs. He neither needs to deal with the depths of profile creation and optimization, nor need he trouble a specialist dealer or color-management specialist. The combination of a powerful calibration and standard DeviceLink profiles provide the optimal conditions for reproducing the print standards in metrological and visual accord on proofing systems at different locations.

In proofing, the data firstly passes through the DeviceLink profile for the simulated print standard and then the calibration file for the applied combination of ink and proof medium.

Failures by some Providers of Proofing Solutions

In the past, some providers of proofing solutions or tools for creating profiles have neglected the subject of calibration. When a proofing system displayed an altered color reproduction, a new profile had to be created. In this case the profiling software is “misused” for calibration, which creates a number of disadvantages for the user: firstly, profiling programs are often more complicated than the calibration assistants in proofing software. Secondly, it is practically impossible to optimize each combination of proof profile and print standard individually when the proof profile continually needs to be created anew. Therefore, particularly in critical areas such as paper tone simulation or the conversion of neutral color tones, it is more difficult and time-consuming to achieve a consistent high proof quality.

Choice of Proofing Solutions

If you want to produce proofs to a high standard for print standards, you should fall back on a proofing solution that combines a powerful calibration with optimized DeviceLink profiles for print standards from the manufacturer – providers of proofing solutions who do not provide this should not be considered. All print standards should be reliably achieved after a single calibration – in fact, with a limited tolerance level in the proof control strip. More details on the choice of proofing systems can be found on the author’s website, **www.colormanagement.de**.

High-quality proofing solutions for print standards comprise a powerful calibration and optimized DeviceLink profiles from the manufacturer for the simulation of the ISO/FOGRA or GRACoL/SWOP standards.

Recommended tighter tolerances for the proof control wedge:

Paper white: < 2.0
Mean difference: < 2.0
Max. difference: < 6.0
Max. diff. primary colors: < 3.0

Proofing systems with independent calibration and optimized DeviceLink profiles can readily achieve tighter tolerances for the media wedge CMYK.

Further Uses for DeviceLink Profiles

The following pages discuss the limits of classic color management with ICC profiles. After a short introduction to the topic, it can be seen that, here, DeviceLink profiles are a means for bypassing the breaking points in color management with ICC profiles.

The Limits of Color Management with ICC Profiles

The production process described on the previous pages makes a conscious use of the strengths of ICC color management. Weaknesses, for example the differences between different manufacturer's perceptual rendering intents, are balanced out through relative colorimetric conversion and black-point compensation. The photographer, as well as the graphic designer, can simulate the colors of the proof on the monitor during the work on images or documents. The RGB images delivered by the photographer can be reliably converted for the most different of printing standards.

Limits of the Depicted Method

The illustrated production process provides a solution for many tasks in color management. Certain areas, however, are not covered because, at the time of this 3rd edition going to press, there are still some large gaps in the ICC specifications. These can also be described as "ICC breaking points" as they cause problems for the large majority of application programs.

From the graphic designer's point of view, these ICC-specific problems are intensified when it comes to applying color management to a complete document. The illustrated production process always assumes that the complete document, with all its component parts, is constructed in the color space of the subsequent print. Should it be converted with all its component parts to another CMYK color space then there are a few ICC breaking points, which shall be looked at more closely on the following pages:

ICC Breaking Point 1: Black and Gray Objects

Black and gray objects are mostly excluded by color management in ICC-based production processes, or they are converted to four-color objects.

ICC Breaking Point 2: Technical Shades

Technical shades are often flat areas of color and gradients in vector graphics or sometimes artificially laid background colors. Where transparency functions are used in modern layout programs, vector graphics are often automatically converted to pixel images. Typical undesired phenomena in the color management of technical shades are the dirtying of pure colors, degraded colored gradients or undesired changes in the ink build-up.

ICC Breaking Point 3: no Tailoring of Complete Color Transformations

The ICC standard is constructed in such a way that any source and target profiles can be linked together as required. Precisely then, when data from the most different of sources in the graphics industry is exchanged and combined anew, does the number of combinations of source and target profiles climb practically off the scale. This makes it extremely difficult in the production process to systematically test all occurring profile combinations, optimize them where necessary and finally approve them.

ICC Breaking Point 1: Black and Gray Objects

The colors gray and black are a regular source of undesired color transformation in color management. This is mostly because the ICC specifications are completely inadequate in this area. For color management in graphic and layout programs, as well as applications for creating and editing PDF files, the ICC does not specify exactly how gray and black images, graphics and text objects should be handled. Here are the three most common errors that can occur:

1. Black objects are built up in four-color after conversion
Such undesired color transformations occur when black objects, such as text or lines in an application program are allocated a CMYK profile and when color management is activated in PDF production or PDF editing. There are color settings in all current graphic and layout programs, as well as applications for producing and editing PDF files, with which an active color management will produce such data garbage. For this reason it is important, when setting up a color-management process, to choose color settings that exclude a four-color conversion of pure black.

2. Gray objects are in four-color process after conversion
The source of error and the results are similar here to those in the first case and can occur in all the application programs mentioned above.

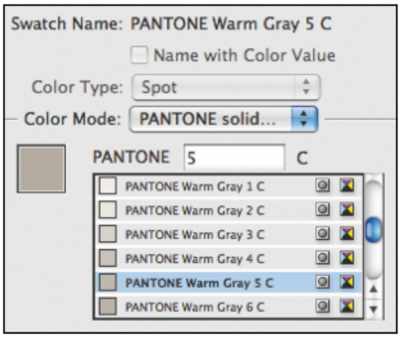
3. Gray objects are completely excluded from color management
While it makes no sense to apply color management in any way with black objects, it would make sense for gray objects. The result should, in turn, be a gray object. At the time of going to press, these sensible options are offered neither by current graphic and layout programs nor by standard programs for producing and editing PDF files.

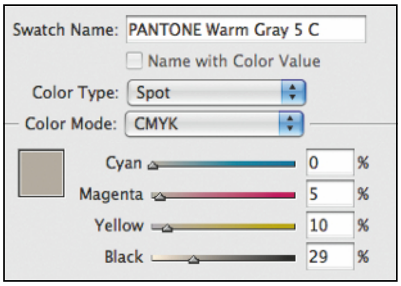
Special Solutions for the Color Management of Gray
Special solutions are necessary to ensure a correct color management of gray objects. These are introduced from page 153 in the section "DeviceLink profiles".

The problem areas gray gradient and text: above, the gradient and text is built up from pure black. Below, the same is built up from four colors, whereby a color fluctuation in the gray gradient and register problems in the text occur.

ICC Breaking Point 2: Technical Shades

By technical shades we mean colors that are numerically defined and that are used in documents as solids or gradients, mostly in vector graphics. In a few cases, however, technical shades can be a component part of pixel images, for example when a soft feathered mask is needed on top of a background tint. If the transparency functions in current graphic and layout programs are applied to vector graphics, then pixel images with technical shades are often produced in the subsequent “flattening” for print.





The screenshots show the color definition of a technical shade in the layout program. Above, creating a true spot color (full-tone color).

Below, the CMYK variation of the same color. The respective CMYK color values are provided in the program.

Technical shades can be realized in print either with an additional printing color or with predetermined CMYK definitions – in both cases they are determined with so-called spot color swatches. The best-known color systems for this are Pantone and HKS. For both systems there are color swatches that show the impression of the actual printing colors as well as CMYK mixtures for four-color printing. An actual spot color is applied in print as an additional color, which increases the printing costs but ensures a larger color space and a high stability in the color reproduction. The CMYK variation of spot colors requires no additional color in print but does not offer the advantages of true spot colors.

True Spot Colors in the ICC Workflow

Color management of spot colors is only rudimentally described by the ICC. Spot colors should be defined in the Lab color space for ICC-based color management. With color management a spot color can then be converted, for example, for a proof. The proof attempts to simulate how the print of a pure solid with 100% of the spot color appears. In the ICC standard, however, it is not defined how shades of a spot color or the mixture of a spot color with other colors should be converted. Even the proof of a simple duplex image with one spot color and black is only possible with technology that is not described in the ICC standard.

CMYK Variations of Spot Colors

A second area of application for ICC-based color management is determination of the optimal CMYK conversion of a spot color for a prescribed printing standard. The determined CMYK tone should correspond on the proof for the printing standard as exactly as possible to the original Lab definition of the spot color.

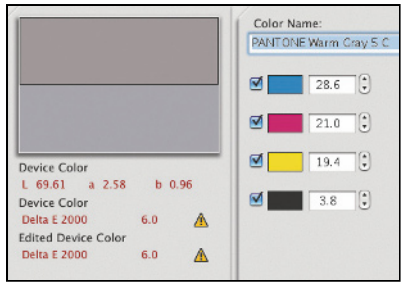
With a spectrophotometer a comprehensive quality control for the proof and print of spot colors can be established. This goes for the print of true spot colors and the corresponding proof as well as CMYK conversions of such colors including proof. As long as a spot color can be reproduced as a CMYK mixture with full saturation, all measurements of the print or proof should give the original Lab value of the spot color.

Achromatic Composition in the Calculation of CMYK Conversions

With large single-color solids, color fluctuations are particularly noticeable in print. For this reason the rule applies that CMYK conversions of spot colors are built up from a maximum of two CMY colors plus black. Such a black generation is also known as achromatic composition. At the time of going to press, special programs such as ColorPicker from GretagMacbeth are necessary for this.

Example: Pantone Warm Gray 5 C

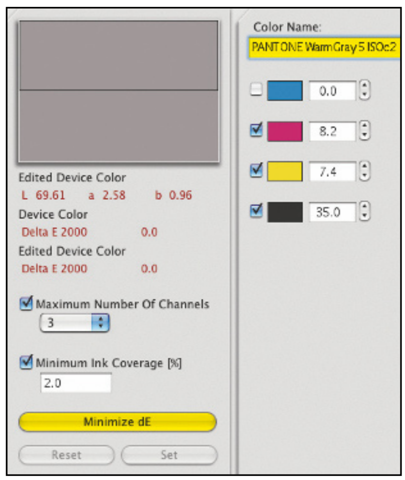
On the basis of the proof and offset print according to ISO 12647 on coated paper, an optimal CMYK combination for the spot color Pantone Warm Gray 5 C should be determined. The Lab definition of this spot color is L 70 a 3 b 1. If this Lab color is separated absolute colorimetrically with the profile ISOcoated_v2 and ISOcoated_v2 is then simulated in the proof – likewise absolute colorimetrically – the color impression is in fact correct but the black generation, with C 29 M 21 Y 19 K 4, by no means complies to the specifications – slight fluctuations in the print would immediately result in a color cast. ColorPicker from GretagMacbeth is one of the few programs that, at the press of a button, can calculate a CMYK variation where one of the CMY colors is set to zero. The resulting black generation of M 8 Y 7 K 35 is much more stable in print than the previous version. Because, at the time of going to press, neither Pantone nor HKS offer optimal CMYK conversions for the color space ISOcoated_v2, corporate design agencies, in particular, who set a high value on the consistent reproduction of house colors, must determine the CMYK values themselves. In doing so they should, without doubt, use a software that allows for an achromatic composition, a maximum of two CMY colors plus black.



ColorPicker from GretagMacbeth can convert Pantone or Lab colors, on the basis of any profile, to three-color constructed CMYK values. The image above shows the standard conversion of Pantone Warm Gray 5 C with the profile ISOcoated_v2.

The Breaking Point of Technical Shades in the Classic ICC Process

If a document is to be converted with ICC profiles for different printing standards, then achromatically composed technical shades often constitute a breaking point. Firstly, it is often necessary to achieve a particular Lab target value for technical shades. For this they should be converted absolute colorimetrically. If the technical shade is a background tint in an image, the absolute colorimetric conversion would, however, cause problems in the highlights and shadows. Secondly, at the time of going to press, it is not possible, in normal conversions with ICC profiles, to guarantee an achromatic composition of technical shades for all target color spaces.



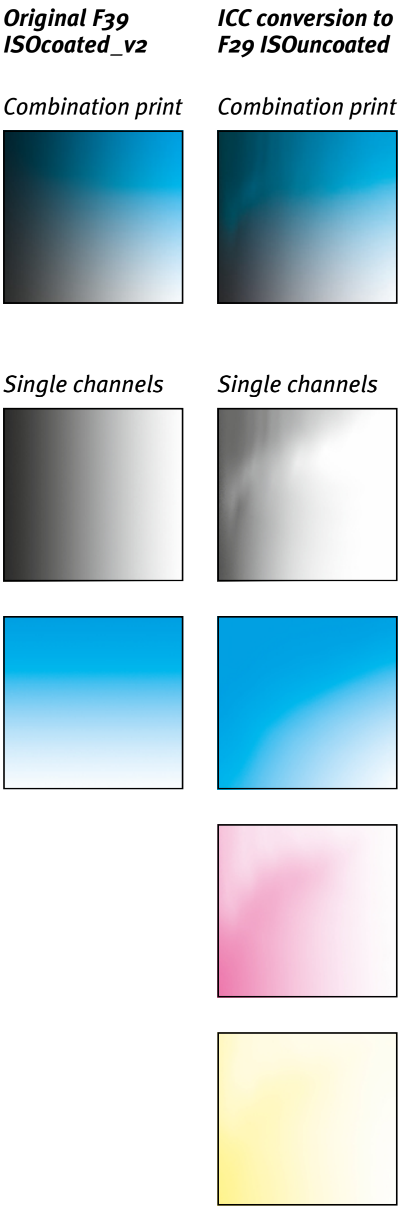
Three clicks are necessary for a three-color construction:
– set the value for cyan to zero,
– deselect the checkbox for cyan,
– click “Minimize Delta E”.

Afterwards a unique color name can be given.

Degraded Color Gradients and the Dirtying of Pure Colors

The phenomenon of degraded color gradients or the dirtying of pure colors has become apparent to most users who have been working a long time with ICC profiles. The cause of this problem is mostly to do with the absence of the possibility to tailor an ICC color transformation from a particular source to a particular target.

ICC Breaking Point 3: Optimization of Color Transformations



The example illustrated above shows a typical ICC breaking point: the image – a gradient of cyan and black – produces a blotchy, uneasy result with a completely different ink build-up when converted with ICC profiles from F39 ISOcoated_v2 to F29 ISOuncoated.

For a better result it is necessary to optimize the color transformation for this exact profile combination, to test it and approve it.

In the color transformation from a source to a target there are critical and less critical images. In photos with lots of small details and high contrasts, a slight color shift is hardly noticeable. With large colored solids or gradients it's a different story. The solution to this problem is, unfortunately, not a simple one.

The basic idea of the ICC standard states that profiles for any device color space or working color space from different profiling software should be able to be linked together without any problem. At input or creation all data should be allocated its own profile, in the layout document data from different sources is packed together in one document and at the end the mixed-color document is converted with the ICC profile for the target color space. Depending on which source profile is attached to the individually imported data in the layout document, dozens of color transformations can soon come together for the target profile for the document output.

The ICC Specifications know no Quality Criteria

To what extent a linking of any source and target profiles produces a visually appealing and clean color transformation, even for critical images, is left to chance in ICC workflows. At the time of this 3rd edition going to press, there are no quality criteria in the ICC specifications for characterization data, for individual profiles or complete color transformations with source and target profile. Ultimately it is left for the users to establish their own quality management for their color transformations.

Independent Quality Management Requires few Color Transformations

To keep quality management for color transformations practicable it is necessary to keep the number of transformations from source to target profile as small as possible. Only then is it at all possible to systematically test each individual color transformation, to optimize accordingly and to approve them.

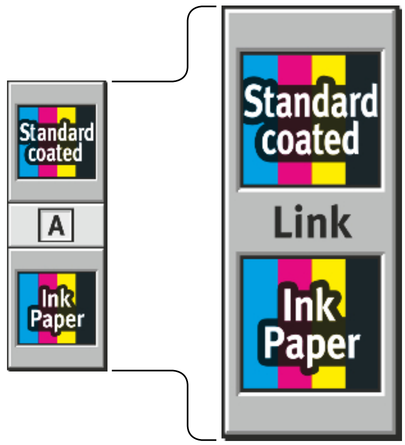
The key to a successful quality management of color transformations lies in limiting the color spaces in the exchange of data between different users to as few as possible. Once a production process has been established that can get by with a manageable number of color transformations, it makes sense to use optimized and tested DeviceLink profiles for them.

The Solution: Special DeviceLink Profiles

DeviceLink profiles are predefined color transformations from a defined source to a defined target. The simplest way of creating a DeviceLink profile is the aggregation of a color transformation of two ICC profiles with a particular rendering intent. When data is passed through such a DeviceLink profile, the exact same result is produced as with the normal color transformation with two individual ICC profiles. A usual application for such DeviceLink profiles is the digital proof, for which each combination of profiles for the proof medium and simulated ISO standard is optimized.

DeviceLink profiles that reproduce a normal ICC color transformation with a rendering intent are symbolized in this book by a graphic of a double profile symbol with the label "Link". There is a list of programs, some free of charge, that generate such DeviceLink profiles from two ICC profiles with a specified rendering intent.

DeviceLink profile

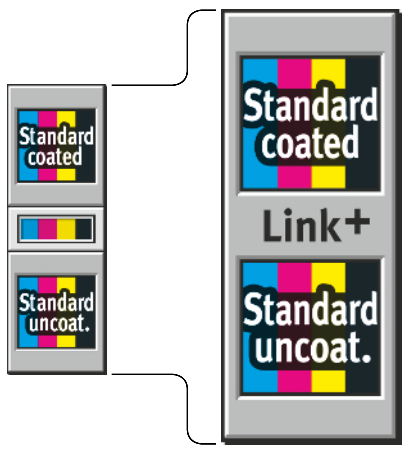


If the symbol bears the label "Link", it represents a DeviceLink profile with a normal link between two ICC profiles with a predefined rendering intent.

Special DeviceLink Profiles with Extended Functionality

In principle, the file format "DeviceLink profile" offers more possibilities than just combining two ICC profiles. For example, in DeviceLink profiles for color transformations between two CMYK color spaces, the CMYK values of the source can be linked in any order to the CMYK values of the target. In order to avoid the ICC breaking points of color management for complete documents, DeviceLink profiles are required that have been calculated with special features for optimized color transformations. Such special DeviceLink profiles are labeled "Link+" in the graphic. Particular ICC problems can be solved with these:

DeviceLink profile with extended functionality



If the symbol bears the label "Link+", the DeviceLink profile has been calculated with special software to avoid typical ICC problems in the color transformation of CMYK data. The CMYK values in the source are linked directly to those in the target without passing through a Lab interface.

1. Editing gray and black objects with black preservation

In almost all application programs that support ICC profiles, gray objects are either excluded from color management or suddenly built up in four-color after the color transformation. The necessary technology to solve this problem is called black preservation. The description can sometimes mean something different, depending on the program. Some use the name to describe the preservation of only 100% black in the transformation.

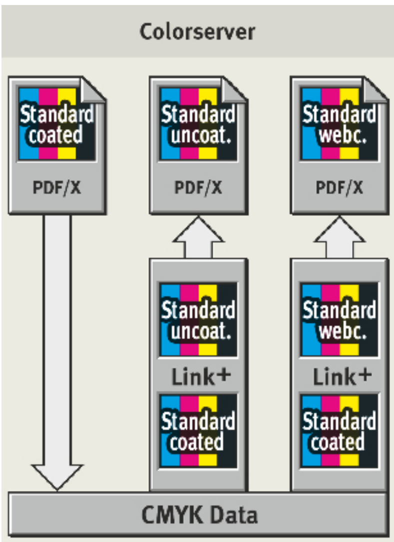
2. Correct color management of technical shades with separations preservation

Technical shades are large one-color solids or gradients. These defined colors often have a range of characteristics that cause problems in color management with standard ICC profiles. So that a color such as Pantone Warm Gray 6 is as stable as possible in print, it should only be built up of black, yellow and magenta. With the use of profiles, only the relationship of the colors to each other should change, not the general build-up. The same goes for gradients: with the use of profiles the ink build-up should basically remain unchanged.

The necessary technology for this is called separations preservation. From a technological point of view, the calculation of separations preserving DeviceLink profiles is much more demanding than black preservation. Programs that offer these functions can also maintain a pure gray.

3. Optimized color compression from the source to the target
In the calculation of a standard ICC profile, the rendering intents are calculated irrespective of what other profiles the profile is linked to. In the calculation of a DeviceLink profile there is the possibility to calculate an optimized color compression from a defined source to a defined target. This can, for example, ensure that pure CMY colors in the source are converted to pure CMY colors in the target.

4. Clear strategies for testing, optimizing and approval of profiles
Standard ICC profiles are geared towards achieving usable to good color transformations in combination with any other profiles. An optimization of the profile for the combination with a single other profile robs it of its universal applicability. In contrast, with DeviceLink profiles the sole intention of use is an optimized color transformation from a defined source to only one defined target. This makes it much easier to test DeviceLink profiles, to optimize and approve them. Usual test criteria are, for example, a best possible correspondence between the source data's proof and that of the target data, the exact conversion of technical shades (e.g. house colors) as well as clean gradients and pure CMY tones in the target color space.



