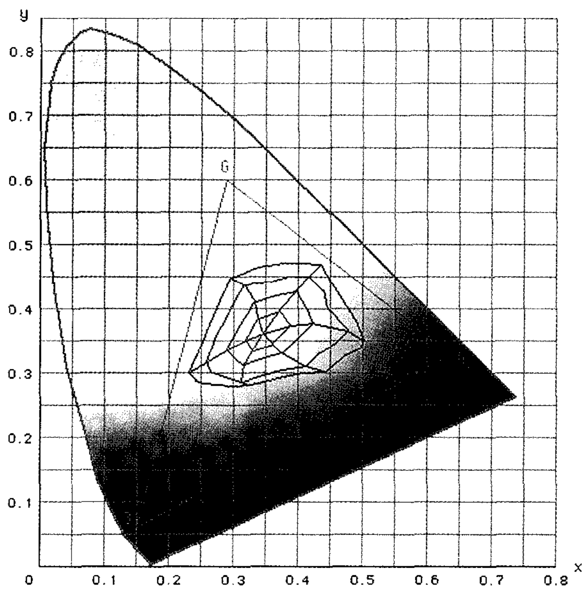
Special Report 2.23

Soft proofing of full newspaper pages



This graphic shows the small size of a newspaper printing colour gamut compared with an RGB colour gamut, both displayed within the CIE colour space

Hard copy colour proofing has never been very popular with newspaper printers. It is time and cost consuming. And in many cases the proof results are hardly comparable to the final print. As the entire prepress workflow is now definitely on the way to full digitisation and automation there is almost no more slot left for the chance of hard copy proofing. This is why IFRA looked into the possibilities of soft proofing of newspaper pages prior to full page output, either computer to film or to plate. What are the criteria a soft proofing system for newspaper production has to fulfill? Which monitors should be used? How does calibration work, and how is colour management involved? Which data formats and which input devices are supported? How is the soft proofing workflow arranged? This report compares those requirements to the specifications of available systems on the market. Practical experiences of users from different countries conclude this Special Report. A detailed evaluation check list is also attached. With this report we want to assist those of our members who look for a fast and reliable soft proofing system.

May 1997

Andy Williams
Research Engineer/Repro

Manfred Werfel
Research Manager

Materials (1)
Pre-Press (2)
Press (3)
Mailroom and Distribution (4)
Electronic Communication (5)
General (6)

For IFRA members only

IFRA · Washingtonplatz · D-64287 Darmstadt · Tel. +49 (6151) 733-6 · Fax +49 (6151) 733-800

Table of contents

1. Introduction

Soft proofing of newspaper pages saves time, material and money, when compared to traditional photomechanical proofs and digital hard copies. It also enables a better management of the production process. For modern full-colour newspapers physical proofing is not viable. For FM-screened pictures (FM = Frequency Modulated Screening) and computer-to-plate processes physical proofs are not feasible at all.

It has been the scope of this study to specify the technical demands of a monitor proofing system for full pages. The study compares the demands to the technical specifications of soft proofing systems on the market and specifies the development of software needed to overcome the gaps.

In order to offer useful information to the printer, the study identifies the places for monitor proofs in the newspaper reproduction chain. Moreover, the study presents a method of evaluating the performance of the monitor proof.

The main application areas for soft proofing are production tracking, layout and colour accuracy inspection. The recommendations are as simple as possible taking these applications into account. In particular, the recommendations deal with the measuring and visual assessment of the colour matching accuracy.

The researchers together with an expert working group have worked out the selection criteria. The study evaluates existing systems for soft proofing according to these criteria. Expert users have provided experiences of soft proofing systems.

VTT Information Technology in Espoo, Finland, has carried out the research work as a commission of IFRA. The project leader was Prof. Caj Södergård and the expert on image processing was Mr. Ari Sirén, M.Sc., the project co-ordinator was Dr. Ulf Lindqvist.

An expert working group with the following members conducted the project:

Les Bovelander,	Scitex Europe, Waterloo, B
Alain Bezy,	Le Republicain Lorrain, Metz, F
Aytun Erdentug,	Parascan, Redwich, GB
Boris Fuchs,	IFRA, Darmstadt, D
Sulo Nuutinen,	Sanoma Corporation, Helsinki, FIN
Ron Johnson,	Aqua 4, Corporation, San Clemente, USA
Joel Maelfeyt,	BARCO, Kortrijk, B
Ilkka Yläkoski,	Data Engineering, Helsinki, FIN
Andy Williams,	IFRA, Darmstadt, D
Manfred Werfel,	IFRA, Darmstadt, D, Moderator
Ian Withers,	Associated Media Base, London, GB

2. The use of monitor proofing in newspapers

Monitor proofing is already in use to a certain degree in several production stages at newspapers (figure 1). Each production stage has its own requirements of the monitor proof.

In this study, the focus has been on examining proofing solutions that visualise the digital page descriptions before or after the RIP as well as showing the content of the output film and plate. This kind of monitor proof provides the following benefits to the user, who most often is a technician, a press operator, but in some cases also an editor or an advertising agency.

The proof

- shows the PostScript interpretation errors
- shows page transmission errors like missing lines
- shows colour separation mix-ups, mostly caused by misread ID codes from plates
- offers the printing press operator a colour reference to stick to over the production run. The reference represents the "average" print-run.
- allows the press operator to get himself familiar in advance with the work to be printed
- is a communication vehicle between the page designer and the press operator
- provides auxiliary functions like production tracking and ink presetting

Production stage to proof	What is proofed?		Proof quality						Who proofs?	In-house or remote?	Resolution required
	Page element	Full page	Colour match	Details	Screen dots	Size	Layout	Typography			
1. Scanner, Digital camera	X		X	X		X			Technician, Operator, Photographer	In-house	High
2. Ad design	X		X	X		X			Designer, Ad agency	In-house/ remote	High
3. Page make-up		X				X	X	X	Technician, Editor, Ad agency	Inhouse/ remote	Low
4. Page description or output on RIP		X	X	X	X	X	X	X	Technician, Pressman, Agency-editor	Inhouse/ remote	High
5. Output on film/plate		X	X			X	X	X	Technician Pressman	Inhouse/ remote	Low/High
6. Printing	X	X	X						Pressman	Inhouse/ remote	

Figure 1. Monitor proofing in different production stages at a newspaper. The focus for this study is on stages 4 and 5.

3. Evaluation criteria for a monitor proofing system

The potential buyer has to consider a set of criteria, when evaluating the feasibility of monitor proofing systems. The evaluation uses the *documentation* provided by the system vendors. The criteria are printed below as a checklist. Not all criteria might be applicable to a certain system. A proofing system might come with several different monitors. In this case each monitor is separately evaluated.

3.1 Monitor

3.1.1 Technical properties

Soft proofing technology is currently based on CRT-monitors, even if LCD displays with carefully designed filters promise a very good colour matching accuracy [GAT,96]. CRT-monitors work by aiming a beam of electrons at a blob of phosphor, which in turn glows. This glow is what we perceive as a pixel on the screen. A standard colour monitor has three dots (dot triad) at each location on the screen; red, green and blue (RGB). There is a corresponding electron gun for each colour that emits an electron beam of varying intensity – this corresponds to colour brightness.

A generic display system consists of a computer, graphics display hardware and CRT-display (figure 2). The host computer manipulates the image values (pixels) and passes the digital pixel values to the frame buffer on the graphics board (= display controller).

The D/A converters of the Video Signal Generator linearly transform the numerical pixel values in the frame buffer to video voltages. Standard voltage intervals exist for various applications. Typically they follow Electronic Industries Association (EIA) standards. Manually adjustable display settings include parameters like colour temperature, brightness, contrast, spatial properties, RGB-gun voltage and convergence.

The size of the monitor (vertically and horizontally) has an effect on the simulation of the printed page. Newspaper pages look different on small monitors. In practice, proofing a broadsheet page demands at least a 20 inch monitor. However, bigger monitors need a higher bandwidth compared to smaller monitors to maintain the frame refresh rates and to prevent flickering. One possibility to prevent flickering in the past was to select long persistence phosphors. Nowadays, vendors do not offer long persistence phosphors, because of small market needs and of technical weaknesses (short life time, low light output).