Application of DeviceLink Profiles
A cross-manufacturer format for DeviceLink profiles is prescribed in the ICC specifications. However, many standard programs that support normal ICC profiles cannot use DeviceLink profiles. At the time of going to press there are specialized programs that cover both of the most important areas of use for agencies, repro houses and printers – the optimized conversion of images in Photoshop and the so-called Colorservers for optimizing PDFs. If a Colorserver supports color transformation with DeviceLink profiles, a CMYK-PDF file can be created for the print by any DTP program, which is then converted with DeviceLink profile for another printing standard. The quality of the color transformation is practically wholly dependent on the DeviceLink profiles used and not the software applying them. The subject of the Colorserver for PDF files will be looked at more closely in the next chapter.

Details on Separations-preserving DeviceLink Profiles

Separations-preserving DeviceLink profiles are much better suited to optimal conversions from CMYK to CMYK than a combination of standard ICC profiles. Only DeviceLink profiles are able to reproduce different ink build-ups from the source in the target and to maintain the color impression. With a CMYK to CMYK conversion in this manner, the image build-up is engaged much more carefully than with a normal ICC conversion.

The Calculation of Separations-preserving DeviceLink Profiles

Highly complex mathematical operations are required for the calculation of such profiles. These determine the Lab value for every CMYK combination in the source data and then search in the target data for a similarly built-up CMYK combination with the same Lab value. If a CMYK gray tone is contained in the source data, for example no yellow, then the software looks in the target data for a suitable combination, likewise with no yellow. In this way technical shades can be optimally converted. And if a neutral tone in the source is built up of all four CMYK colors, then the software searches for a corresponding CMYK combination. In this way the black generation, for example, in images is largely maintained.

Limiting the Maximum Ink Coverage

To convert print data for different printing standards with separations-preserving DeviceLink profiles it is necessary to set a limit for the maximum ink coverage in the DeviceLink profile. Here, the maximum ink coverage for the target color space is decisive. At the time of going to press there are only a few programs for producing DeviceLink profiles that offer the option of separations preservation, but do allow for a limiting of the maximum ink coverage – profiles from programs not offering TAC limits are not suitable for high-quality CMYK to CMYK color transformations.

The Effect of Separations Preservation on Color Transformations

In a color conversion with two ICC profiles, information on the black generation in the source data is lost. This is more drastic in achromatically composed gradients of black and, at most, two CMY colors. On the following page we compare, in a conversion from FOGRA39/ISOcoated_v2 to FOGRA29/ISOuncoated, the results of a normal ICC color transformation and a transformation with an optimized DeviceLink profile with separations preservation.

Comparison of ICC Conversion/Optimized DeviceLink Profile

Converted to ISOuncoated with ICC profiles | *Original image in the F39/ISOcoat._v2 color space* | *Converted to ISO-uncoated with optimized DeviceLink profile*

middle row: Original
The combination print and the color separations of the color original. The brownish-gray fields on the right represent achromatically composed Pantone colors.

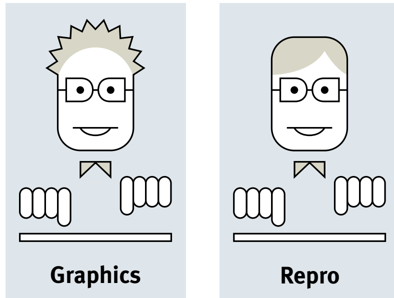
left row: Transformation with ICC profiles
All elements pass through the separation in the ISOuncoated profile and are subsequently constructed wholly in four-color. The gradient becomes less clean and the Pantone shades are much more unstable in print.

right: Transformation with a separations preserving DeviceLink profile
Different ink build-ups in the source data are transferred cleanly to the target. Clean gradients and a stable print of Pantone shades.

Optimized DeviceLink Profile for Industry Standards

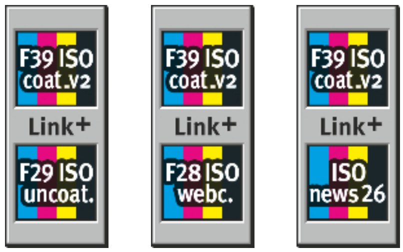
A user working to industry standards can be spared the creation of special DeviceLink profiles by falling back on standard profiles for recurring tasks. With the recurring task, for example, of creating print data for newspaper advertisements, offset print data for coated paper must often be converted for newsprinting. Working to industry standards this would be a conversion from standard coated (FOGRA39/ISOcoated_v2 or GRACoLcoated) to standard newspaper.

Various manufacturers offer ready DeviceLink profiles for this, which avoid all the ICC breaking points. With these the entire print file, with all its images and vector graphics, can be converted from, e.g., F39/ISOcoated_v2 to ISOnewspaper26.



DeviceLink profiles for color transformations in different industry standards can be used in agencies as well as repro houses.

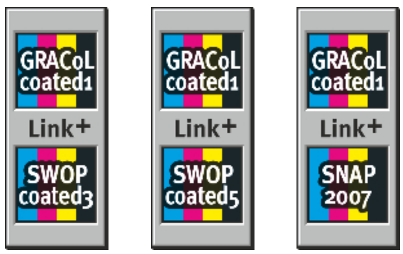
Standard Coated as Master Color Space for Image and Vector Graphic
ICC-based color management for RGB images functions, meanwhile, quite acceptably. The question of how a sensible color management for vector graphics looks remained unanswered for a long time. By virtue of the ICC breaking points, pure colors should remain pure, gradients should be converted cleanly and achromatically composed technical shades, such as the Pantone Warm Grays should maintain their ink build-up. Not to forget that gray objects should be adjusted in their gradation.



Three high-quality DeviceLink profiles are required to convert FOGRA39/ ISOcoated_v2 data to the other most important ISO/FOGRA standards for rotary web printing on LWC paper, offset printing on uncoated paper and newsprinting.

If a document, with images and vector graphics, is constructed consistently in a standard coated color space (FOGRA39/ISOcoated_v2 or GRACoLcoated), then the entire component parts of the document can be cleanly converted to another print standard with the standard DeviceLink profiles. The quality of this conversion is practically wholly dependent on the DeviceLink profile used.

Key Technology for Repro Houses and Agencies
For repro houses, and even agencies, who want to produce the most effective print data for print standards, this is, at the time of going to press, the most coherent and effective approach to apply color management to the whole document.

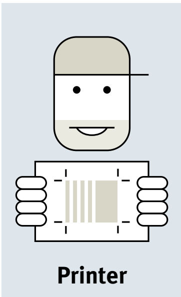


Three high-quality DeviceLink profiles are required to convert GRACol coated1 data to the SWOP coated3 and 5 standards and to SNAP2007, the US standard for newsprinting.

This means looking to see which manufacturers are offering DeviceLink profiles for conversions from, e.g., FOGRA39/ISOcoated_v2 to other FOGRA/ISO standards or from GRACoL to SWOP. Without doubt, a comparison between different providers, with meaningful test files and data from their own production, should be made. More information can be found at the author's website **www.colormanagement.de**.

The following chapter describes how such standard DeviceLink profiles can be integrated into one's own production process. Before that, however, there are some tips for printers on the application of DeviceLink profiles as well as some general advice for the creation, control and optimization for special purposes – ultimately one or two tasks crop up where either the source or target color space is not a print standard.

Special DeviceLink Profiles for Printers

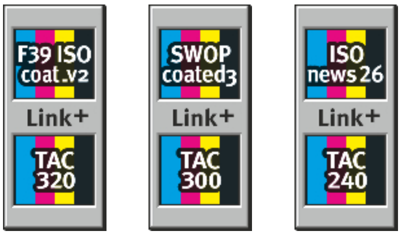


In the printers, DeviceLink profiles serve to optimize print data.

DeviceLink profiles allow for an optimization of print data that would normally be totally impossible with normal ICC technology or very limited in conversion. Some of these optimizations occur within the print's color space. The data on a proof would look the same, before and after the optimization. The general printability or the reliability of production is therefore increased.

Limiting the Total Area Coverage TAC

The TAC can be limited at a certain point, for example, in CMYK data from any source without altering any colors that have a lesser ink coverage. Ink coverage is also known as the "Total Amount of Color". The abbreviation, TAC, is used here in the graphic symbols for such DeviceLink profiles.



DeviceLink profiles for limiting the maximum ink coverage must be calculated for each individual printing standard.

Reseparation of Print Data

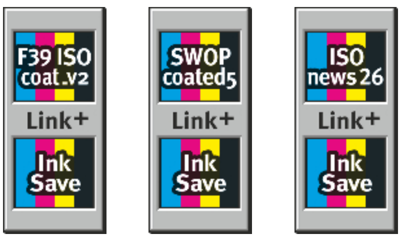
In print data of any source, the separation of all component parts can be unified by the DeviceLink profile, without requiring the source profile for the individual parts. In this way, neutral shades, for example, can be built up more strongly with black so that they remain more stable in print.

Saving Printing Ink

Specially calculated DeviceLink profiles allow for a strong change in the black generation in order to be able to print with much less printing ink.

Different Printing Standards Require Different Profile Variations

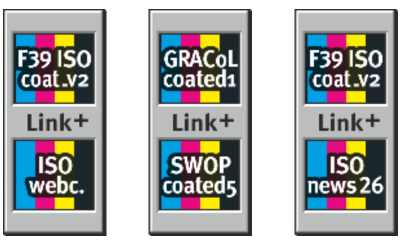
In all three cases the DeviceLink profile in question is tailored to the respective printing process. If, for example, very different types of paper are printed on, then an individual DeviceLink profile is required for paper type and each intended use. The preprepared DeviceLink profiles can be fallen back on when printing according to standards.



DeviceLink profiles for saving printing ink must also be calculated for the respective printing standard.

Conversion of Print Data between Different Printing Standards

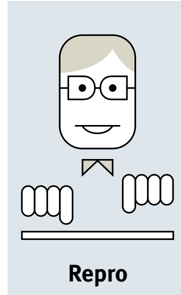
Furthermore, of course, conversions between different print standards or from an international print standard to the printers' internal standard can also be carried out. A clean conversion from, e.g., FOGRA39/ISOcoated_v2 data for coated paper to ISOnewspaper26 data for newsprinting can be carried out reliably and fully automatically with tested DeviceLink profiles – various manufacturers offer preprepared profiles for such transformations between two ISO standards. DeviceLink profiles are also useful in the conversion of standard data to an internal standard: with carefully created, optimized and tested DeviceLink profiles, standard data can be transferred to an internal standard for printing with stochastic screening or highly pigmented colors. This makes it much simpler for the printers' customers to produce data and proofs because they can produce them completely in a standard coated color space. The calculation, control and optimization of such profiles requires, however, an accredited repro specialist.



Where data is delivered in a different color standard than the one to be printed, appropriate DeviceLink profiles are used for the necessary color conversion.

Creating Individual DeviceLink Profiles

Individual DeviceLink profiles must be created by repro specialists.



With individually created DeviceLInk profiles, special tasks can be accomplished for which no standard profiles are available. A great deal of technical repro knowledge and experience is required for the calculation, control and optimization of individual DeviceLink profiles. Furthermore, programs are needed that are often not exactly cheap. This page gives a brief overview of the most important steps:

1. Calculation with suitable software
Depending on the intended use of the DeviceLink profile being generated, the software must offer certain functions. There must definitely be a mode for the calculation of separations preserving DeviceLink profiles including the limiting of the maximum ink coverage. The function to maintain pure CMY colors is also necessary.

2. Controlling the results
Test files containing critical images, for example different gradients, representative photos and pure colors, are necessary for control. For the control, the data, before and after the conversion, is compared in different ways with each other – by the soft proof on the monitor, the appearance of individual separations, measurement with the pipette in Lab and CMYK as well as proofs. If the control is successful then the DeviceLink profile can be used. Otherwise it must either be recalculated or edited manually.

3. Manual editing
If the control suggests that manual corrections are required for a DeviceLink profile, then suitable tools are needed. These can be in the form of special programs for editing DeviceLink profiles as well as plug-in to use Photoshop as an editor.

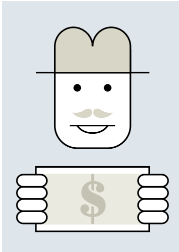
Typical Areas of Use for DeviceLink Profiles
For a repro service provider a typical area of use is the optimizing of CMYK legacy data for proofing and printing in accordance with international standards. If the CMYK legacy data was once approved with a Cromalin proof, then a DeviceLink profile is created for the transformation from the Cromalin proof's color space to FOGRA39/ISOcoated_v2 or GRACoLcoated1.

An individual DeviceLink profile for converting from the Cromalin to the FOGRA39/ISO coated_v2 color space optimizes the existing CMYK legacy data.

The most common area of use in the printers for individually created DeviceLink profiles is the conversion of standard print data to an internal standard. If the printers does not have their own repro department, it makes sense to create DeviceLink profiles in collaboration with a trusted repro house.

In printing to an internal standard, an individual DeviceLink serves the adjustment of the provided GRACoLcoated1 data.

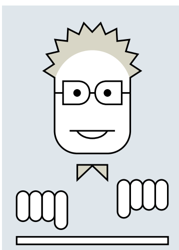
Summary for Different User Groups


Print Buyer

Print Buyer
Proof: If high demands are made of the proof, then it is not sufficient to rely on compliance to the tolerances in the proof control wedge. If it is necessary to ensure a visually and metrologically corresponding proof result in different places, then the print buyer should agree with his production partners on proof media, the DeviceLink profiles used, the calibration and narrow tolerances for the proof control wedge.

Color management of complete documents: In regards to the demands on color management, the limitations of standard ICC profiles and their application must be considered. Technical shades and gradients as well as grayscale images and graphics cannot be reliably converted to different printing standards with normal ICC profiles and application programs. This is only possible with special DeviceLink profiles, whose application in Colorservers is shown in the next chapter.

Whoever regularly commissions projects, in which print data is converted for different printing standards, should find a partner who works with DeviceLink profiles. In this way, more effective and economic means of production can be established, in comparison to still often used manual adjustment of data.


Graphics

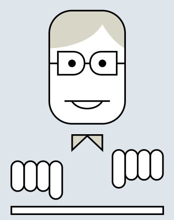
Graphic Design Studio / Advertising Agency
Proof: If print standards are to be reliably and consistently proofed, then the proofing solution should have powerful calibration and DeviceLink profiles for print standards provided by the manufacturer.

Color management of complete documents: If the intention is to achieve, with color management, as high an automation as possible, then you should be aware of the limitations of the ICC standards: technical shades, gradients as well as grayscale images and graphics cannot be controlled with normal ICC profiles and application programs.

For automated color workflows in an agency, they should concentrate on solutions that provide prepared conversions for common industry standards. The standard coated color space constitutes a master color space for images and vector graphics. Conversions not within the prepared standards should be left to the repro partner. It makes sense to find someone who also works with DeviceLink profiles.

Repro Service Provider

Proof: The creation of high-quality proofs to print standards will, in the future, become more possible in the in-house departments of agencies and publishers. It is therefore an advantage for repro service providers, in collaboration with partner printers, to be able to offer internal standards for printing with stochastic screening, extended gamut CMYK inks, UV inks, etc., in addition to the print standards.

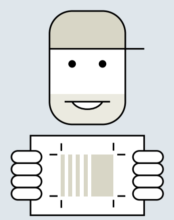


Repro

Color management of complete documents: With print standards and controlled conversions with DeviceLink profiles, further production stages will shift in the direction of agencies. Special repro know-how is therefore required when it comes to tailoring DeviceLink profiles for special tasks. This is where traditional repro knowledge, with the assessment of separations, and working with color values in ICC-based color management meet. Repro houses that do not intensively deal with the new technology, run the risk of operating more laboriously and more expensively than the competition.

Printers

Proof: In order for the internal proof to print standards to achieve the best possible accord with the customers, it makes sense to rely on a solution with a powerful calibration and the manufacturer's DeviceLink profiles. If the proofs controlled with a proof control wedge correspond visually well to those of the print buyer, then only the proofing system needs to be regularly calibrated.



Printer

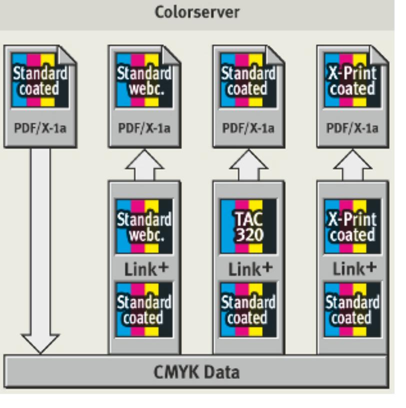
Color management of complete documents: ICC profiles are a good means of assessing print data on the monitor and in the proof. If print data is to be converted from one printing standard to another, then the limits are soon reached with normal ICC profiles – above all with technical shades, gradients as well as grayscale images and graphics. DeviceLink profiles are required for a targeted optimization of print data, including the maximum ink coverage or unified conversion of all component parts in a print file. Their application is described in the next chapter.


6

PDF/X-1a and DeviceLink Color Servers

The problems of the ICC standards have quite a large effect in the production process, from the layout to the print-ready PDF file. For this reason it is necessary to understand the basics of the ICC standard's interaction with PostScript and PDF.

To be able to produce reliably as well as use the strengths of the ICC standard, PDF/X-1a is the suitable format for the transfer of print data. These can be converted to different printed standards using color servers with DeviceLink profiles that allows a fully automatic color-management process for clearly defined tasks in agencies, repro houses and printers.



Graphics and Layout: the Light and Dark Side of ICC Profiles

The previous chapter touched on the ICC myth of mixed-color documents. According to this idea, a document can be converted to any target color space when all the individual objects (images, vector graphics or colored text components) have embedded profiles. The companies represented in the ICC have never tested if this actually works in practice. However, this has never stopped Adobe from pushing this color-management approach in the further development of the PDF format, or indeed other manufacturers of graphics and layout programs. The users are left to test the color-management functions, to localize errors and to construct appropriate workflows themselves. The industry is still far from an industrially functioning color-management technology, either in graphics and layout programs or in the creation and processing of PDFs. As long as the companies assembled in the ICC do not decide to thoroughly test and optimize the ICC specifications then this will not change in the future.

This means that ICC profiles in individual images, graphics and text components can cause a lot of trouble in the creation and processing of print data. Graphic designers, who create print data, and printers, who receive them, often associate negative experiences with ICC profiles. On the other hand, ICC-based color management also offers a big advantage in the work stages of graphics and layout:

The Advantage: Soft Proof in Graphics and Layout Programs

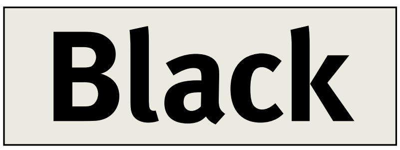
The ICC technology allows for a soft proof in graphics and layout programs that corresponds very well with the ISO proof and print. This is a great advancement for the user.

Firstly, the design process becomes much more flowing and target-oriented because the interaction of different color tones can be judged directly on the monitor and a proof print shows the same colors. In the past, some designers prepared nice colors on an uncalibrated monitor, laboriously optimized them with tests and, if necessary, compiled them for a third time for the print document. For these users, a color-true soft proof in graphics and layout programs, together with the possibility of creating color-corresponding presentation prints and proofs with their own inkjet printer, is a revolution.

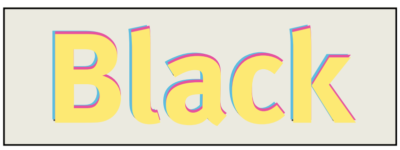
Secondly, graphic designers often receive CMYK from unknown sources, which they import directly into the prepared layout. Thanks to the soft proof they can now determine in the layout program if these images look good or if some post-editing in Photoshop is necessary – it is not necessary to open and control all of the delivered images in an image-editing program before the layout. And there are no more nasty surprises on the proof. So for layout designers, a good soft proof with ICC profiles is a great help.

The Disadvantage: Undesired Color Transformations in the Production Flow
Thanks to ICC color management there are sources of error in the creation and processing of print data that ten years ago were unimaginable. The application of ICC-based color management in graphics and layout software, in programs for creating and processing PDFs and in the RIPs for color printers, proofing systems and imagesetters has become more complex with each new software version. This applies particularly to the embedding and application of ICC profiles in individual images, graphics or text sections in documents and print data.

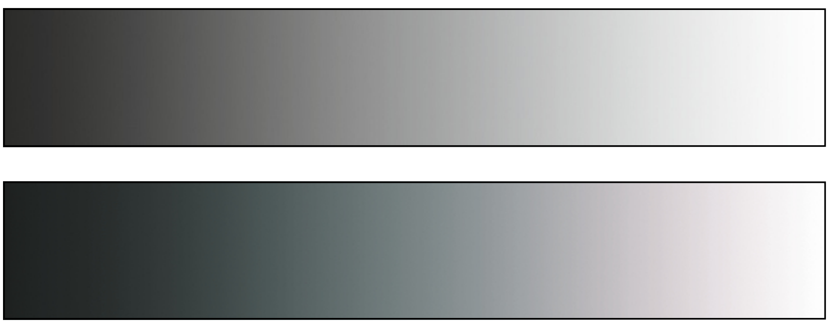
Because the ICC specifications for color management is incomplete and various software providers implement ICC color management differently in their products, the sources of error become more complex in the interaction of these products. For this reason the reliable handling of color in the creation of print data requires a certain basic knowledge of which stages of production ICC color management can set off undesired color transformations and how these can be best avoided. For this it is essential to look deeper into the color-management concepts of graphic and layout programs and the PDF format.



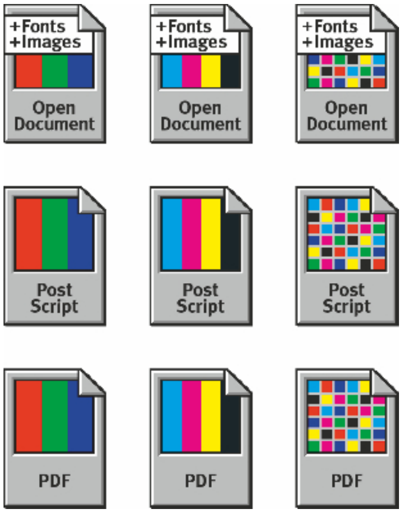
Black text or gray objects that are suddenly built up in four-color are typical undesired ICC color transformations in the printing production.



The error can occur in the layout program when creating the PDF file as well as in the image setting, as shown on the following pages.



Mixed-color Documents and Print Data

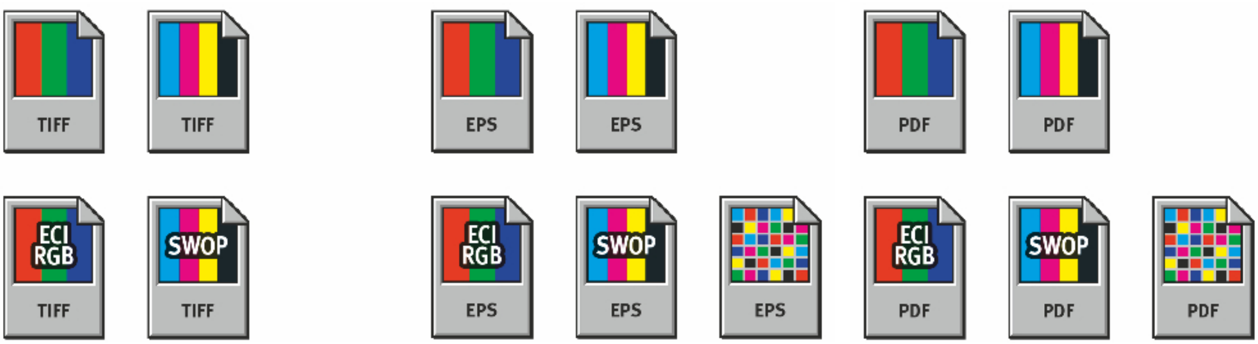


At a number of points in this book we speak of the Janus-faced side of ICC-based color management. With this we mean that ICC profiles, on the one hand, strongly improve the color reproduction of input and output devices, but on the other hand makes color processing in complete documents more unclear and error prone. To understand this and to exclude errors where possible, it is important to know the properties of mixed-color documents and print data.

RGB, CMYK and Mixed-color Documents

Graphic designers are used to constructing documents in the print's CMYK colors. Regardless of where the document's individual components are edited – identical CMYK values in graphics, layout or image-editing programs produce the same color in print. This is key for the design process, because typography, graphics and image editing are fusing more and more with each other. However, when identical CMYK values in the various component parts produce different results in the complete document or printed result this is, from the designer's point of view, the worst case scenario in color management. The concept of mixed-color documents in the ICC workflow is responsible for exactly this failure.

RGB or CMYK documents are consistently constructed in a single color space. Typical RGB documents are office files or HTML pages with RGB images. Typical CMYK documents can be open files from graphics or layout programs or CMYK PDF files for print. With mixed-color documents each individual element, whether an image, graphic or text, can exist in gray, RGB, CMYK or Lab – with or without an embedded profile. Such documents can be, for example, open documents from graphics and layout programs, PDF files or documents from Mac OS X applications, which use the operating systems' color-management functions.



An overview of some file formats that can be imported into graphics and layout programs: EPS and PDF can serve as containers for complex objects comprising images, graphics and text objects – their individual components can exist in different color spaces, represented in these graphics by colored squares.

Application Programs with ICC Functionality

Application programs, or applications, with ICC functionality are capable of displaying mixed-color documents or PDFs on the monitor using ICC profiles, printing them or converting them to another data format. Applications with ICC functionality can be graphics or layout programs, programs for displaying or editing PDF files as well as for driving proof printers or image-setters.

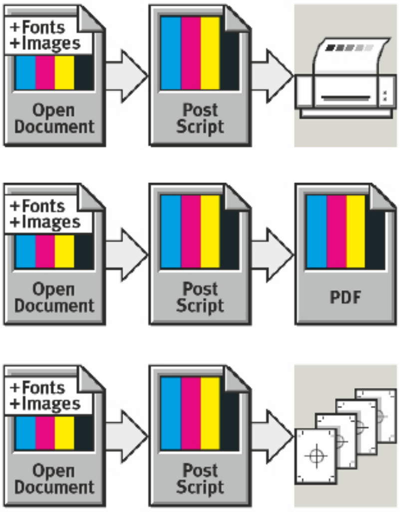
Controlled and Predictable Color Management of Mixed-color Documents is Practically Impossible

What happens, unnoticed by the user, "under the hood" of the respective program is extremely complex and even more so when one considers that, on the one hand, importable elements such as EPS or PDF files can exist as mixed-color and, on the other hand, the open document will be converted to a different data format at different stages of the production process (e.g. to PostScript data for printing or to a PDF for transferring data to the printers). It should never be forgotten that, as the crowning glory, there are no quality criteria in the ICC specifications to ensure that a complete color transformation from a source to a target will produce a visually acceptable result.

In mixed-color documents each imported image or graphic with its own embedded profile causes an individual color transformation in work stages such as the display on the monitor, the output on different printers or the PDF export. With large documents containing perhaps hundreds of imported images and graphics, often possessing different embedded profiles, the result can be dozens or even hundreds of different color transformations. For the output on a color printer or in the conversion to the offset printing machine's color space, each time there is a different pairing of the individual element's embedded profile and the respective target profile for the color printer or offset printing machine.

A quality assurance with the control and approval of each individual color transformation in the production process is virtually impossible with mixed-color documents. Therefore, these should be avoided at all costs for a color-reliable production. To put this into practice, some background knowledge of PostScript and PDF is useful.

PostScript: Robust Format for CMYK Documents



PostScript is a very robust data format when it comes to preparing CMYK documents for color printers, PDF creation or imagesetting.

PostScript is a basic technology for working with graphics and layout programs. A closer look behind the scenes of PostScript shows that there is a breaking point in color management here.

PostScript was originally developed as a command language to drive black and white printers and black and white imagesetters. If a graphics or layout program is able to create data with PostScript commands then any PostScript printer can be driven with it. Before the introduction of PostScript, every typesetting program used its own command language for the printer and imagesetter, which sent up the development costs of such especial programs, printers and imagesetters dramatically and thus limited their use to a few highly paid specialists. With PostScript the development costs for graphics and layout programs, as well as for printers and imagesetters, were drastically reduced, whereupon a drop in price followed for such systems. The specialized typesetting systems and imagesetters practically disappeared from the market within less than ten years.

The most important components of PostScript are the PostScript printer driver, the PostScript RIP and the data format EPS. The PostScript printer driver converts the document from a graphics or layout program into a print file that consists of PostScript commands. The PostScript RIP interprets these commands and calculates each individual screen dot on the paper, the film or the printing plate. An EPS file is a PostScript file that contains any PostScript commands for the conversion of images, graphics and text blocks as well as a preview image. When an EPS file is imported into a graphics or layout program, only the preview image, in almost all programs, is used for the display on the monitor. The PostScript part of the EPS file, on the other hand, is used in creating a print file via the printer driver. In the printer's PostScript RIP only this part of the file is evaluated, the preview image is ignored.

The EPS Problem in Color Management

Many graphics and layout programs offer color-management options for the soft proof on the monitor and for the print output. Imported EPS files are almost always excluded from this. This is to do with the separation of the preview image and the PostScript part of the EPS file, because graphics and layout programs have mostly only access to the preview image. In order to print from documents with imported EPS files on color printers with color management, the cleanest solution is a PostScript RIP, which can work explicitly with ICC profiles.

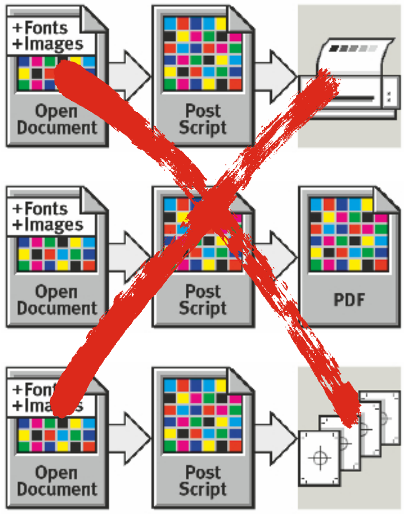
PostScript and CMYK Documents in the Color-management Workflow

PostScript is a very robust data format when it comes to driving color printers, proofing solutions, Acrobat Distiller or an imagesetter from a CMYK layout. Because PostScript is still heavily used, the color-management workflows shown in this book are based almost entirely on CMYK documents. This guarantees a good practicability in established production environments.

Color Management with PostScript

PostScript and Mixed-color Documents

PostScript and color management with mixed-color documents do not get along. This is, among other things, down to the fact that PostScript knows neither ICC profiles nor rendering intents. The output of mixed-color documents via PostScript with color printers, imagesetters or Distiller as a PDF file is not a sensibly controllable process.



Production processes, in which PostScript files are created from mixed-color documents should be avoided at all costs.

Color Management in the PostScript Printer Driver

PostScript printer drivers indeed offer menu items that look like color management. Do not waste your time determining what lies behind these – it is better never to activate such menu items.

The Option "PostScript Color Management" in "Save file" Dialogues

Never press this button if you desire predictable colors in print. If you activate this then strange things can happen in the RIPs of color printers, imagesetters or Acrobat Distiller. The results are rarely predictable and calculable.

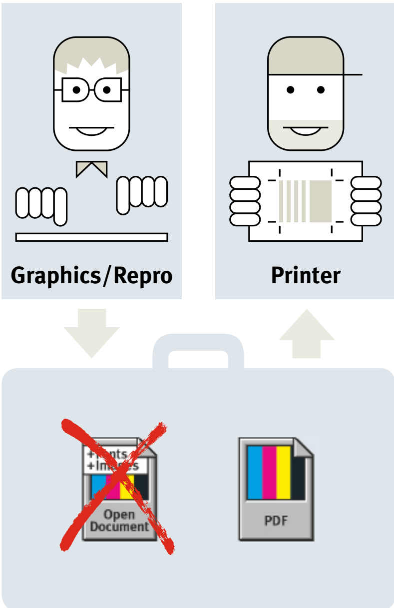
PostScript RIPs for Color Printers

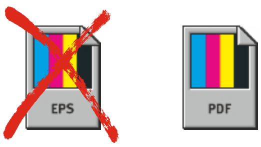
If you buy a PostScript color printer you should first test if it can handle ICC profiles correctly. Above all, the color printer should offer the possibility to manage and establish source and target profiles, including different rendering intents, in the PostScript RIP. Different profile configurations saved in the RIP should be easily and understandably accessible through the printer driver or hot folder.

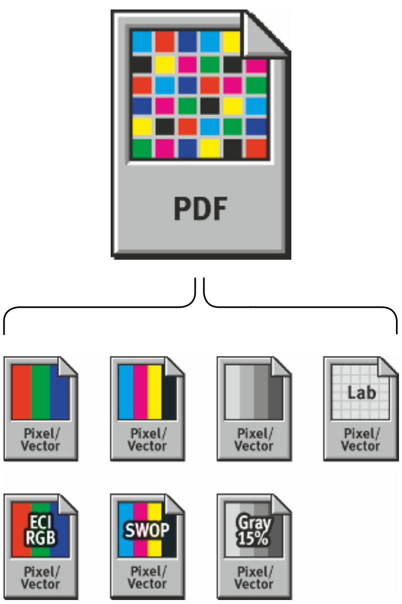
The Frequent Lack of a Consistent Paper White Simulation

In the conversion of the PostScript file for the printer, two steps generally occur: the first step is the "interpretation" of the individual PostScript objects (pixel images, vector graphics or text). A high-resolution pixel image is calculated from these. In the second step, this image is transferred pixel by pixel to the printer. If the allocation of color profiles occurs before the interpretation, only the actual objects, i.e. images, graphics and text, are captured by the color management. Areas with no objects ("paper surfaces") always remain white. If the allocation occurs after the interpretation, each pixel of the high-resolution image is changed – only in this way is a paper white simulation possible over the entire printed design.

PostScript RIPs for color copiers and color laser printers can almost always only apply the first method and are therefore unsuitable for any task where a paper tone simulation is required. PostScript RIPs for proofing systems consistently apply the second approach, with which a paper tone simulation is possible for the entire printed design.







PDF: Advancements and Pitfalls in Color Management

With the definition of the Portable Document Format (PDF), Adobe began in the early 1990s to change the PostScript-based way of working in the production of printed material. This concerns two areas in particular:

1. PDF as delivery format for print data
A print-ready PDF file already contains all the images, graphics and typefaces – this simplifies the delivery of data. Once the PDF data arrives at the printers it can be checked with little effort using especial programs. However, if the printers receive open files with enclosed images and typefaces, then they must additionally produce print-ready PDF files in order to proof them and process them further. This extra work is often passed on by the printers to the customer as an additional cost in the bill.

2. PDF as a replacement for EPS
As a file format for images and graphics, the PDF offers all the functionality of the EPS format and much more besides. The embedding of typefaces in EPS files is often only possible with special auxiliary programs. This is a standard function with PDF. There are no free programs for high-resolution examination and printing of EPS files, PDF files, however, can be viewed and printed with Acrobat Reader.

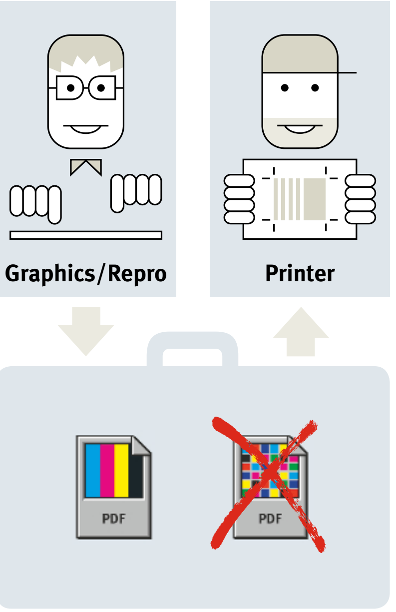
Color Spaces in PDF Files
With regard to color, PDF is a very complex format. Images, graphics and text sections can exist in a PDF file in all the different color spaces that can be created in Photoshop or graphics programs, with or without an embedded profile. In addition there are some especial color spaces in the PDF format.

Color spaces without profile	Color spaces with profile	Especial color spaces
DeviceGray	ICCbasedGray	Black (pure black)
DeviceRGB	ICCbasedRGB	Separation
DeviceCMYK	ICCbasedCMYK	
DeviceN (spot colors)	CIELab	

If objects exist in an ICC-based color space, then a profile and a rendering intent is always included. Because of the limitations of the ICC format it is, at the time of this third edition going to print, practically impossible to fully automatically and reliably convert a mixed-color PDF file for different printing standards. On the one hand, the PDF format is extremely suitable as a container for “profile junk” when print data is generated from mixed-color documents.

Pure CMYK PDF as Format for Print Data

PDF files for the printers should essentially be delivered as print-ready. To avoid any images, graphics or text sections being transformed in color at the printers, PDF files for print should not contain any ICC-based color spaces or DeviceRGB colors. Pure CMYK PDF files should be sent to the printers that have been prepared for the standard of the respective printing process (spot colors that are to be printed as such can, of course, be included).



Avoiding Undesired Color Transformations of CMYK Objects

The more actively the producers of print data use color management for documents and PDF files, the quicker it can occur that individual images, graphics or text sections undergo undesired color transformations. This is particularly fatal for CMYK objects, which should be printed exactly as they are constructed. There are three main problem areas here:

1. Color transformation during the creation of the PDF

CMYK files are color transformed during the creation of the PDF and, so, are already faulty in the PDF file. In some programs a simple menu setting is enough for this.

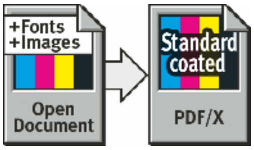
2. The transfer of individual profiles of separate objects into the PDF file

In this case, different CMYK profiles from individual images, graphics or text sections are transferred to the PDF file. The result is a mixed-color PDF file. The undesired color transformation occurs in the further processing at the printers.

3. Undesired embedding of profiles in the PDF file's separate objects

Some programs for creating PDFs, under certain settings, essentially embed profiles in all images, graphics and text sections. The result is again a mixed-color PDF file. The undesired color transformation occurs at the printers.

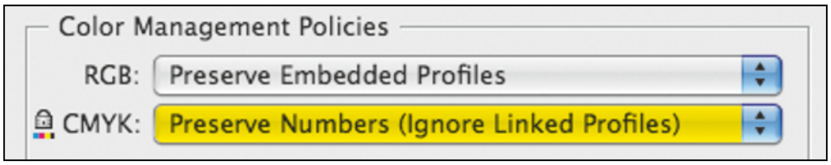
Color Reliability from the Layout Document to the CMYK PDF



To avoid undesired color transformations of images or vector graphics in the creation of a PDF, the following points should be observed:

1. Construction of layout documents in the CMYK color space of the print
All elements in the layout program should be prepared for the standard of the respective printing process, above all imported CMYK images. If, for example, an advertisement is to be designed for newsprinting, then all imported CMYK images should also be optimized for newsprinting.

2. Deactivate embedded profiles of individual CMYK objects in color settings
In graphics and layout programs it is essential to be sure that embedded profiles of imported CMYK images and CMYK graphics are deactivated in the color settings. In case of doubt it is better to completely deactivate color management in graphics or layout programs. In Adobe Creative Suite 2 embedded profiles in CMYK objects are deactivated in all standard color settings. This wasn't the case for many standard color settings in the previous version.



Current layout and graphics programs are provided with color settings by which embedded profiles in CMYK images and graphics are deactivated (example: Adobe Creative Suite 2).

3. PDF settings that create a pure CMYK PDF
The third critical point is the settings for the creation of the PDF. A presetting should be chosen here that only produces pure CMYK PDF files with no embedded profiles in the individual objects. However, there is, on many routes to creating PDFs, an interaction with the layout programs color settings. If there is a setting active by which embedded profiles in CMYK images or CMYK vector graphics are catered for, then it can occur that these objects will be color transformed in the creation of the CMYK PDF file. Further details on the subject of PDF creation can be found on page 180.

Color Settings and the PDF Creation must be Attuned to Each Other
In the construction of a document and in the creation of the PDF, all three points must be fulfilled in order to be certain that, at the end, pure CMYK PDF/X files are produced, whose individual CMYK objects have not been color transformed during the PDF creation and are adjusted for the standard of the printing process.

PDF/X as Delivery Format for Print Data

Along with the rules just described for the creation and delivery of print data, there are two further important points that, in the past, were only carried out by a few users: the control of the PDF file for adherence to certain criteria as well as identifying that a file has been checked and for which print standard it has been prepared. For this reason, companies and associations, on an international level, have joined forces in establishing minimum criteria for PDF files in the international standard ISO 15930, which are delivered to printers as print-ready data. This sets clear parameters for all manufacturers of software that can create or export PDF data, how PDF files must be constructed for print.

PDF/X-1a file with an output intent

A PDF/X-1a file is always a pure CMYK file that, with the output intent, carries a label for the printing standard for which it has been created.

The output intent is either an ICC profile or a simple line of text and, for the sake of simplicity, is shown in these graphics like an embedded profile, although, technically, it is something different.

The ISO 15930 is also known as PDF/X, where the X stands for the eXchange of print data. If a software is able to create PDF/X data then exactly that, which has been explained at the beginning of this section, happens: the data is checked for adherence to certain criteria. If the creation is possible in accordance with these criteria then the PDF file receives a label indicating that it is a checked file in accordance with the PDF/X criteria. Furthermore, it is indicated for which print standard it has been prepared. The labeling for the print standard occurs in the PDF/X file by means of the output intent, either in the form of a text line or an ICC profile that is enclosed with the PDF file.

The Function of the Output Intent

Attaching the output intent is something completely different from embedding profiles in individual images or graphic objects in the PDF file. While embedded profiles in individual images or graphics in the PDF file can cause undesired color transformations in the proof or imagesetting, a profile as an output intent is guaranteed to cause no trouble in the output of the PDF file. The receiver of the PDF file can tell by the output intent for which printing color space the file has been prepared. Only if it is clearly obvious that the file has been prepared for a different printing color space than required can the output intent be extracted by the printers in order to carry out a manual color transformation of the complete PDF file. This is, for example, helpful when gravure data is to be converted for rotary offset.

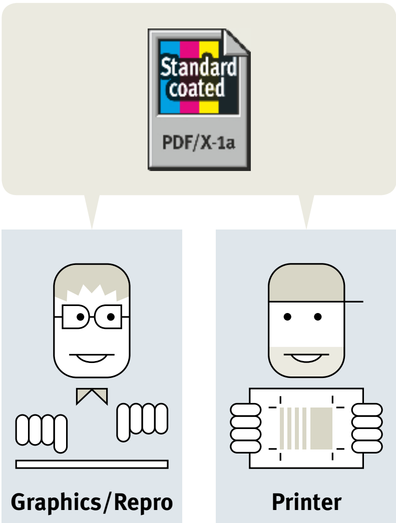
PDF/X-3 files with output intents

There are two different philosophies within PDF/X. PDF/X-1a is intended for the passing on of print-ready CMYK data. In the creation of PDF/X-1a a check is run to determine that no RGB objects or CMYK images with embedded profiles are present in the print file. PDF/X-1a is therefore the exact format to suit the workflows described in this book. The second variation of PDF/X is called PDF/X-3 and, what's more, the passing on of PDF files in which individual objects with attached profiles for any color space can exist.