The graphics board settings define **spatial resolution** (for example 1024 x 768 pixels). The settings should correspond to the monitor's shadow masks and the resolution of the monitor. A high resolution (for example 1600 x 1200) leads to small fonts, if the physical monitor is not big enough. It may also lead to lower refresh rates and therefore to heavier flickering and lower visual quality.

The shadow mask of the monitor affects the picture quality. It ensures that the electrons from each gun strike the corresponding phosphor. The three electron beams arrive at slightly different angles from the three separate electron guns. It is therefore possible to construct and align the shadow mask so that the electron beam from one gun will strike the correct phosphor dot, but the other two phosphors will be in shadow. In this way, the intensity of

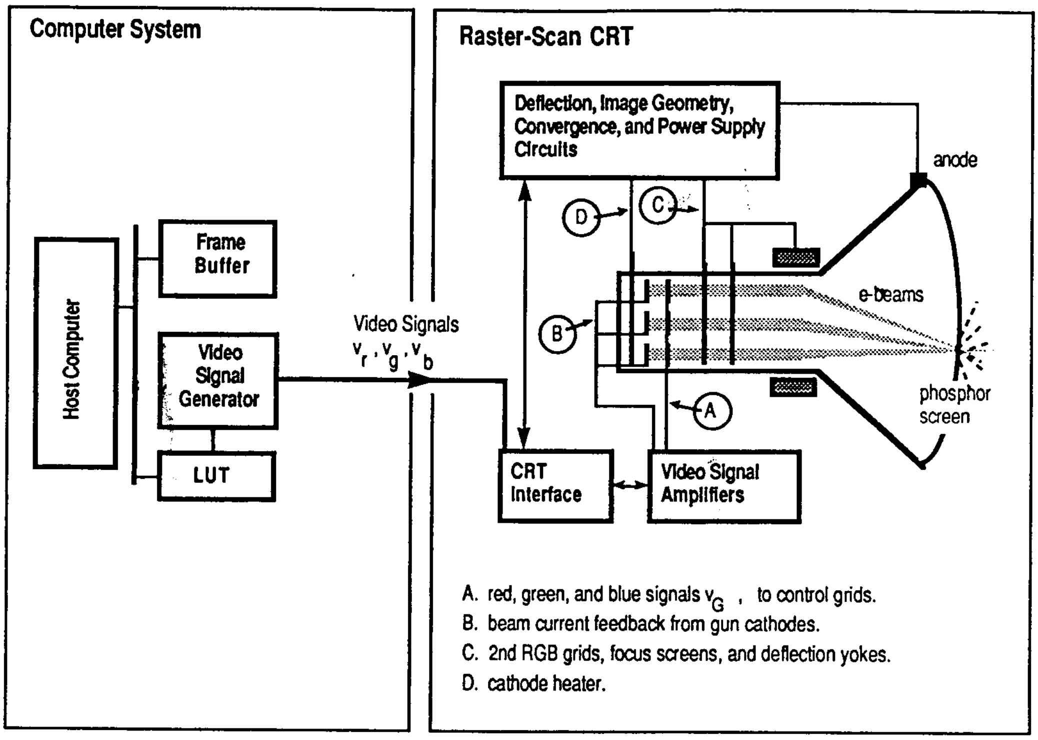


Figure 2. A generic display system [Berns, 93].

red, green and blue is separately controlled at each dot triad location. The shadow mask is usually an *INVAR* mask (64% iron, 36% nickel) which is a thin plate with small holes punched in it. Only about 20–30% of the electron beam actually pass through the holes in the mask and hit the screen phosphor. The rest of the energy dissipates as heat from the mask. As a result, shadow mask monitors are prone to colour purity problems as they heat up due to slight shifts in the position of the holes relative to the phosphor dots. The *Trinitron* tubes have shadow masks with vertical slits instead of holes leading to a higher penetration of electrons and subsequently less heating. However, modern INVAR monitors come close to the Trinitrons in colour purity.

Channel independence means that the RGB values do not affect each other. Constant phosphors keep their chromaticity when the excitation level of the phosphor changes and constant channels do not interfere with other channels. In practice, only dedicated fully stabilised monitors with independent RGB amplifiers have totally independent channels. Usually the red channel electronic beam strikes only red phosphors, but in some displays the red beam strikes also green or blue phosphors [Berns, 93]. The same is true for the green and blue beams.