For PDF/X-3 a limitation to pure CMYK data is not prescribed. Mixed-color PDF files are also allowed, as long as an output intent indicates the printing standard for which the file has been specified.

In these graphics, the output intents for mixed-color PDF/X-3 files are shown as attached profiles.

PDF/X-1a Instead of PDF/X-3



PDF/X-1a as an exchange format has, in comparison to PDF/X-3, a list of advantages: The printers clearly communicate that they only accept pure CMYK data as print-ready.
The creator of the PDF-file can use the X-1a settings in his program and the printers can immediately see, without special testing tools, that the data is pure CMYK.

Historically speaking, PDF/X-3 is a German-Swiss answer to the American initiative PDF/X-1a. The Americans planned an ISO standard for print-ready PDF files in which explicitly only CMYK and spot colors were allowed. The original aim of PDF/X-3 was to create an alternative to X-1a that allowed for PDF files to be converted to different color spaces in the RIP at the printers.

However, it quickly transpired that this is an extremely complex undertaking. The version finally adopted by the ISO had a decisive difference from the original intention: The creator must decide on a printing standard before(!) sending the PDF/X-3 file. The printers, with a PDF/X-3-compliant color-management workflow, can convert this file with the profiles in the individual images, graphics or text sections to the printing standard specified by the creator.

So, the conversion of PDF/X-3 has almost nothing to do with the original idea. If the creator of a PDF/X-3 file has to decide explicitly on a CMYK color space before the delivery to the printers, then he can just as easily deliver pure CMYK data. Whoever, as color-management specialist, can create mixed-color PDF/X-3 files under controlled conditions, can also convert these completely to CMYK before delivery to the printers and send them as a PDF/X-1a file. With InDesign CS, for example, the effort in purposefully creating an PDF/X-3 file or an equivalent PDF/X-1a file is equally small. Therefore, for the creator of print data, PDF/X-3 provides no advantage in productivity that would justify the greater time and effort for the printers in the quality control.

The Absurdity of Pure CMYK PDF/X-3 Files

PDF/X-3 is set down as a standard in a way that pure CMYK data is also PDF/X-3-compliant. However, PDF/X-1a is clearly the better choice for the most reliable data transfer of CMYK data. The data creator, in creating PDF/X-1a, simply cannot overlook RGB images or profiles in individual CMYK objects. The printers can see with PDF/X-1a that prepress has actually created pure CMYK data and has labeled it as such. So, PDF/X-1a ensures a clear communication with the creator of print data and the printers, without anyone having to agree on special programs for checking and labeling PDF files.

To achieve the same production reliability with PDF/X-3 for pure CMYK data as with PDF/X-1a, the creator of the print data must necessarily use special programs for checking and labeling the PDF/X-3 file, and the printers must also be able to read out the label. Because there are different programs for controlling and labeling PDF files, the data creator and printers must first come to an agreement so that their work methods are compatible. This is much more complicated than simply agreeing on PDF/X-1a.

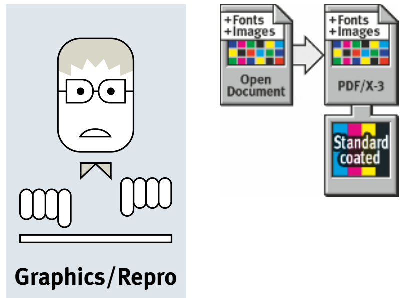
The Unsolved Problems of PDF/X-3

PDF/X-3 as a Slingshot for Profile Junk

With the arrival of the ISO standards PDF/X-1a and PDF/X-3 there are clear parameters for the programmers of graphics, layout and pdf-creating software as to how PDF files for print should look: The PDF/X-1a button should create pure CMYK PDF files, with PDF/X-3 all the options can be included that control the embedding of profiles and rendering intents in individual images, graphics and text sections.

However, because there are no guidelines, either from the ICC or the ISO, as to how this should look in detail, programming carries happily on. In many places it is not transparent for the user what happens, in terms of color management, when he presses the button to create PDF/X-3. With all the programs that, at the time of this third edition going to press, can create PDF/X-3, it is possible, without further ado, to create PDF/X-3-compliant print data that contains profile junk. Pure black text, for example, can be furnished with an ICC profile that, in the PDF/X-3-compliant conversion, can cause the text to be suddenly built up in four-color.

Equally as fatal is the subsequent embedding of profiles in CMYK images and CMYK graphics during the creation of PDF/X-3. This is likewise possible with standard commercial programs like InDesign, Acrobat Distiller or the PDF/X-3 export from Mac OS X. In a PDF/x-3-compliant process at the printers this would cause a color transformation of the images and graphics, although the images and graphics contained no profiles whatsoever in the original document.

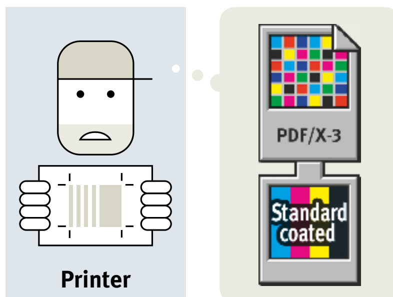


For the data creator the PDF/X-3 format offers the option to unintentionally transfer the "profile junk" from the layout program to the print-ready PDF file.

The Printers' PDF/X-3 Catch 22 Situation

When printers receive PDF files in which individual CMYK images, graphics or text sections contain profiles, they generally remove them. If such data is PDF/X-3 then removing the profiles is clearly in breach of the guidelines for processing PDF/X-3 files. So PDF/X-3 cause more uncertainty than clarity in the communication with the customers.

The best solution to this dilemma is to only accept PDF/X-1a as print-ready and to point out, in the conditions for data delivery, that profiles in individual CMYK images, graphics and text sections will be removed as a matter of principle, even with PDF/X-3 files.



Mixed-color PDF/X-3 files put the printer in a Catch 22 situation. The removal of profiles in CMYK images or CMYK graphics breaches the PDF/X-3 guidelines. However, the use of profiles leads in many cases to undesired color transformations to the extent of a four-color build-up of previously black text.

Renowned industry organizations such as FOGRA, ugra and the bvdm describe, in their recommendations and guidelines, PDF/X-3 as the format of choice for data exchange.

Possible problems in the data transfer and further processing of mixed-color PDF/X-3 files are hereby ignored.

The Campaign for PDF/X-3 in Germany

With the final adoption of the PDF/X-3 ISO standard in the year 2002, there was a campaign in Germany by various associations and institutions for the use of PDF/X-3 as the standard format for data transfer from prepress to the printers. FOGRA and the German Printing and Media Industries Federation can be highlighted here in particular, who collectively conceived and published the "ProzessStandard Offsetdruck" (Offset Printing ProcessStandard) handbook. Many trade magazines and trade journalists have taken up this subject thankfully and published relevant trade articles.

Practically none of these articles have defined for the reader the similarities and differences of PDF/X-1a and PDF/X-3, because large renowned organizations made a recommendation and the trade journalists were grateful for a report that they could spread. The broad response from the press was so successful that, at the time of the third German edition going to press, the average German creator of PDF print data always thinks of the variation PDF/X-3 when it comes to the subject of PDF/X. When asking if the differences between PDF/X-1a and X-3 are known, the answer is nearly always no. The rules and guidelines of the leading German industry organizations are simply adhered to – in Germany, if there are settings for PDF/X-3 and PDF/X-1a in a software for creating PDFs, then the PDF/X-3 setting is used.

The Failures of FOGRA and the bvdm

Reading the relevant publications like, for example, the "MedienStandard Druck 2004" (Printing MediaStandard 2004) or the "ProzessStandard Offsetdruck 2004" (Offset Printing ProcessStandard 2004), the subject of PDF/X-3 is handled very superficially. Generally, only the delivery of PDF/X-3 is recommended. Whether this should be pure CMYK data and how the creator should then control and label his print data is not dealt with further in either of the mentioned guidelines.

Furthermore, there is no advice in either brochure that, with delivered PDF/X-3 files, the printers are to use at all costs the profiles in the individual objects. According to the PDF/X-3 standard this naturally also goes for embedded profiles in individual CMYK images and graphics. So a printer, processing PDF/X-3 in accordance with the FOGRA and bvdm guidelines, may not ignore or even remove any of the profiles in individual CMYK images or graphics, despite this very procedure being usual and sensible.

With respect to PDF/X-3, the FOGRA and bvdm guidelines have created a gray area. It is conceivable, for example, that the customer creates PDF/X-3 files with embedded profiles in individual images and graphics and uses a proofing system that applies these in compliance with PDF/X-3. If the printer then removes the profiles in the PDF/X-3 data and, consequently, does not achieve a good match to the proof in print, then, according to FOGRA and the bvdm, this is clearly the fault of the printer.

The best way to avoid such problems from the start would be for FOGRA and the bvdm to prescribe, in their guidelines, the standard PDF/X-1a for the delivery of pure CMYK data and to recommend PDF/X-3 only for clearly defined special cases in which there was a clear production advantage over PDF/X-1a. The definition of such special cases would, however, be a very difficult undertaking, in light of the sketchiness of the ICC specifications concerning PDF/X-3. This is particularly true when compared to workflows in which PDF/X-1a serves as the basis format for color servers with DeviceLink profiles. This would, after all, solve many problems of practice for which the PDF/X-3 was originally conceived but of which it isn't capable in its present form.

Recommendation to Breach the PDF/X-3 Guidelines of FOGRA and the bvdm
As a German author I very much appreciate the work by FOGRA and the bvdm, and I am an active member in both organizations. However, printers will find on the following pages the recommendation to explicitly breach the PDF/X-3 rules from FOGRA and the bvdm, and to communicate this clearly to their customers. Rules and guidelines for the co-operation between the creators of print data and the printers should serve to provide clarity and understanding. If you the reader agree with my analysis that the guidelines from FOGRA and the bvdm for PDF/X-3 are not helpful, you will find further information in the following sections.

The Delivery of PDF/X-1a is Compliant with the FOGRA and bvdm Guidelines


At first sight, the biggest difference in the recommendations of this book with regard to print data transfer is the concentration on PDF/X-1a instead of PDF/X-3. If you, as the printers' customer, create PDF/X-1a print data then you are in compliance with the FOGRA and bvdm guidelines, because a PDF/X-1a file is always a valid PDF/X-3 file. If the printers want PDF/X-3 files and you deliver PDF/X-1a, then this is totally correct.

The Removal of CMYK Profiles from PDF/X-3 Files is not Compliant with the FOGRA and bvdm Guidelines


Nearly all printers remove the profiles from individual CMYK images or CMYK vector graphics when mixed-color PDF files are delivered. This is necessary if the delivered CMYK color values are to be transferred one-to-one to the printing plate. If the printer also does this with delivered mixed-color PDF/X-3 data, then this should be explicitly communicated outwardly in order to avoid the aforementioned conflict situation.

Strategy for the Application of PDF/X-1a in Print Production

The strategy introduced here recommends that printers only accept PDF/X-1a as print-ready.

The printers should communicate clearly to the customers what requirements they have for data and proofs, and what they do when these do not meet those requirements. Furthermore, tips for the creation and control of PDFs help to avoid or intercept faulty PDF files when creating print data. The fifth points explicitly breaches the FOGRA and bvdm guidelines for the processing of PDF/X-3 data. Only if you, as printer, communicate this clearly in your own guidelines for the delivery of data, can you avoid the aforementioned PDF/X-3 Catch 22 situation.

Seven points that the printer should communicate:

1. Only PDF/X-1a files will be accepted as print-ready. The printer's tips and advice for creating PDF/X-1a files should be followed.

2. All delivered PDF/X-1a files and proofs must be in the standard color space of the paper type specified in the confirmation of order.

3. The standard color space for which they have been produced must be identifiable in the files and proofs.

4. Proofs must contain the media wedge CMYK or IDEAllinace Color Control strip and be produced within the permitted tolerance values.

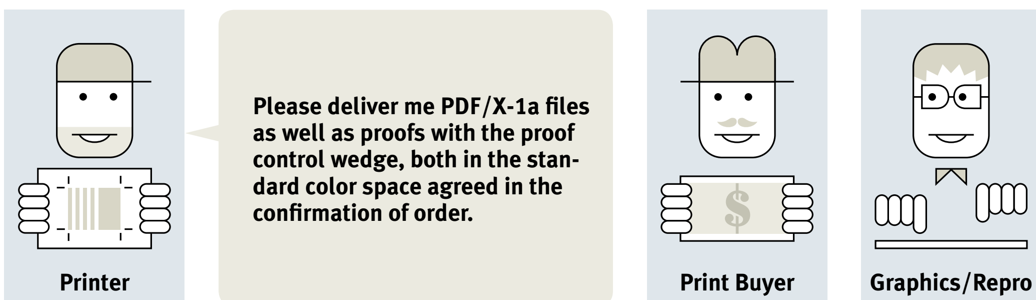
The method of dealing with mixed-color PDF/X-3 files, as recommended in this strategy, explicitly breaches the FOGRA and bvdm guidelines.

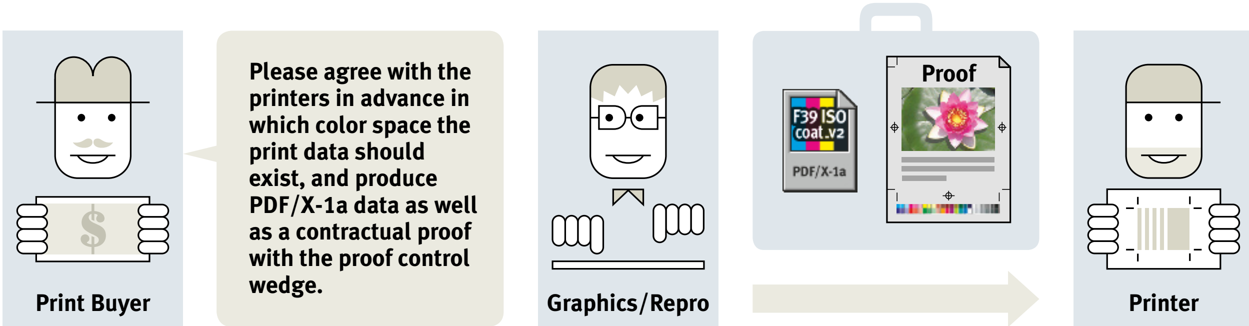
The procedure if the print data does not meet these guidelines:

5. Profiles in individual CMYK objects in the print data will be removed. This also applies to delivered PDF/X-3 files.

6. If the delivered print data contains RGB objects or CMYK objects with profiles, the printer shall produce an in-house proof at the expense of the customer. This also applies to delivered PDF/X-3 files.

7. If print data is delivered without a proof, the printer shall produce a proof for the customer's approval. Otherwise, the customer must confirm in writing that he will in any case accept the printed result, with regard to color, as it is produced.





Seven points that the creator of print data should observe:

1. Confirm with the printers in plenty of time, and in writing, for which standard paper type the print data and proofs should be produced.

2. Build the complete document consistently in the CMYK color space of the intended printing process.

3. Check critical images in an image-editing program before placing them in the layout.

4. You should have the color-management function in your graphics or layout program set to “Ignore embedded profiles for imported CMYK data”.

5. Only create PDF/X-1a data for print.

6. Check the separation in the PDF/X-1a print data.

7. Prepare a standard proof of the PDF/X-1a print data and output the proof control wedge with it for control. Hand over the print data with the proof to the printers.

A rule for the whole industry:
Limit yourselves to the international standards for CMYK data in offset printing or to comparable standards for gravure and newsprinting.

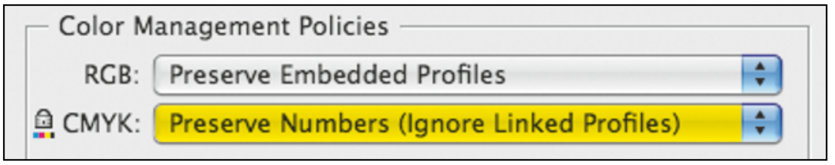
Avoiding Profile Problems in the Creation of PDF/X-1a

PDF/X-1a provides clarity for the creator as well as the printer that print-ready CMYK data has been handed over. However, the use of an X-1a setting for the PDF creation does not automatically guarantee that all CMYK images and graphics end up in the PDF/X-1a file exactly as the user imagines. Possible sources of error are the color settings in the layout program or wrong options in the generation of the PDF.

Avoiding Problematic CMYK Color Settings in the Layout Program

It has already been briefly mentioned on page 176 that the color settings in graphics and layout programs must be attuned to the specifications for the creation of the PDF. It is necessary, here, to ensure that embedded profiles for imported CMYK images and graphics are deactivated.

Embedded profiles in imported CMYK objects must be deactivated in the color settings for graphics and layout programs.

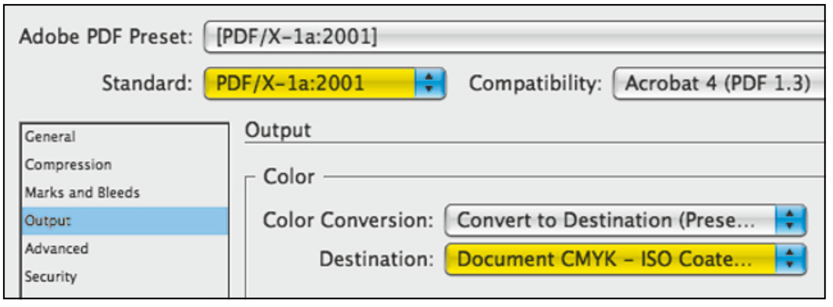


Explicit CMYK Color Transformations in the PDF/X-1a Creation

The second possible source of error is an explicit color conversion in the PDF creation menu. This can happen quicker than one might think: if, for example, the layout document's color space is set to "EuroscaleCoated" and "ISOcoated" is chosen in the direct PDF export because this is required by the printers, then – depending on layout program – almost all imported CMYK images and graphics, as well as the CMYK color solids set up in the layout program, will be color transformed. It doesn't matter whether imported CMYK images and graphics have embedded profiles or not.

In order to avert such a color transformation, the option "Document color space", "as source" or similar should be selected as the color space when creating PDF data. Unfortunately, these descriptions vary in different manufacturers' programs. Therefore, the actual CMYK color space in the document should always be identical to the color space required by the printers for PDF/X files.

In order to avert an explicit color transformation of all CMYK objects, the target color space should always be set to the document's color space when creating PDF/X-1a.

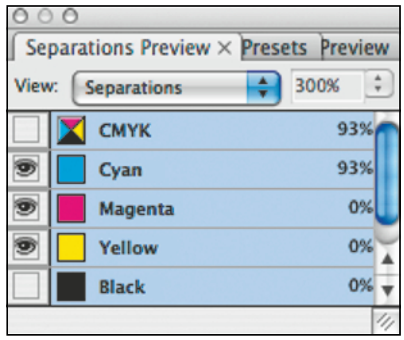


Stages of Control in the Creation of PDF/X-1a

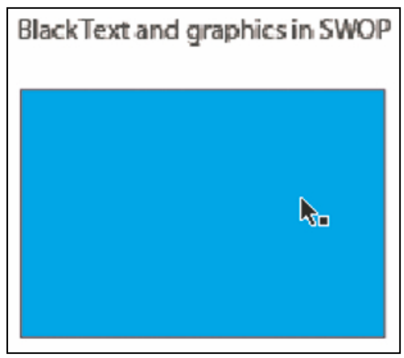
You have a number of possibilities to trace color problems before or after the PDF creation:

The Preflight in the Layout Program
Most layout programs offer a preflight function to check the document before creating a PDF file. Ideally, the preflight should show in which color space imported images and graphics exist, whether they have embedded profiles and also whether these profiles are active. Only when the latter is met can it be predicted with a preflight before the PDF creation, whether or not imported CMYK images or graphics will be color transformed by the layout program. Unfortunately, at the time of this third edition going to press, most layout programs do not yet offer this possibility in the internal preflight.

The Separation Preview in the Layout Program
If the layout program has a separation preview then this can be very helpful in tracing undesired CMYK color transformations. If the black channel is deactivated and supposedly black objects are visible in the CMY channels, then it can be safely said that an undesired color transformation has occurred.



The Preflight in a PDF Tool
There are various tools that run a preflight during or after the PDF creation. If the inspection occurs during the PDF creation then some problems can often still be detected and sometimes automatically rectified, whereby, for example, profiles in imported CMYK images and graphics are automatically removed. If the preflight runs after the PDF creation, then it is difficult to determine if individual components in the layout file have already been color transformed and written into the PDF/X-1a file.



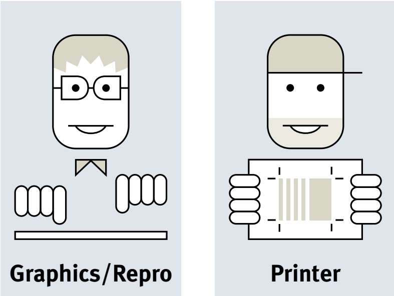
The Separation Preview and Pipette in a PDF Tool
If the applied PDF tool offers a separation preview then it can also be quickly identified here, by deactivating the black channel, whether or not objects appear in the CMY channels that don't belong there. For the control of house and logo colors it is helpful if these can be measured in the PDF tool with a pipette.

The separation preview in modern layout programs or Acrobat Professional shows if black text or technical shades have been color transformed.

In this example, the previously black text is visible although the black channel has been deactivated for the display. The solid cyan suddenly has a tonal value of 93% instead of 100%.

The Proof of the PDF/X-1a File
A good proof of a PDF/X-1a file shows exactly the colors of the subsequent print. If the colors on the proof are correct, and the separation preview does not show any four-color black objects, then the data can be handed over to the printers without problem. If individual images or graphics display undesired colors, then the error must be looked for in the individual image, in the layout program's color settings or in the color settings for the PDF creation and rectified, until a newly created PDF/X-1a file displays the desired colors on the proof. A PDF tool with a good soft proof on a calibrated monitor can help to identify faulty objects before creating the proof.

PDF/X-1a and Color Servers with DeviceLink Profile Support

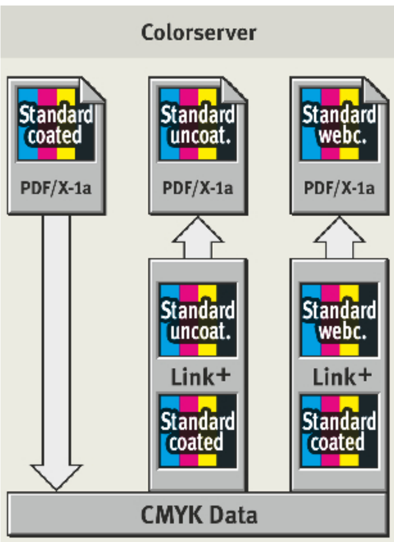


A color server is a program that automatically transforms PDF files from a source color space to a target color space. For a long time color servers, which supported DeviceLink profiles, were exotic programs used in prepress by only a handful of specialists. At the time of this third edition being published, this situation is changing abruptly for several reasons.

Fall in Price for DeviceLink Color Servers
Programs that can color transform PDF files with the aid of DeviceLink profiles have fallen dramatically in price. Every agency that must regularly prepare data for different printing standards can now afford a color server. Furthermore, the technology is also sensibly deployable for repro service providers and printers.

Widely Accepted Standards for Print Data, Proof and Production Print
International standards for print data, proofs and print are already widespread and have proved to be very useful for the industry. With appropriate settings in established programs, such as the Adobe Creative Suite or the proofing products from, e.g., AGFA, CGS, EFI ,GMG, Kodak and other providers, they are now available to many users worldwide.
If high-quality DeviceLink profiles, which can carry out the conversion between different standards, are also present, then for the user it is a matter of pressing a button to convert print data from one printing standard to another.

Wide Distribution of PDF/X-1a
PDF/X-1a, at the time of this third edition going to press, has established itself worldwide as a delivery format. It is the ideal data format for DeviceLink color servers. It ensures that a PDF file is consistently built up in the CMYK color space – a prerequisite for color transformation with DeviceLink profiles. With the output intent, a PDF/X-1a file's color space is clearly labeled. In this way it can be ensured that the chosen color conversion in the DeviceLink color server is compliant with the PDF data to be converted. After the color transformation, the PDF/X-1a file is given a new output intent and is thus labeled for the new color space.

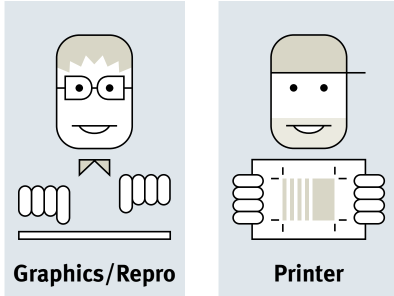


Example of a color server: A PDF/X-1a file for ISOcoated runs through two different DeviceLink profiles. It is converted to the ISO-uncoated and ISOwebcoated color spaces and labeled accordingly with the new output intent.

The Quality of the Color Conversion is Dependent on the DeviceLink Profile
Whether or not images, technical shades or gradients can be converted visually appealingly in a DeviceLink profile is wholly dependent on the DeviceLink profile used. This specifies for every CMYK value in the source an exact CMYK value in the target. Providers of tailored and carefully controlled DeviceLink profiles for standard conversions can save the user extensive tests in quality control.

Standard Coated as Basis Color Space for Color Servers

It was mentioned briefly in Chapter 5 that, when using color servers, it is sensible to use a standard coated as the master color space (FOGRA39/ISOcoated_v2 or GRACoLcoated1) for images and vector graphics – for the following reasons:



Offset Printing is the Broadest Application

Offset printing on coated paper is the printing process in which most printed material is produced. If the master data for a DeviceLink color server is set up in the stanard coated color space, then the data can be used for offset printing on coated paper without any conversion.

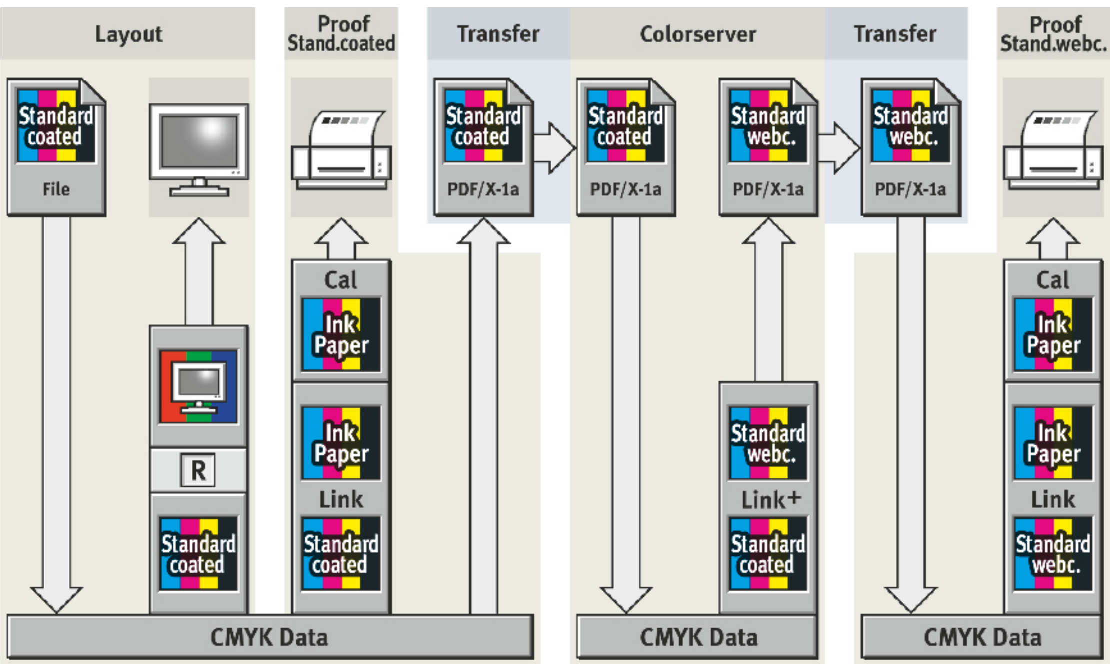
Wide Distribution in the Presettings of Application Programs

FOGRA39/ISOcoated_v2 or GRACoLcoated1 meanwhile exists as a presetting in graphic and layout programs as well as in proofing solutions. This makes it easy to build up a complete color-management workflow, from image editing to layout, artwork and the creation of print data to the proof in a standard coated color space. The approval of the master data for the DeviceLink color server is made with a proof for FOGRA39/ISOcoated_v2 or GRACoLcoated1.

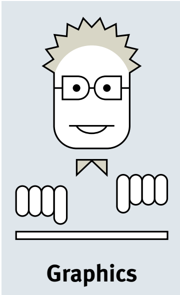
FOGRA39/GRACoLcoated Encompasses all other Usual Standard Color Spaces

An analysis of the currently available standard color spaces for offset, gravure, continuous stationery and newsprinting shows that FOGRA39/ISOcoated_v2 or GRACoLcoated1 containing more or less all of these color spaces. This eases the manufacture of DeviceLink profiles that convert the print data from standard coated to another standard color space. But it is also possible, with carefully created DeviceLink profiles, to convert from standard coated to larger color spaces, e.g. for printing with wide-gamut CMYK inks.

This graphic shows a color-management workflow on a standard coated basis through various stages: Standard coated (FOGRA39/GRACoL) is consistently worked in, from the layout program to the finished PDF/X-1a file. After the proof, the PDF/X-1a file is transferred to the color server, which converts it to standard webcoated (FOGRA28/SWOP3). A proof for standard webcoated then follows from the converted file.



DeviceLink Color Server in the Agency According to FOGRA/ISO

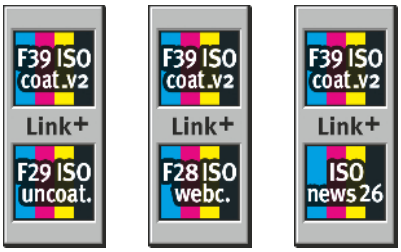


If a color server with DeviceLink profiles is to be used in an agency, then a simple operation without particular color-management knowledge is of primary importance. This can be achieved by applying pre-configured solutions for the proof as well as the for the color server. The graphics on this page show the production for the most important printing standards dealt with in the agency environment.

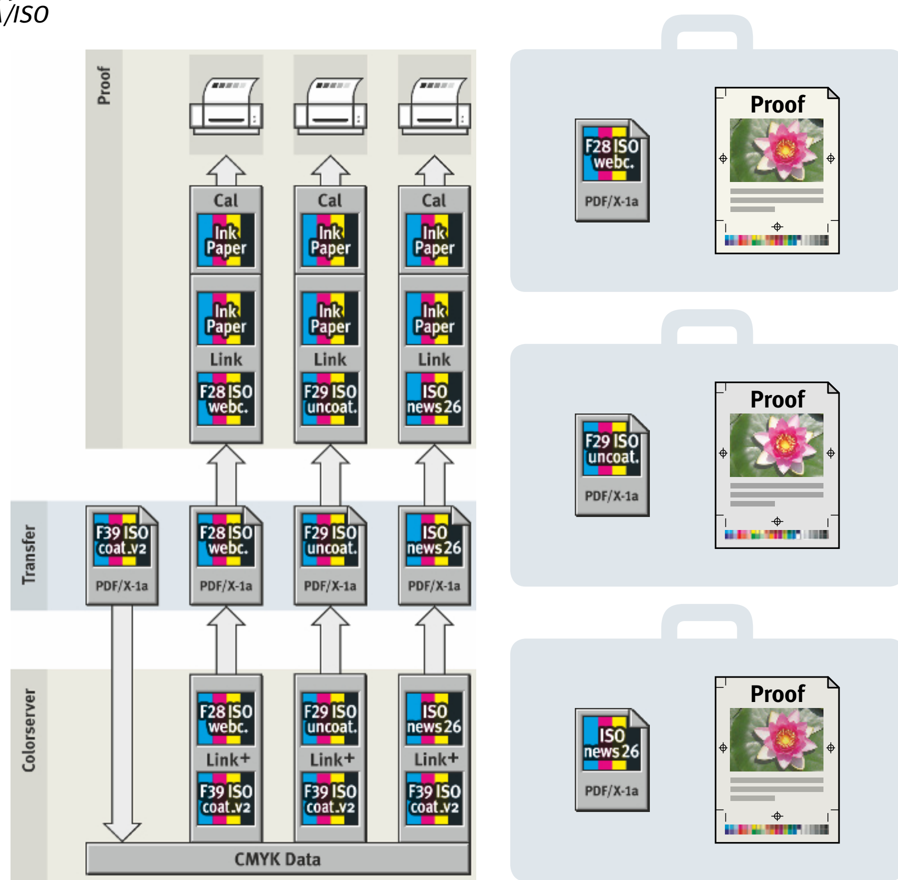
Firstly, FOGRA39/ISOcoated_v2 PDF/X-1a print data is created and then approved on an FOGRA39/ISOcoated_v2 proof. The designer then copies the FOGRA39/ISOcoated_v2 PDF/X-1a file to the input folder on the color server for the desired target color space. The file is then automatically color transformed and labeled with the appropriate output intent. After a proof of the converted PDF/X-1a file for the new printing standard, the proof and file are sent to the printers.

The quality of the conversion in the color server depends, as already mentioned, almost entirely on the quality of the DeviceLink profile used. Various providers of DeviceLink color servers offer ready-made profiles for standard conversions. Before purchasing a color server, different solutions should be compared with each other through tests with in-house files.

Standard conversions



Agencies require only a few DeviceLink profiles in order to convert FOGRA39/ ISOcoated_v2 data to other FOGRA/ISO standards.

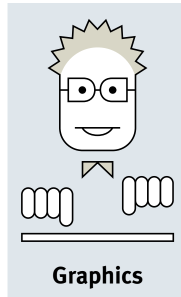


FOGRA39/ISOcoated_v2 PDF/X-1a files are created from the layout program, which are then converted to the other FOGRA/ ISO standards in the color server with the DeviceLink profiles.

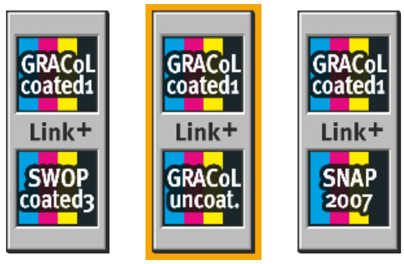
The result are again PDF/X-1a files that can be directly proofed and delivered to the printers.

. . . and According to GRACoL/SWOP

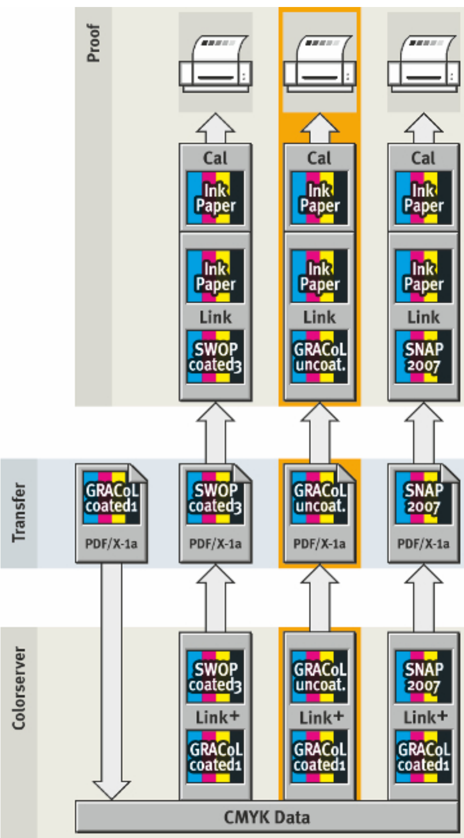
For agencies working with standard profiles based on GRACoL and SWOP specifications, the usage of a DeviceLink ColorServer is similar to the FOGRA/ISO workflow. GRACoLcoated1 serves as the master standard. SWOP data for web-offset and SNAP data for newsprinting are generated via DeviceLink profiles. Unfortunately, there is no “GRACoLuncoated” profile available at the time of publishing. Because of this, the workflow for uncoated papers is marked with an orange background in the diagrams on this page.



Standard conversions



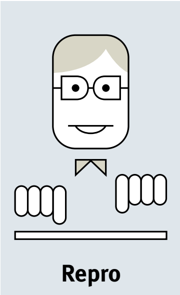
Agencies require only a few DeviceLink profiles in order to convert GRACoL-coated1 data to other FOGRA/SWOP/SNAP standards. GRACoLuncoated is not available at the time of publishing.



GRACoLcoated1 PDF/X-1a files are created from the layout program and are then converted to other GRACoL/SWOP/SNAP standards in the color server with the DeviceLink profiles.

The results are again PDF/X-1a files that can be directly proofed and delivered to the printers. The workflow for GRACoLuncoated is not available at the time of publishing.

DeviceLink Color Servers in the Repro Service – FOGRA/ISO

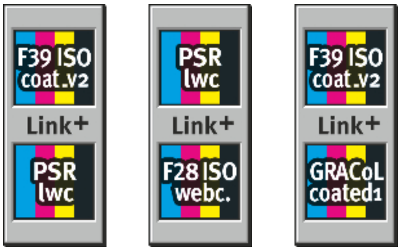


From a technological point of view, the workflows in the repro service are the same as in the agency. So, the same color servers can be utilized. However, unlike the agency, the repro service will require further standard conversions and produce and optimize DeviceLink profiles themselves. As described in the fifth chapter, a software is required here that allows a separations preservation with a limit to the ink coverage. It is often necessary to manually optimize an automatically calculated DeviceLink profile.

Tasks for the Use of DeviceLink Profiles

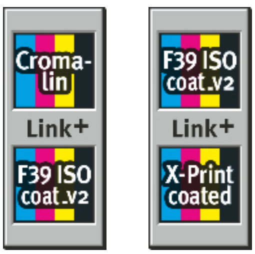
A task found in many repro services is the conversion of CMYK legacy data to one of the ISO standards. Many service providers, for historical reasons, have house standards as well as the ISO standards. Optimized DeviceLink profiles are the best way to convert CMYK legacy data so that they show the same colors on an ISO standard proof as they do on a proof to a house standard. If only image data is to be converted then a Photoshop plug-in, as well as a free Applescript for Mac OSX 10.5 and higher can be used

Further standard conversions



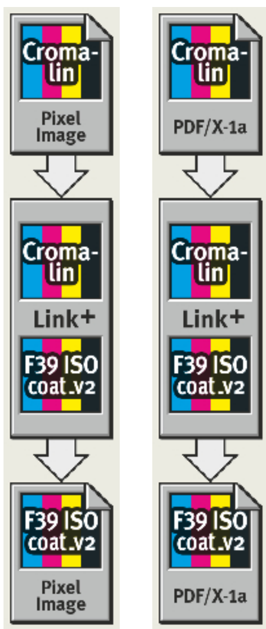
Compared to agencies, repro services require a greater number of DeviceLink profiles in their basic setup for standard conversions, such as the conversion of data between PSR gravure and various offset standards or from FOGRA/ISOcoated_v2 to GRACoL-coated1

Self-provided DeviceLink profiles



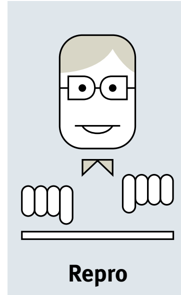
With suitable software and repro know-how, repro services can create their own DeviceLink profiles for specific tasks, as described on the left.

In repro service there are often large stocks of CMYK legacy data. Both of these workflows show the use of DeviceLink profiles in converting pixel images or PDF data, that were previously proofed non-digitally on Cromalin, to FOGRA39/ISOcoated_v2.



In collaboration with printing partners, DeviceLink profiles can be created for converting from ISO standards to house standards.

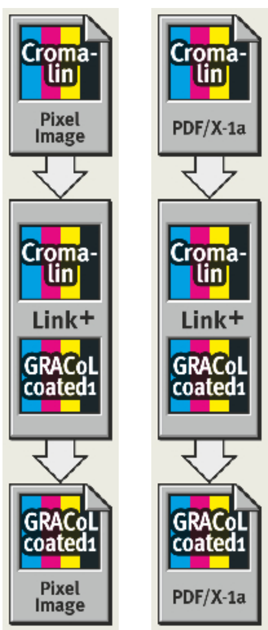
DeviceLink Color Servers in the Repro Service – GRACoL/SWOP



As with agencies, the workflows for repro services according to GRACoL/SWOP are very similar to the FOGRA/ISO based workflows. GRACoLcoated1 is used instead of FOGRA39/ISOcoated_v2. With regard to gravure printing, the situation in the US is quite different from the European/ECI gravure approach. Most European gravure printers print with primary colors very different from weboffset in terms of hue. Particularly the gravure yellow, which is more reddish than that in weboffset printing. For this reason, special profiles are available in Europe for gravure printing.

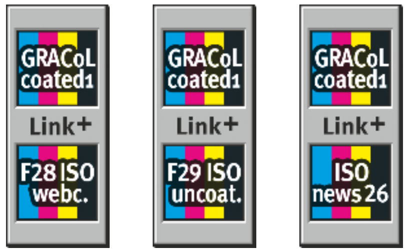
In the US, gravure printing should be adjusted to match weboffset printing as best as possible. Because of this, it is recommended to deliver SWOP data and proofs to gravure printers in the US.

In repro service there are often large stocks of CMYK legacy data.
Both of these workflows show the use of DeviceLink profiles in converting pixel images or PDF data, that were previously proofed non-digitally on Cromalin, to GRACoLcaoted1.



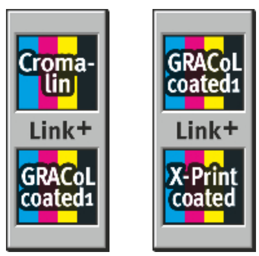
In collaboration with printing partners, DeviceLink profiles can be created for converting from GRACoL/SWOP standards to house standards.

Further standard conversions

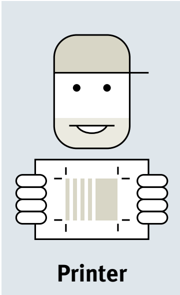


Repro services with international clients can convert GRACoLcoated1 data with standard DeviceLink profiles to all FOGRA/ISO standards.

Self-provided DeviceLink profiles



With suitable software and repro know-how, repro services can create their own DeviceLink profiles for specific tasks, as described on the left.