Macro spatial independence of RGB pixels means that surrounding pixels do not affect the selected pixel intensities. Most commonly poor spatial independence is due to unstabilised power supply. An accuracy of 25 V over the 27 kV black-to-white interval guarantees good independence. Fortunately, the problem is easily detected by showing a test image on the screen with a white square (about 5 cm each side) in the middle of the screen, while the surrounding is black. Measuring this small square (for example in CIELAB) and comparing it with the same measurement, when the white page covers the whole screen, reveals monitors spatial independence. Monitors with poor spatial independence should not be used. Lowering the monitor luminance improves the spatial independence. However, this makes it difficult to compare soft proof with hard copy proofs and printed colour images, because the viewing illumination of a monitor is normally high [Berns, 93].

Micro spatial independence is the absence of interaction between RGB signal channels and is even more essential than macro independence [Mael, 97]. It is possible to detect missing micro independence in the following way. Display a saturated colour rectangle (about 10 cm horizontal and 2 cm vertical) against a background of different shades of grey (for example 5%, 50% and 100%). No colours should appear on the grey background.

The bandwidth (MHz) of the monitor determines the spatial resolution (vertical and horizontal) and the refresh rate of the monitor image. **Colour resolution** (bits/RGB channel) expresses how accurately the colours are coded. The resolution depends on the graphics board's D/A converter and on the display memory size. Typical depths are 8 bits per RGB colour. However, if the monitor is digitally calibrated with look-up tables (LUTs), 8 bits per colour are not enough. The **refresh rate** depicts how often the screen picture is renewed. Typically, the rate should be at least 70 times a second or 70 Hz non-interlaced to avoid flickering.

The **maximum brightness** should be high enough to preserve a good contrast ratio. Brightness depicts the physiological sensation of light intensity. The corresponding psychophysical measure is *luminance,* that is expressed as candela/m^2 or nit. A typical maximum luminance value is 120–150 candela/m^2 giving an operational luminance of 80–100 candela/m^2. This is in line with the emerging standards in graphic arts proofing, that recommend a maximum illumination of 500 lux (see below).

Electro-magnetic emissions should fit into common standards. Generally, low emission monitors follow the Swedish government's SWEDAC (Swedish Board for Technical Accreditation) MPR II specifications or the stricter TCO (Swedish Confederation of Professional Employees) standards. Both limit the emissions of VLF (Very Low Frequency) and ELF (Extremely Low Frequency) electric and magnetic fields. Although new monitor technology generates less radiation than older units, additional active and passive shielding mechanisms reduce emissions even further. The majority of monitors produced now falls within the MPR II specifications although some still do not. The price differential between regular and low-emission units has declined substantially. The basic specifications can be retrieved from the internet [www.noradcorp.com/swedish.htm].

3.1.2 Proofing properties

The soft proof should fulfil three criteria of quality and usability. These criteria are also used in print quality assessments [Sch, 96].

1) Colour gamut
2) Tonal range
3) Resolution

Proofing quality

Digital pixel values usually have a linear relation to monitor driving voltages. However, different **display controllers** have different slopes and intercepts in the relationship between digital values and voltages. The EIA standard determines tolerances that most display controllers adapt to and which a voltmeter can measure. Tolerances as small as 0.1 V affect the monitor characterisation. This means that monitors should be characterised together with their display controllers unless the controller provides a possibility to adjust the voltage signal with offset and gain controls individually for selected monitors.

Monitors are not **spatially uniform**. This is due to difficulties in compensating increased path length towards the edges of the screens, phosphor nonuniformities on the faceplate and external effects such as changes in temperature and magnetic fields. Some monitors allow for compensation of nonuniformities by measuring the monitor at several different parts in the calibration phase. However, significant distortions are difficult to compensate computationally, because the compensation produces wrinkles on the images.