DeviceLink Color Servers in the Printers

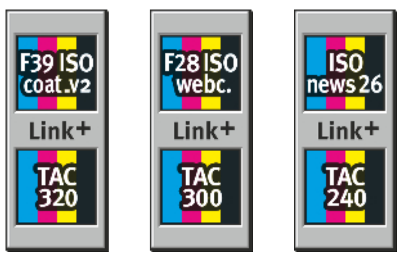
Many PDF Workflow Systems Support DeviceLink Profiles
Most printers have so-called PDF workflow systems at their disposal, with which incoming PDF files can be checked, repaired if necessary and imposed for the printing form. The majority of current PDF workflow systems support DeviceLink profiles, so a color server doesn't necessarily need to be purchased.

Using ready-made DeviceLink Profiles
Tasks that require tailored DeviceLink profiles are, for example, the limiting of the maximum ink coverage or the saving of printing ink. If the printers print to ISO 12647-2, then they can fall back on the ready-made profiles from various manufacturers. Together with selected profiles for color conversion, certain basic configurations of DeviceLink profiles arise for different types of printers, which are described on the opposite page.

Using Self-generated DeviceLink Profiles
As already mentioned, there are tasks that are better solved with self-generated DeviceLink profiles than with standard profiles. To create such profiles, specific software and a repro specialist are required. Self-provided DeviceLink profiles are used in the same color server as the standard profiles.

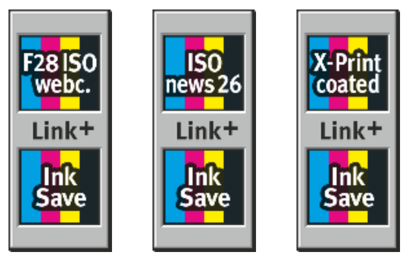
From CMYK Legacy Data to the ISO Standard
The workflows in the printers are similar in part to those in repro. With the implementation of proof and print according to ISO there is also often CMYK legacy data and appropriate house standards for proofs. If the differences from the ISO standard are small then these can be balanced out in a reprint with an altered flow of ink in the machine. However, if the differences are great then a conversion of the legacy data with individually created DeviceLink profiles is also a good aid.

Limiting the ink coverage



DeviceLink profiles for limiting the maximum ink coverage must be calculated for each individual printing standard.

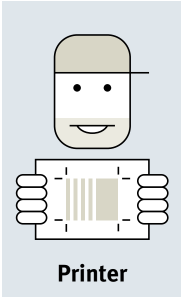
Saving printing ink

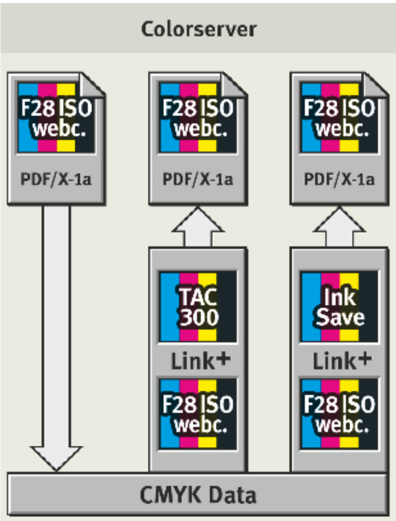


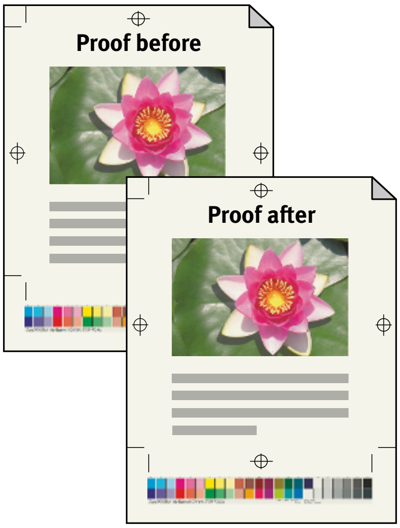
DeviceLink profiles for saving printing ink must also be calculated for each individual printing standard. Either ISO standards or the printers' house standards come into question here.

From the ISO Standard to the House Standard

There are papers, printing inks and raster processes for which there are no suitable ISO standards. The printers can, in this case, develop a house standard and a DeviceLink profile for the data conversion from the ISO standard closest to this house standard. This simplifies the communication with customers, who – independent of the printers' specific house standard – can deliver data in the ISO standard.





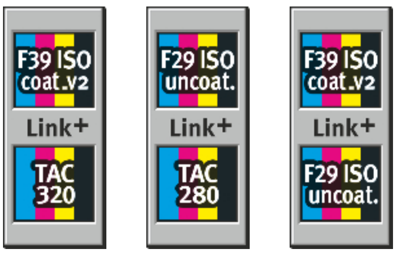


DeviceLink profiles for limiting the maximum ink coverage or for saving printing ink distinguish themselves in so much as the PDF file exists in the same color space, before and after the color optimization. The results of the proof, before and after the color optimization, are likewise identical.

Basic Configuration for Different Printers – FOGRA/ISO

Each printer has a different profile, with regard to the paper types they use and the corresponding FOGRA/ISO standards. For sheet-fed offset, heat-set and cold-set weboffset, however, tasks can be defined that can be solved with standard DeviceLink profiles. Just as it is normal for every printer to have a software for the preflight and repair of PDF files, a color server with standard DeviceLink profiles is also to be recommended. Specific color optimizations can then be simply set up with individually created DeviceLink profiles.

Sheet-fed offset

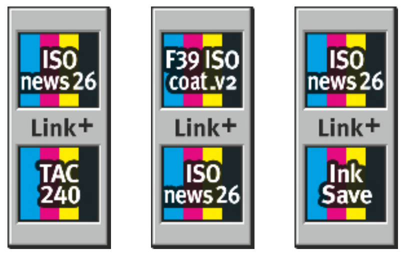


In sheet-fed offset, mostly coated and uncoated types are printed on. To avoid print problems on both sorts of paper, it is recommended to use appropriate device profiles that limit the maximum ink coverage, or total amount of color (TAC).
It also often occurs that customers deliver CMYK data for coated paper for printing on uncoated paper. A DeviceLink profile for converting such data produces crisp colors and, at the same time, limits the TAC to 280%.

Heat-set weboffset

In heat-set weboffset, many coated papers with different grammage are printed on, which are represented by the profiles ISOcoated and ISOwebcoated. DeviceLink profiles to limit the TAC avoid print problems.
If print data is delivered for ISOcoated or gravure standards, then DeviceLink profiles help in the color conversion to ISOwebcoated.
A further DeviceLink profile saves printing ink on LWC paper.

Cold-set weboffset

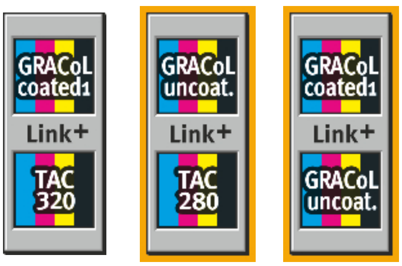


In cold-set weboffset mainly newsprint is printed on. A DeviceLink profile to limit the TAC avoids print problems from the outset. If print data is delivered for coated paper a DeviceLink profile takes care of the color conversion. Saving printing ink can be realized with a further DeviceLink profile.

Basic Configuration for Different Printers – GRACoL/SWOP

The workflows on the printer's side for GRACoL/SWOP are quite comparable to the FOGRA/ISO workflows. Please note that, at the time of publishing, no "GRACoLuncoated" standard is available. This will hopefully be resolved in the future.

Sheet-fed offset

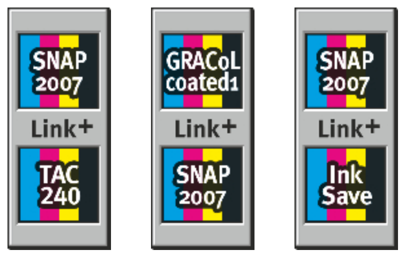


In sheet-fed offset, mostly coated and uncoated types are printed on. To avoid print problems on both sorts of paper, it is recommended to use appropriate device profiles that limit the maximum ink coverage, or total amount of color (TAC).
It also often occurs that customers deliver CMYK data for coated paper for printing on uncoated paper. A DeviceLink profile for converting such data produces crisp colors and, at the same time, limits the TAC to 280%. GRACoLuncoated is not available at the time of publishing.

Heat-set weboffset

In heat-set weboffset, many coated papers with different grammage are printed on, which are represented by the profiles SWOPcoated3 and SWOPcoated5. DeviceLink profiles to limit the TAC avoid print problems.
If print data is delivered for GRACoLcoated1, then DeviceLink profiles help in the color conversions.
Further DeviceLink profiles are saving printing ink.

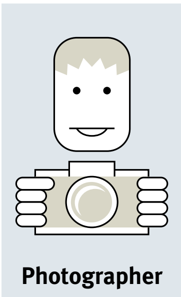
Cold-set weboffset



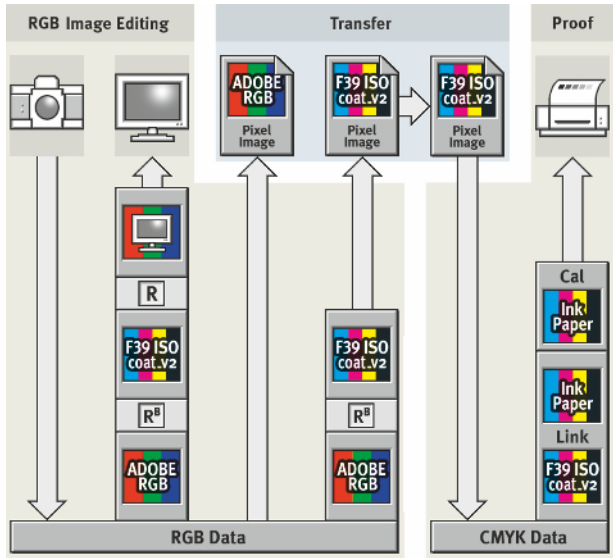
In cold-set weboffset mainly news print is printed on. A DeviceLink profile to limit the TAC avoids print problems from the outset. If print data is delivered for coated paper a DeviceLink profile takes care of the color conversion. Saving printing ink can be realized with a further DeviceLink profile.

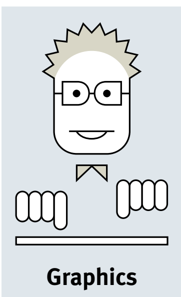
The Production Chain According to FOGRA/ISO

The graphics on this double page exemplify the possibilities to organize color-reliable data and proofs, from the photography, graphics and reproduction right through to the printers. Each stage shows the profiles and rendering intents used. DeviceLink profiles are exclusively used for proofing the color transformation in the color servers. The concluding strategy chapter (7) provides an overview of which steps are important in configuring production workflows.

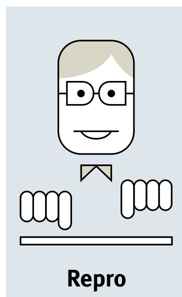


The photographer transfers AdobeRGB images from his camera and switches on a soft proof for FOGRA39/ISOcoated_v2 for image processing. He delivers his image data in AdobeRGB and FOGRA39/ISOcoated_v2, while a professional proof of the FOGRA39/ISOcoated_v2 images document the color balance of his images.

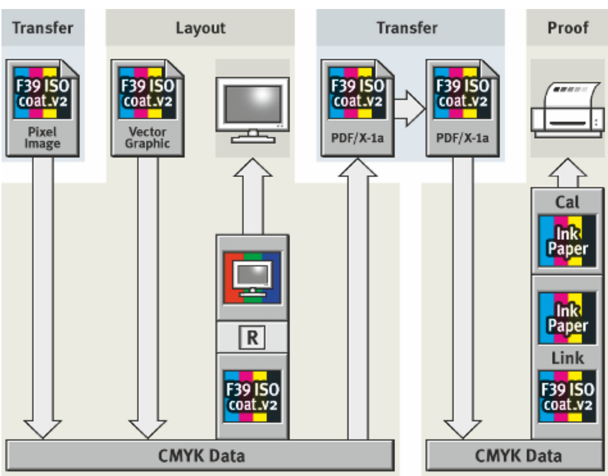


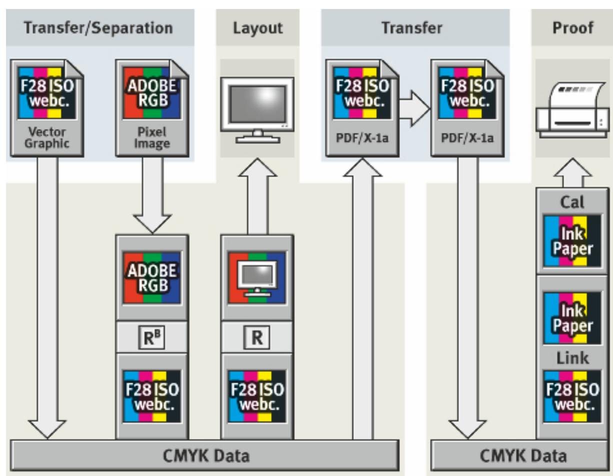


The graphic designer takes the photographer's FOGRA39/ISOcoated_v2 images, combines these with vector graphics in the FOGRA39/ISOcoated_v2 color space and creates an FOGRA39/ISOcoated_v2 PDF/X-1a file. The contract proof for the printers is created from this. Alternatively, the FOGRA39/ISOcoated_v2 PDF/X-1a file also serves as the master data for a color server.

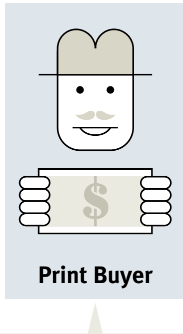


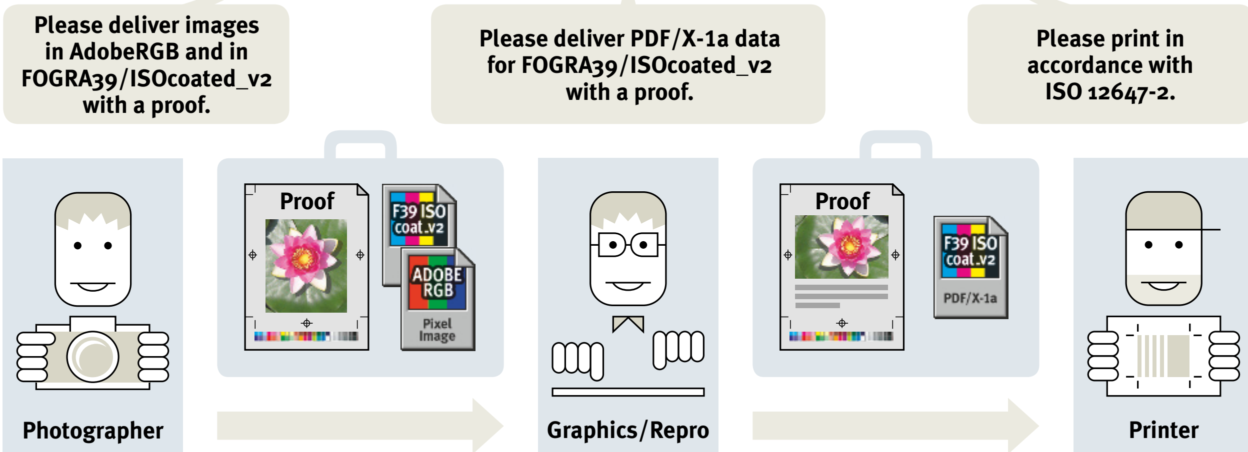
This path shows the creation of print data for different printing standards without the use of a color server. The repro service takes the photographer's AdobeRGB images and separates them for the desired printing standard. Vector graphics are set up in the color space of the print. Finally, a PDF/X-1a file is created, from which the contract proof for the printers is produced.

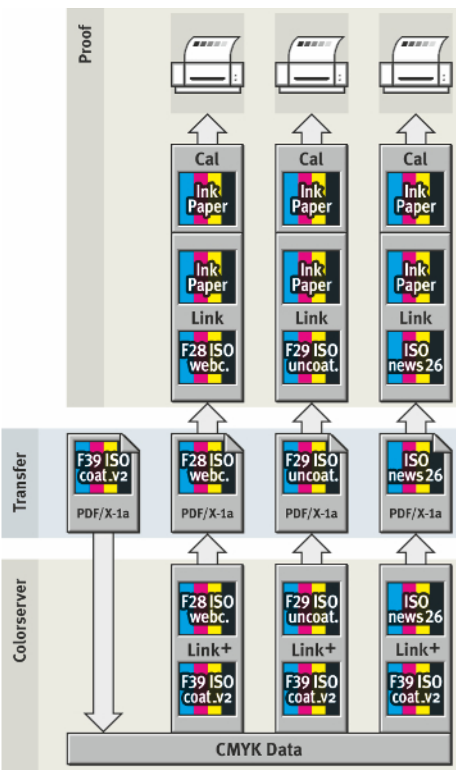


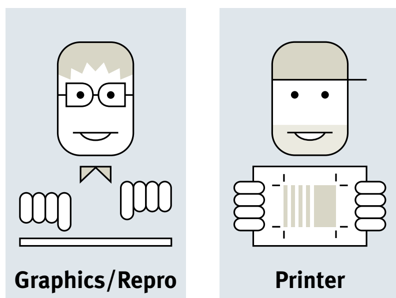


Guidelines for print buyers and transfers between the stages of production





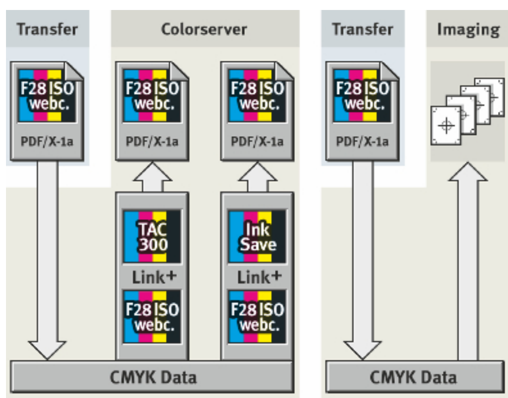




Color servers in the printers serve the optimization of delivered print data, for example for limiting the TAC or saving printing ink. Apart from this, the color server can also be used for converting to other FOGRA/ISO standards. If printing plates are made from PDF/X-1a files then no color management takes place.

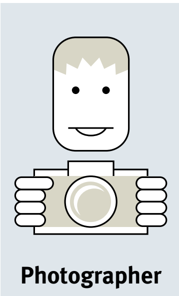
A main purpose for color servers in agencies or repro services is the conversion of FOGRA39/ISOcoated_v2 PDF/X-1a files to other FOGRA/ISO standards.

New proofs are subsequently created from the converted PDF/X-1a files for the respective FOGRA/ISO standard.

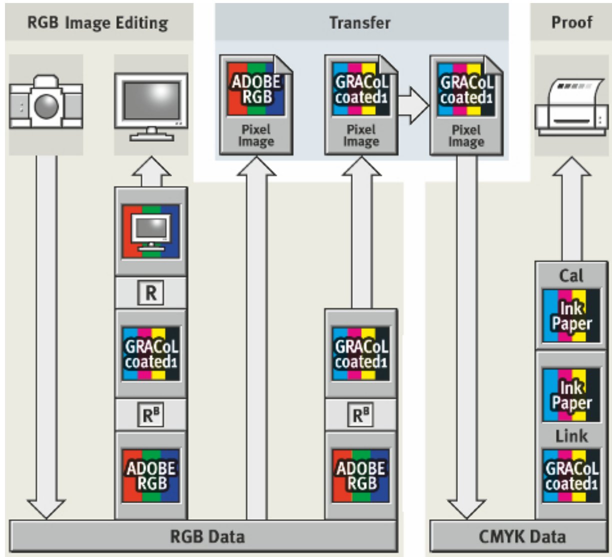


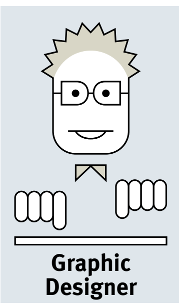
The Production Chain According to GRACoL/SWOP

The graphics on this double page exemplify the possibilities to organize color-reliable data and proofs, from the photography, graphics and reproduction right through to the printers. Each stage shows the profiles and rendering intents used. DeviceLink profiles are exclusively used for proofing the color transformation in the color servers. The concluding strategy chapter (7) provides an overview of which steps are important in configuring production workflows.

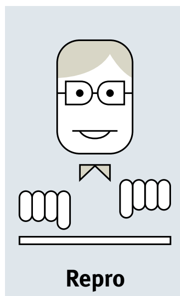


The photographer transfers AdobeRGB images from his camera and switches on a soft proof for GRACoLcoated1 for image processing. He delivers his image data in Adobe-RGB and GRACoLcoated1, while a professional proof of the GRACoL-coated1 images document the color balance of his images.