The **brightness**, that is **luminance** level, of the monitor has to be close to the illumination of environment. The colour proofing environment in printing industry has currently been standardised [CIE, 96]. An old ISO 3664 standard recommended very high illumination of 2000 lux (1270 lux for transparencies) that does not match viewing conditions in the graphic industry. An updated standard, ISO 13655, will recommend a lower illumination level of 500 lux that better approximates industrial viewing conditions and the luminance levels of the monitors. The ICC standard also addresses this problem of equal brightness between different media. The proposed PCS (Profile Connection Space) has enough bright and dark areas to represent all device colour spaces. However, ICC does not recommend any brightness values. Luminance is most easily measured with a low-cost photometer, but can also be measured with more expansive colorimeters and spectrophotometers.

The **colour gamut** depicts how large a colour space the monitor can display. The colour space is a three dimensional body (luminance, hue, saturation) centred around the luminance axis. At minimum (black) and maximum (white) luminance, the chromaticity is zero. The gamut is a predominant factor determining how well pages are simulated on screen. Particularly green phosphors seem to be critical for simulating cyan colours on the screen. Green phosphors will not widen the gamut enough in typical cyan process colour regions (figure 3). The colour gamut can be smaller and its shape might change after adjustments of the white balance. Therefore phosphor chromaticities should be measured after the white point adjustment or the colour gamut should be specified to a selected white point.

Monitor stabilisation as well as the **matching of white** and other colours to the paper white (usually D50) and print colours demand a transformation of the monitor RGB values. This transformation is usually computed

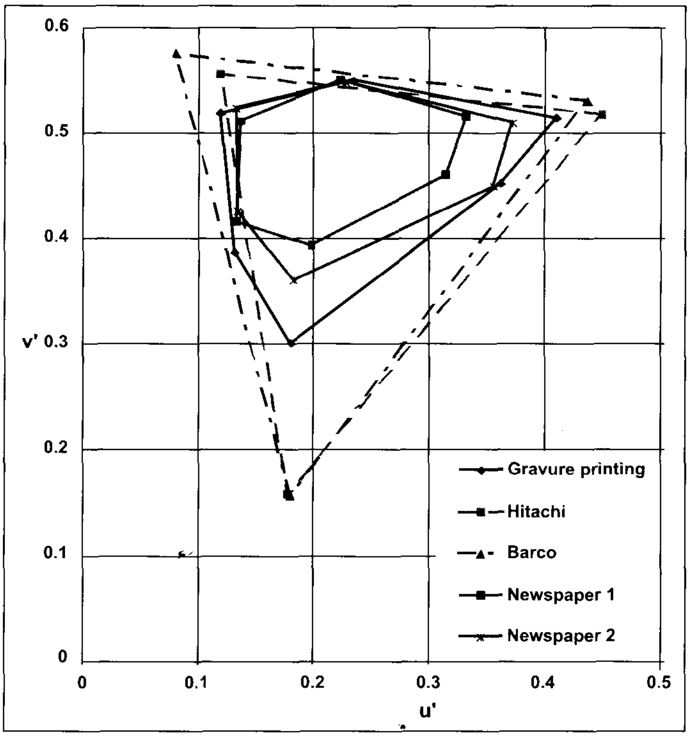


Figure 3. Press and monitor (Hitachi CM211ME and Barco CDCT 5351) colour gamut as a CIE uv projection of the three-dimensional CIE Luv space. VTT Information Technology has made the measurements and calculations for all devices except Barco. The Barco values are taken from the literature [Sch, 88].

with a simple 3 by 3 matrix mainly for speed reasons. However, this transformation reduces the colour gamut leading to an "underuse" of the phosphor colour space. This is especially true if the transformation is digital.

Usability

The **warm-up time** is very individual for different monitors and can vary from 15 minutes to 3 or more hours. During the warm-up period both the luminance and chromaticity values change. Figure 4(a) depicts the warm up behaviour of a Sony monitor for a white screen. For lower grey levels, the deviations are greater and the stabilisation time is longer. **Screen savers** should be turned off so as not to slow down the warm-up process.

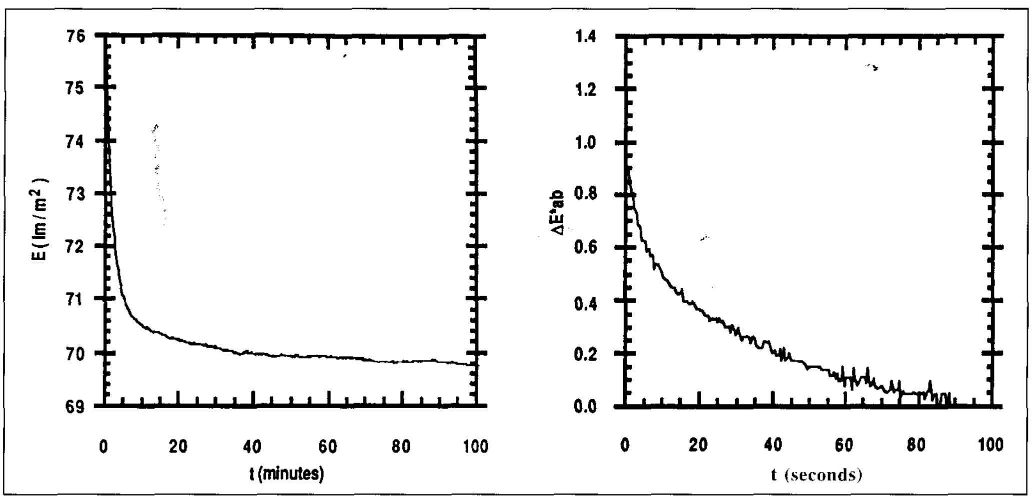


Figure 4. (a) The effects of the warm-up period on monitor brightness for a white screen.
*(b) The colour error in CIELAB E*ab-units after changing a white screen to middle grey [Berns, 93].*

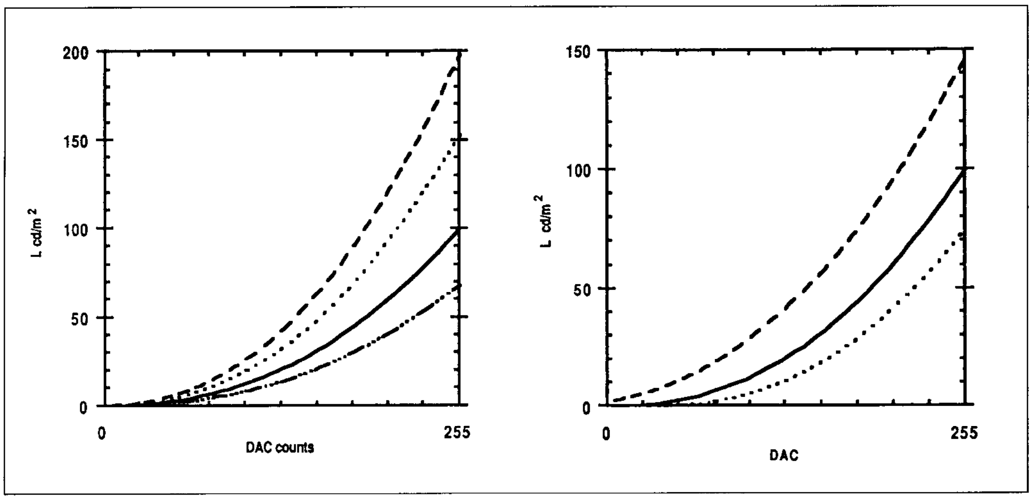


Figure 5. a) Gain and b) offset adjustment changes gamma, that is the tube gun voltage – luminance relation [Berns, 93].

In addition to warm-up variations, monitors also start to fluctuate when the **display content** radically changes. Changes between two different displays may need more than one minute to stabilise. This has to be considered, when calibrating and characterising monitors. Figure 4(b) presents the chromatic error, after a white blank screen changed to middle grey. The stabilisation took about 90 seconds [Berns, 93].

Monitors also show "normal" short time variations without any external reason. Keeping the digital values unchanged the CIELAB values can vary in some unstabilised monitors between 0.5-1.0 E units. This **short time variation** might disturb calibration.

Display controllers use **look-up tables** to linearise the monitor's behaviour. In addition, **offset** and **gain** controls adjust the driving signals. These settings are usually inside the monitor housing, unreachable for casual users [Berns, 93]. Adjusting gain and offset setting changes the monitor **gamma** function (figure 5). Gamma depicts the relationship between driving voltage (= approximately the digital input to the D/A converter) and the luminance of the monitor.