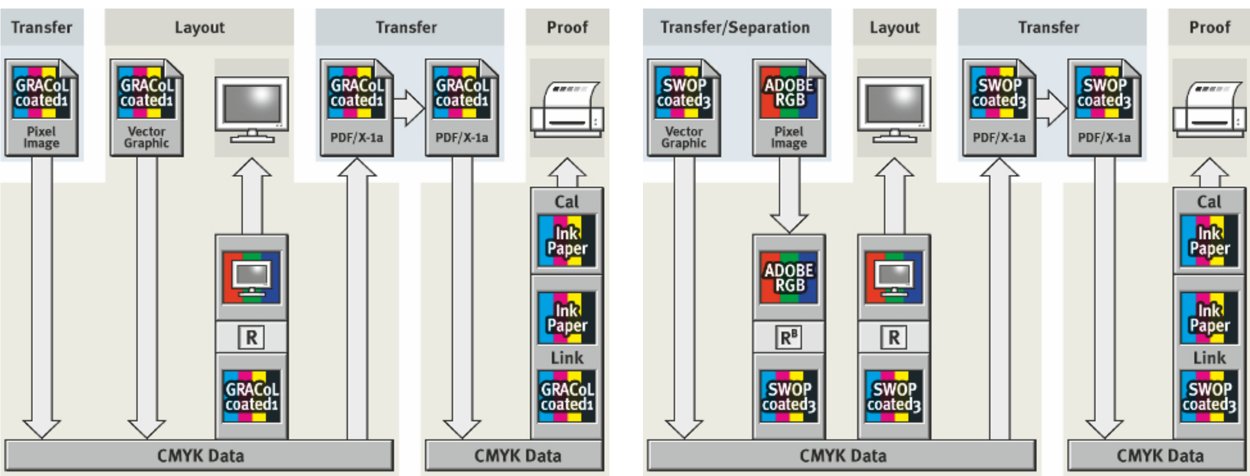




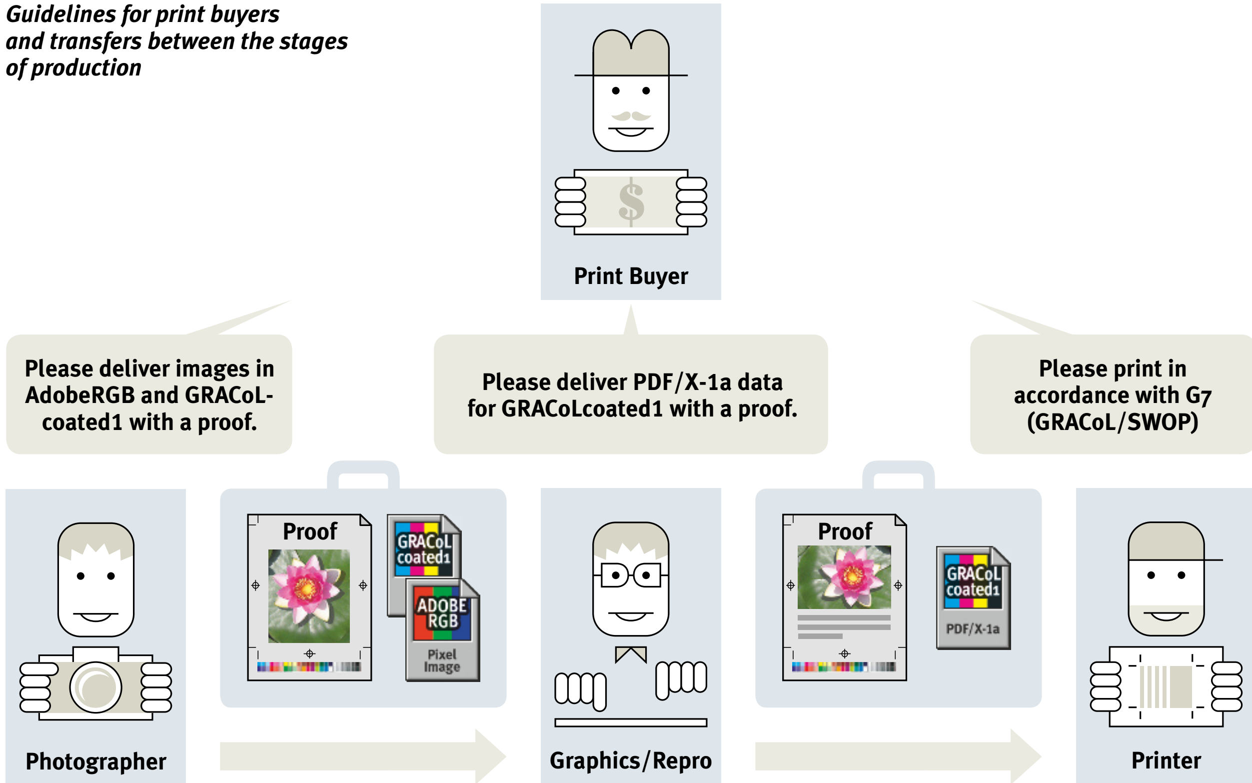
The graphic designer takes the photographer's GRACoLcoated1 images, combines these with vector graphics in the GRACoLcoated1 color space and creates an GRACoL-coated1 PDF/X-1a file.
The contract proof for the printers is created from this. Alternatively, the GRACoLcoated1 PDF/X-1a file also serves as the master data for a color server.

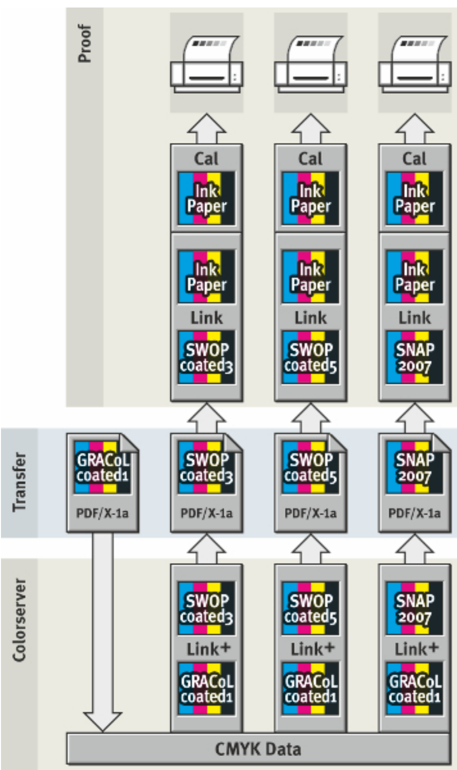


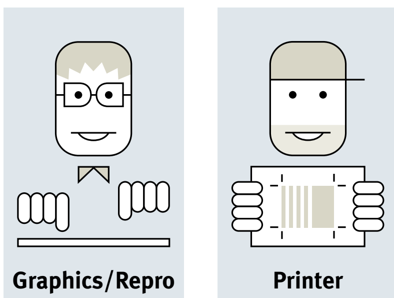
This path shows the creation of print data for different printing standards without the use of a color server. The repro service takes the photographer's AdobeRGB images and separates them for the desired printing standard. Vector graphics are set up in the color space of the print. Finally, a PDF/X-1a file is created, from which the contract proof for the printers is produced.



Guidelines for print buyers and transfers between the stages of production



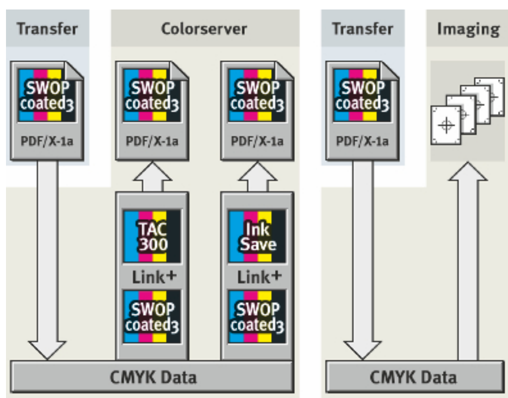


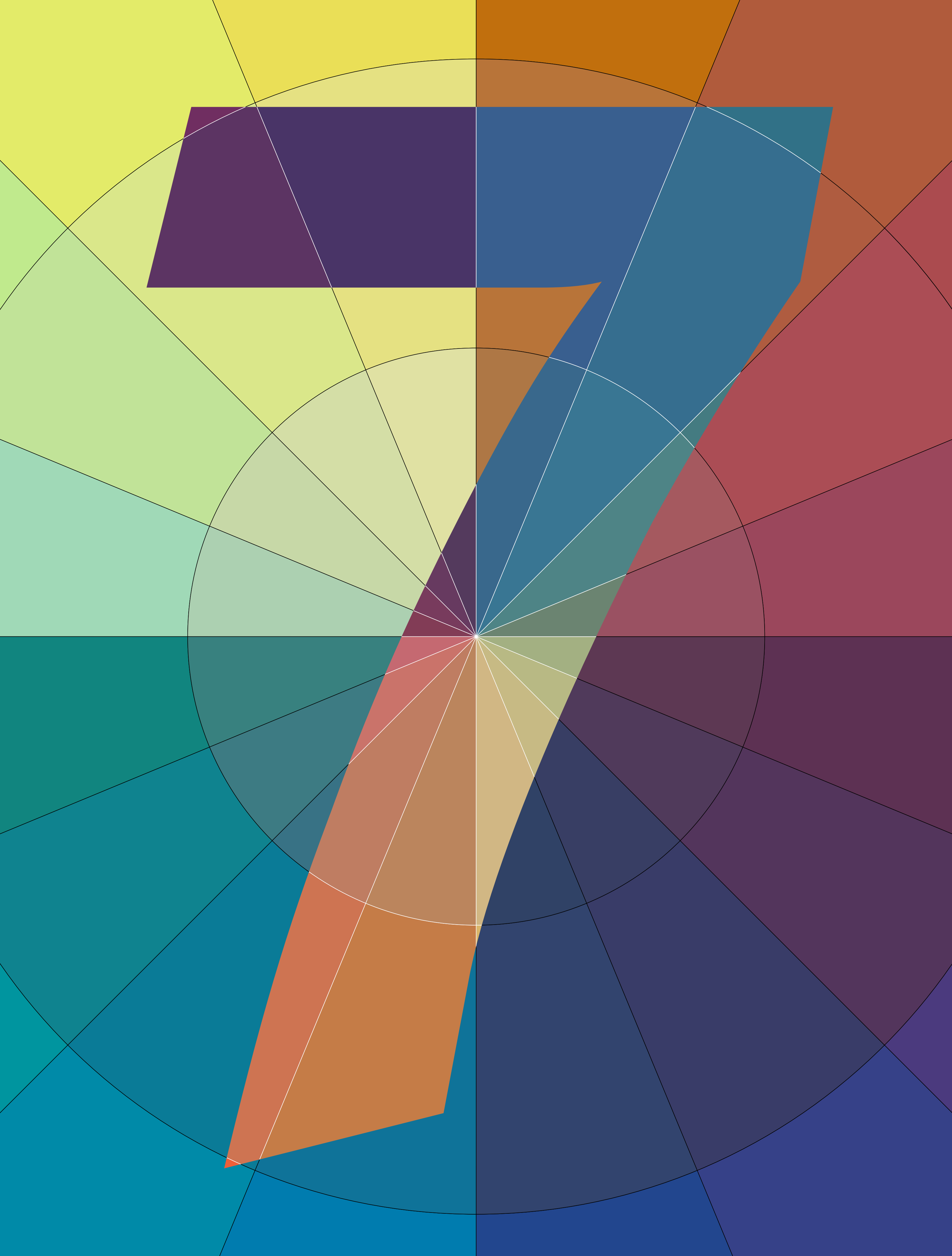


Color servers in the printers serve the optimization of delivered print data, for example for limiting the TAC or saving printing ink. Apart from this, the color server can also be used for converting to other GRACoL/SWOP standards. If printing plates are made from PDF/X-1a files then no color management takes place.

A main purpose for color servers in agencies or repro services is the conversion of GRACoLcoated1 PDF/X-1a files to other ISO standards.

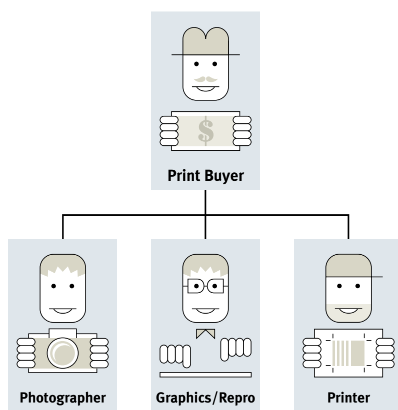
New proofs are subsequently created from the converted PDF/X-1a files for the respective GRACoL/SWOP standard.




7

Corner Stones for a Color-management Strategy

The following sections summarize once more the recommendations of the last two chapters on the color-management workflow for different user groups. After both comprehensive subjects of digital proof and monitor profiling, there follow recommendations for the individual user groups – from photographers to graphics and repro through to the print.

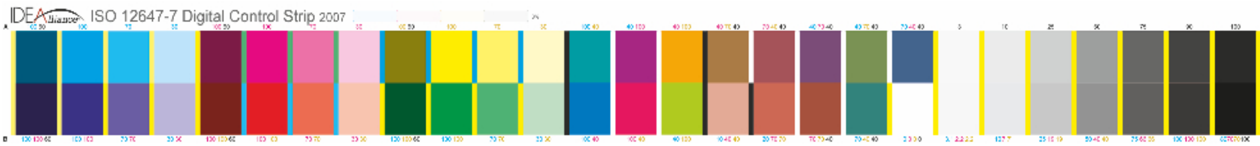


1. The Digital Proof

Proofing systems should have a high-quality calibration for a combination of ink and proof medium.

Based on the calibration, the manufacturer should preconfigure in his solution optimized DeviceLink profiles for the simulation of different standards.

Digital proofs in accordance with FOGRA/ISO or GRACoL/SWOP standards are the central tool for evaluating and approving digital data. For print buyers it is essential to explicitly request proofs with the FOGRA media wedge CMYK or IDEAlliance Color Control Strip from their production partners. For print buyers working to a high standard with different repro services it is advantageous to measure the proofing control wedge themselves.
Photographers passing on digital data can protect themselves with a proof for the FOGRA39/ISOcoated_v2 or GRACoLcoated1 color space. If they are able to measure the FOGRA media wedge CMYK or the IDEAlliance Color Control Strip themselves then they can communicate on the same level with repro services.
If graphic designers or repro services create print data then a proof with the media wedge CMYK should be included in the delivery as a matter of principle.
Printers should explicitly request proofs with media wedges for specified ISO printing standards from their suppliers. Only on this basis can they agree with their suppliers upon criteria for the quality control of proofs that can be effectively applied on both sides.



Calibration comes before Profiling
A proofing software with a high-quality calibration ensures that a manufacturer's supplied reference for a combination of ink and proof medium can be reached at any time. If the manufacturer provides suitable profiles for the calibrated ink/media combinations and ISO/GRACoL/SWOP standards, then the user need neither purchase a profiling software nor contract a color-management service provider. Because each profile combination of proof medium/ink and print standard, as a rule, requires an optimization, it is sensible if the manufacturer carries this out and supplies it as a DeviceLink profile.
A complete proofing solution encompasses the proof printer, a proof software with a powerful calibration, supplied DeviceLink profiles for different print standards, an integrated media wedge/Color Control Strip as well as a spectrophotometer for the calibration and evaluation of the proofing control wedge.

After a calibration the limited tolerances should also be easily achieved with the use of standard DeviceLink profiles.

For the proof of a standard coated PDF/X-1a file, the data first passes through the DeviceLink profile and then the calibration for the combination of ink and paper.

Tolerances according ISO 12647-7
Paper white: < 3.0
Mean difference: < 3.0
Maximum difference: < 6.0
Primary colors: < 5.0
Primary colors: < 2.5 (Delta H)
CMY Gray: < 3.0 (Delta H)

2. The Soft Proof and RGB Working Color Space

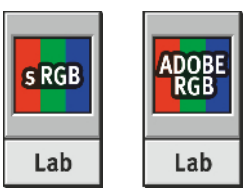
Basically, the soft proof allows for an evaluation on the monitor of how the subsequent proof will look. For this, the monitor's white point should be set to 5000–6000 Kelvin. For older CRT displays, with a maximum brightness of 85 Candela, and in lighter environments, 5500–6000 Kelvin is the correct choice. For TFT displays, which can be set to a maximum brightness of 120–150 Candela, 5000–5500 Kelvin is the better choice. This is particularly true for production environments with darkened ambient light. Decisive for the choice of white point is ultimately the comparison with a proof in a dimmable light booth next to the monitor.

A profiled monitor with correctly set-up application software must show a good match with a proof in the light booth.

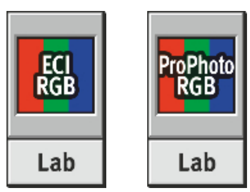
The choice of the optimal gamma for the monitor depends on the task at hand as well as the type of monitor. If data for ICC-based color management is to be edited on the monitor, but at the same time a good display for office and internet applications is required, then a gamma of 2.2 is the right choice. This is also true when relatively inexpensive monitors are used, which are already preset in the factory to a gamma of 2.2. However, a monitor with a hardware calibration and a gamma of 1.8 is to be recommended if photographer, post-production and the repro service have all agreed on the ECI-RGB or ProPhoto color space with a gamma of 1.8. In this case, a somewhat brighter display in internet and office programs must be accepted.

Rendering Intent for the Soft Proof

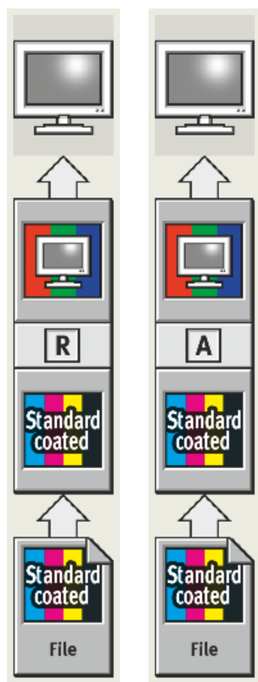
If printing color spaces are simulated on the monitor whose paper white is not exactly a* 0 b* 0, then the rendering intent chosen for the soft proof plays an important role. If FOGRA39/ISOcoated_v2 or GRACoLcoated1 is the only printing standard to be simulated then the relative colorimetric intent often produces a visually slightly better result. However, if different printing standards are to be simulated on the monitor, then the soft proof should be made with the absolute colorimetric intent throughout. Generally, a fine tuning of the monitor settings is then required and possibly also the applied profile.



Gamma 2.2
For production environments where the correct color reproduction of digital photos, artwork, internet and office applications is important, the monitor should be set to a gamma of 2.2. Digital photos should be processed in the AdobeRGB color space, internet and office data in sRGB.

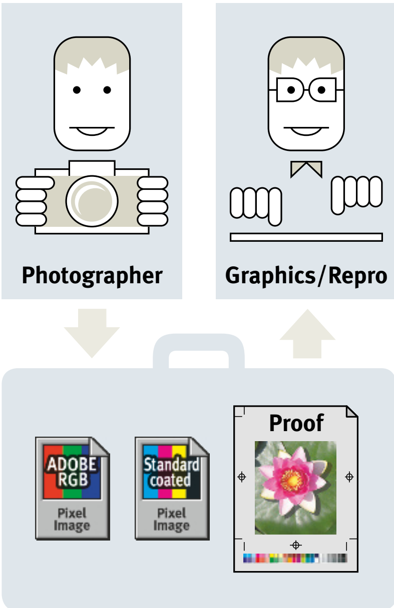


Gamma 1.8
For production environments where only high-end photography, post-production and repro work is done, the working color space ECI-RGB or ProPhotoRGB and a monitor gamma of 1.8 is the better choice.



For the color reproduction on the monitor, the choice of rendering intent is of importance, as well as the choice of profile.

3. Photographer: from the RGB File to the Standard Coated Proof



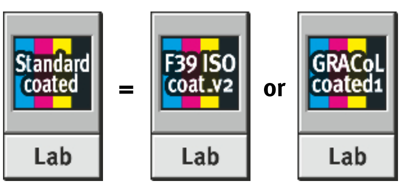
After the digital proof has been set up and the monitor has been profiled, it is important for the photographer to come efficiently from his camera's RGB data to the proof in a standard coated color space (FOGRA39/ISOcoated_v2 or GRACoLcoated1). For this it makes sense to optimize the RGB data in such a way that they can be consistently converted with the relative colorimetric rendering intent and black-point compensation to standard coated. For this it is necessary to assess the RGB data with a standard coated soft proof. For motifs with highly saturated colors, manual intervention is required.

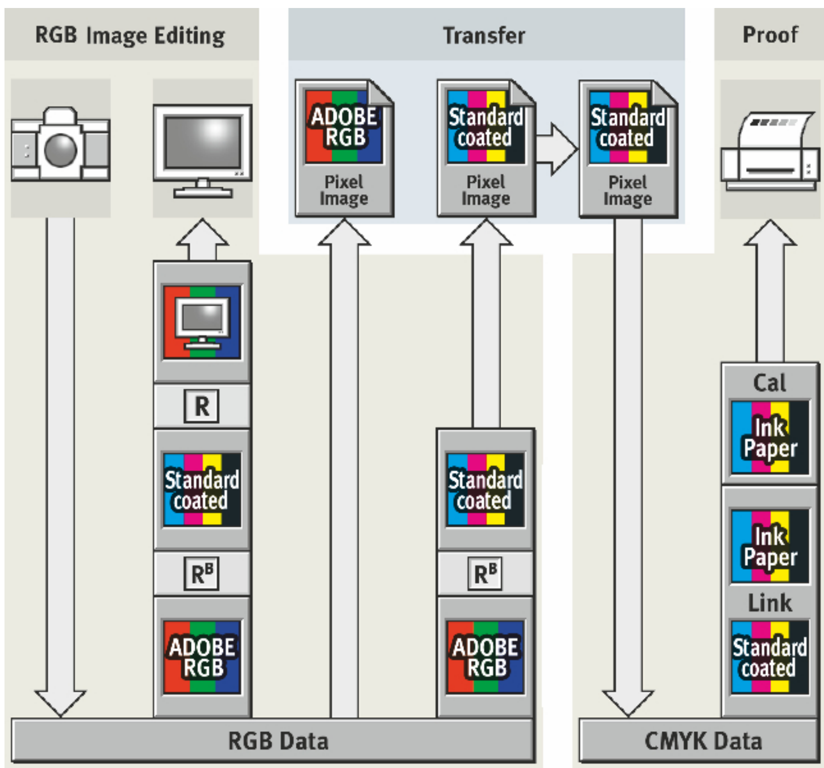
If the RGB data is optimized in this way, then they can be fully automatically converted to the standard coated color space and then proofed. They are now optimally prepared so that other users can use profiles from any other profiling software for subsequent conversions. The consistent relative colorimetric conversion with black-point compensation ensures an impression as similar as possible across different profiling software.