Black level control is sometimes wrongly called brightness control. The black level should be set so that the black picture content shows up as true black on the monitor. Improper adjustment of this control is the most common problem of poor picture quality. The **contrast** setting determines the intensity of a full white input signal. After setting the black level, contrast is selected to get a comfortable viewing brightness.

The black level raises or lowers the entire luminance curve. The control affects mostly the dark areas. In electrical terms, black level controls the bias or offset of the video signal.

Contrast control determines the light intensity produced for white with intermediate values towards black being scaled appropriately. In a well designed monitor, the monitor maintains correct black setting and preserves the correct greyscale, when adjusting the contrast.

The easiest way to adjust the black level and the contrast of a monitor is to perform the following three steps in sequence [Poynton]:
1. Turn the contrast control to minimum and display a black picture,
2. Adjust the black level (brightness) control to reproduce black correctly
3. Adjust the contrast control to display the maximum luminance level (= white) that you desire.

It is important to adjust the black level to reach the maximum dynamic range of the CRT. In the third phase the luminance is determined to be close to the illumination level used for viewing the printed page.

After the black level and the brightness adjustments, the contrast ratio (luminance of black / paper white) can be measured. A good **contrast ratio** needs proper ambient

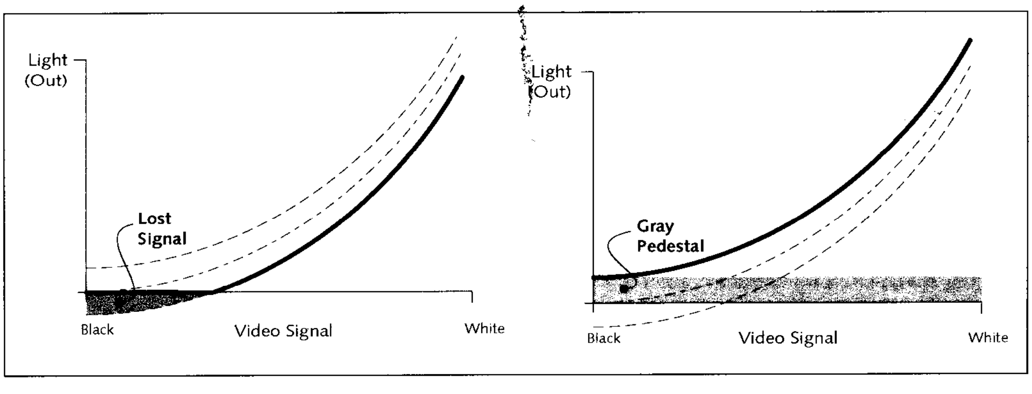


Figure 6. Too low (a) and too high black level settings (b) affect the image quality of a monitor.

illumination. Too bright ambient light wipes out the image contrast on the screen.

Colour consistency over time and between different monitors is measured as E deviations from the reference colours of a test chart like IT8.7/1.

3.2 Stabilisation, calibration and characterisation procedures

The concepts of stabilisation, calibration and characterisation (= profiling) are frequently intermixed. Stabilisation keeps the device (monitor, scanner, proofer) to its current state. Calibration ensures that these stabilised states equal standard values (for example brightness) as well as the states of other monitors and devices. Characterisation describes these states mathematically making it possible to simulate the behaviour of the device. Colour characterisation defines how different image processing components interpret colour by the use of device independent colour values (that is CIELAB). Characterisation or profiling produces so-called colour profiles as a report of the colour interpretation. A summary of steps in monitor calibration and profiling is shown in figure 7.