RGB files with the embedded profile for the RGB working color space, along with standard coated data and the appropriate proof, are delivered to the customer. This shows the customer clearly and comprehensibly the color design from the photographer's point of view. It also serves as a safeguard against the subsequent service providers, so that they blame their own color-management problems on the photographer.

The image-editing software used (e.g. Photoshop) should be able to simulate a standard coated color space (FOGRA39/ISOcoated_v2 or GRACoLcoated1) when retouching in RGB and convert RGB data automatically to the standard coated color space.

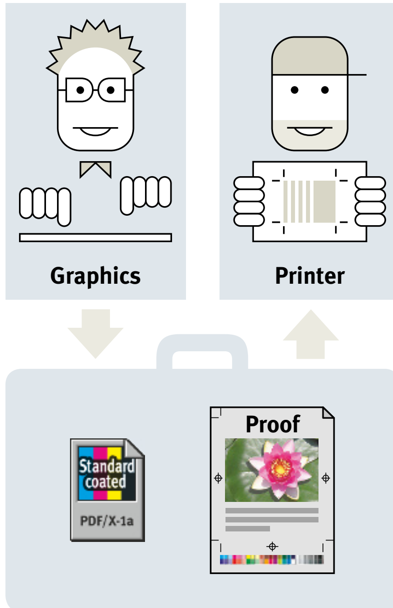
The proofing system used should satisfy professional requirements for prepress. So it is also recommendable for photographers to use a system with a powerful calibration and ready-made DeviceLink profiles for a standard coated color space.





4. Graphics: Creating and Proofing Simple PDF/X-1a Files

After the proofer has been set up and the monitor has been profiled in the graphics office, it is important to arrive as efficiently as possible at print-ready PDF/X-1a files including the proof. The standard coated color space (FOGRA39/ISOcoated_v2 or GRACoLcoated1) for CMYK data is agreed with the image supplier, or RGB images with embedded profiles are requested to be separated in-house into the standard coated color space. The finished document is built wholly in CMYK with a soft proof for standard coated. Care should be taken that the color settings in the layout program and in the PDF/X-1a creation do not cause any undesired color transformations for imported images and graphics.

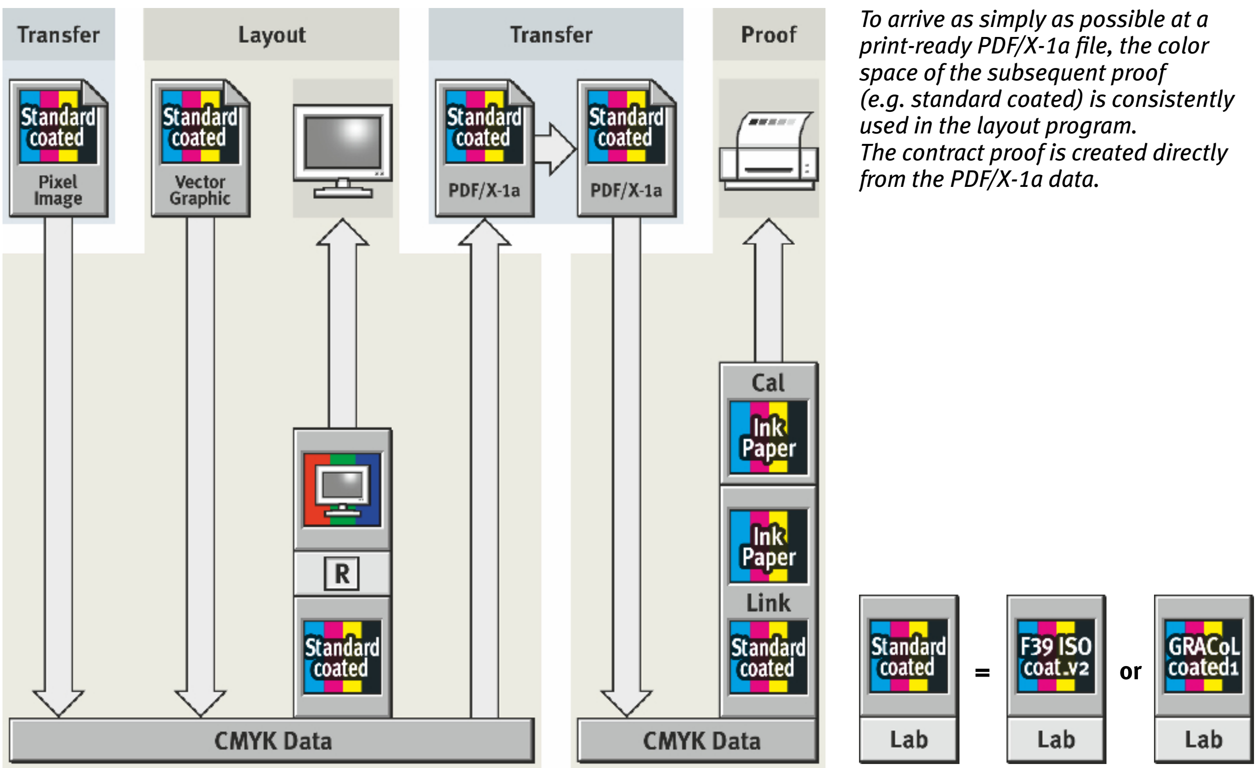


Demands on the Layout Program

It is essential that the layout program offers the possibility in the color settings to deactivate color management for imported images and graphics. Furthermore, the layout program should offer a separation preview to check for any undesired color transformations. For a consistent color management, from the layout to the PDF/X-1a file, the layout program should be able to embed the profile for the CMYK color settings as a PDF/X output intent.

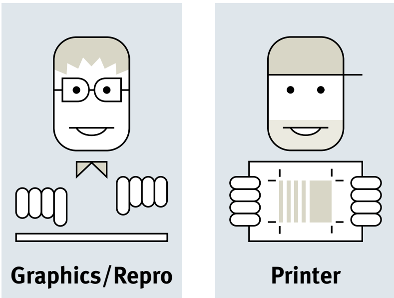
Delivery

PDF/X-1a files as well as a proof of these files are always delivered. If the client assumes the role of productioner, then he should be able to check the delivered PDF files for their adherence to the PDF/X-1a parameters and other criteria.



To arrive as simply as possible at a print-ready PDF/X-1a file, the color space of the subsequent proof (e.g. standard coated) is consistently used in the layout program. The contract proof is created directly from the PDF/X-1a data.

5. From Graphics to Reproduction: Color Server



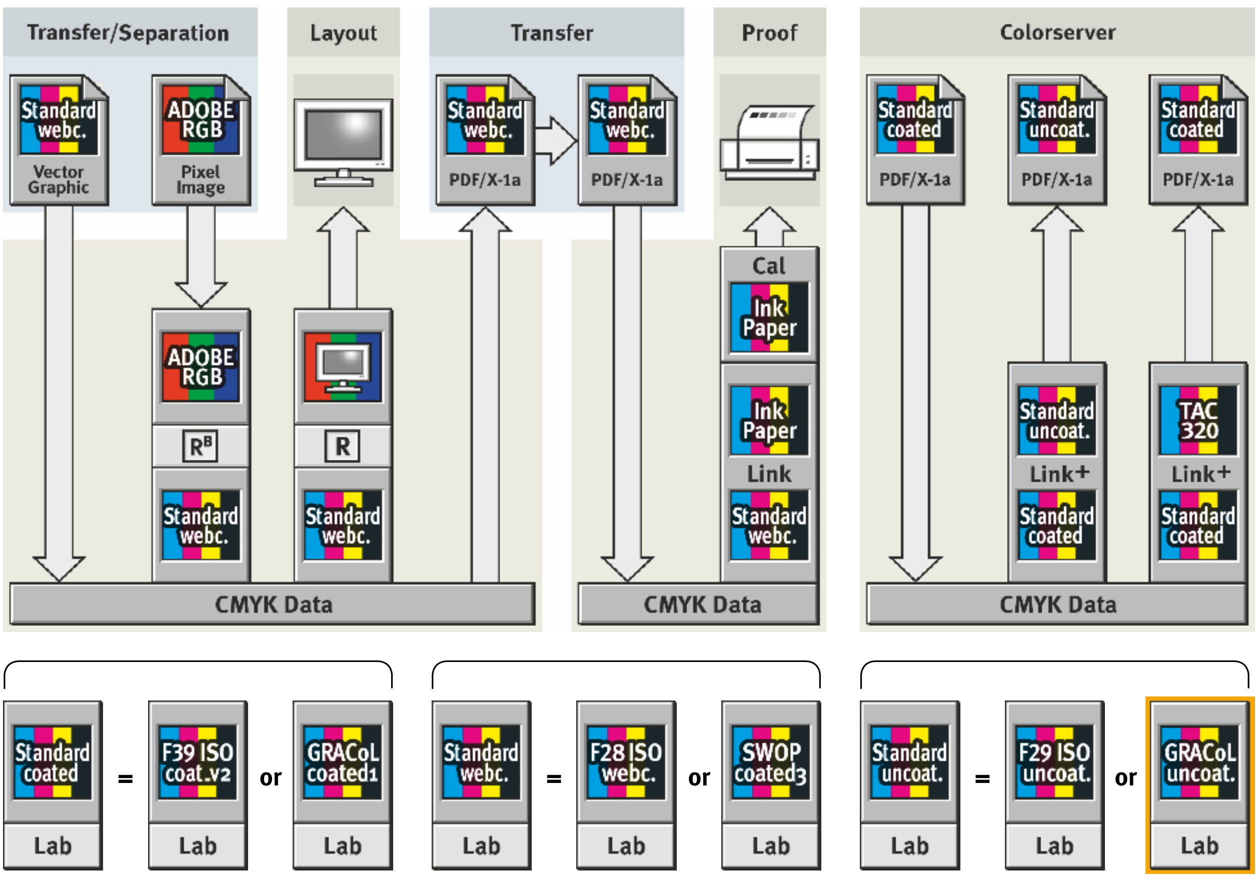
The clearly separated roles of graphics and reproduction of former times, these days merge quite fluidly. For gaining knowledge in color management it therefore makes sense to deal step by step with the complexity of the tasks to be accomplished. In the last chapter complete documents were built up in a standard coated color space, saved as PDF/X-1a and subsequently proofed. Now the point is to build up documents in other color spaces and to take the same path through PDF/X-1a data to the proof in these color spaces. To make use of the layout programs' further color-management capabilities, the separation of RGB images can be made here. However, grayscale images, vector graphics and CMYK images must, as before, be imported "print-ready". There again follows a PDF/X-1a file and a corresponding proof.

Color management in the layout program is, at best, suitable for image data. Vector graphics must be set up print-ready in the CMYK color space. The graphic shows a workflow up to the proof in a webcoated color space.

Standard coated PDF/X-1a data can be converted to an uncoated standard or limited to a maximum ink coverage of 320% with standard DeviceLink profiles in a color server (right).

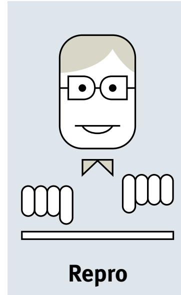
Key Technology – Color Servers with DeviceLink Profiles

If complete documents with imported grayscale images and vector graphics are to be transformed from the standard coated color space to other standards then a PDF color server and standard DeviceLink profiles are required. Print buyers producing for different printing standards from one data set, should find a production partner who uses a color server. Printers can, in addition to color conversions, optimize their print data with a PDF color server and standard DeviceLink profiles – e.g. by limiting the maximum ink coverage or a particularly ink-saving image build-up.

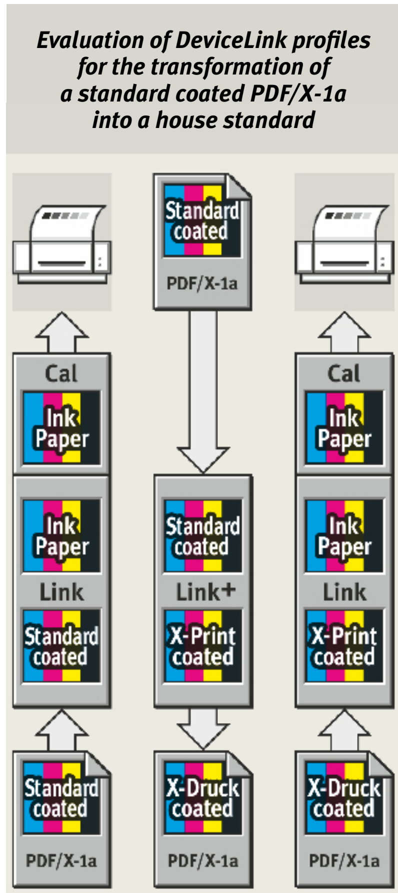


6. Creating DeviceLink Profiles

A whole row of specific tasks in color management can be efficiently solved with individually created DeviceLink profiles. In contrast to the use of standard profiles in proofing solutions and color servers, such work can only be carried out by repro and color-management specialists. Important tasks are, for example, converting legacy data sets, adjusted to Chromalin analogue proofs, to ISO standards or the configuration of color servers to convert ISO data to special house standards. A further use for individual DeviceLink profiles lies in the consolidation of the classic color correction in Photoshop with the extended possibilities for optimizing the black generation of print data. Print buyers requiring printing specifically to house standards and not just to ISO standards, should find a repro partner capable of creating individual DeviceLink profiles.

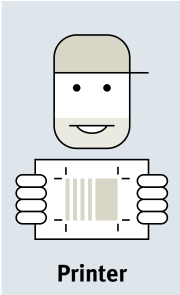


To evaluate DeviceLink profiles, special test files are required that, along with photos, also contain critical areas such as gradients and pure colors.



1. *Build-up and proof of a test chart in a standard coated color space*
2. *Conversion of the test chart with a DeviceLink profile to the house standard*
3. *Proof of the converted test chart and comparison of the result with the first proof*

7. Printing in Accordance with ISO 12647-2 or G7



If the graphic designers and repro services have done their homework, then the printers will receive PDF/X-1a data with contract proofs. In turn, the printers can communicate how print-ready PDF files and the corresponding proofs are to be supplied. So, PDF/X-1a print data and proofs according to the ISO standard are the basis of a color-reliable gateway between prepress and the printers. Only when this basis exists does the standardization in the production of printing formes and printing in accordance with ISO 12647-2 or G7 make sense.

The standardization itself allows for short set-up times. Both printing according ISO 12647-2 and G7 rely on the use of ISO-conformal printing inks. The central point for ISO 12647-2 is the optimization and control of dot gains in the production of printing formes and in the print as well. For G7, the printer has to achive the neutral print density curves as described in the G7 reference.

If the printers master the standardized print according to FOGRA/ISO or GRACoL/SWOP proofs then they can optimize their process freestyle so that higher densities and screen values can be printed on the basis of standard data, thus setting themselves aside from the competition.

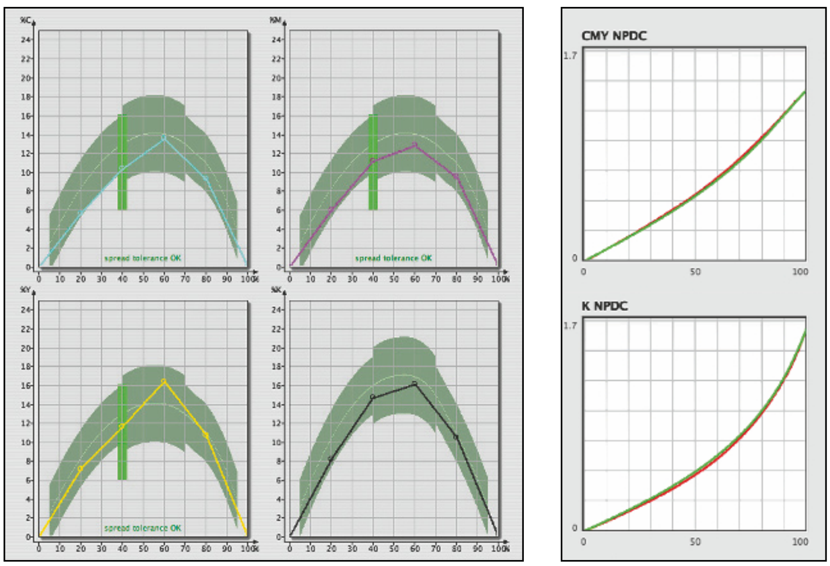
Print buyers, who have their print data and proofs produced to FOGRA/ISO standards, should choose printers who verifiably print in accordance with the ISO 12647. Print buyers, who have their print data and proofs produced to GRACoL/SWOP standards, should choose printers who verifiably print in accordance with G7.

Data and proofs:

for print according ISO 12647-2

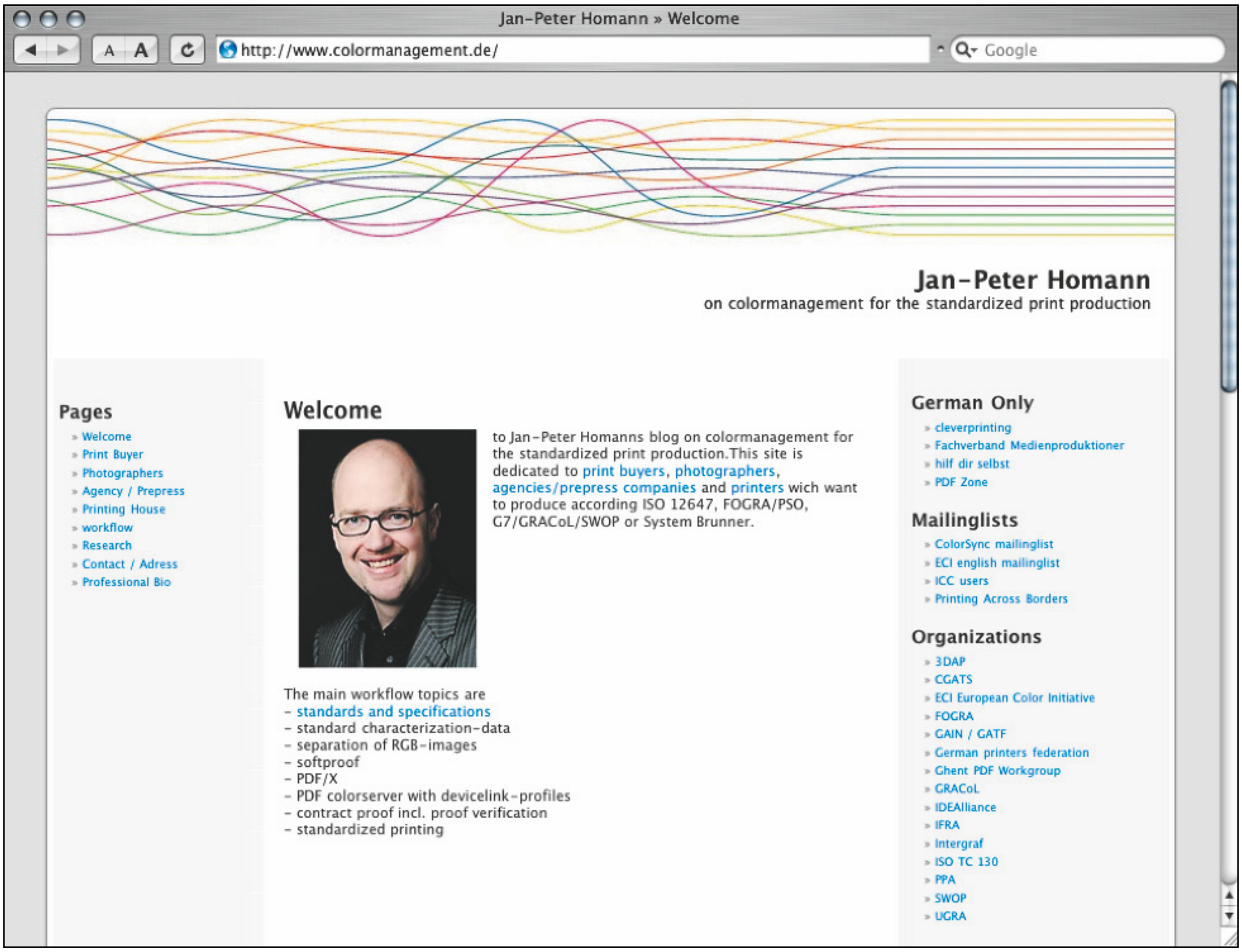
for print according G7

The prints in the Altona Test Suite serve as a visual reference for a production process set up in accordance with ISO 12647-2.



For an optimal implementation of ISO 12647-2 or G7, a software is required that allows a quick and efficient evaluation of test prints.

Further Information



Further information for print production according to the described strategy can be found at the author's website **www.colormanagement.de**.

Index — A to F

Index — G to P