Use accurate calibration measurement devices. The simplest case is when the monitor stabilisation and calibration procedures only require luminance measurements. [Wan, 95]. Use the factory chromaticity values in these schemes. However, monitors age individually and the phosphor emission and channel constancy characteristics

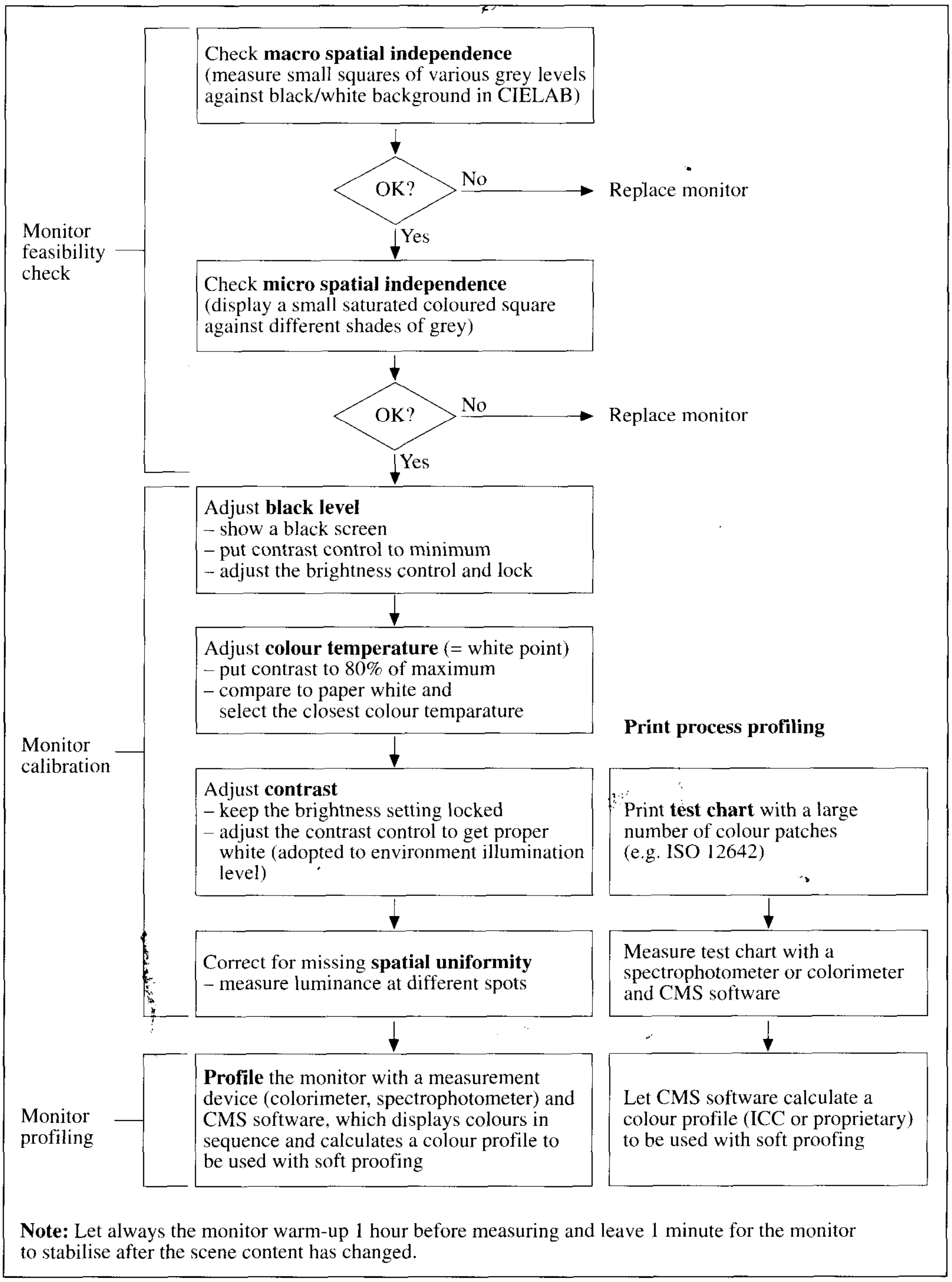


Figure 7. Flow diagram of calibration and profiling with a soft proofing system (CMS = Colour Management System)

change over time. Therefore, monitor calibration and characterisation need a colour measuring device. A well designed 3- or 4-channel colorimeter is an adequate colour measuring device. Spectrophotometers measure the visible spectrum through considerably more channels than colorimeters – typically 30 channels – and therefore provide a more accurate colour signature of the monitor.

However, spectrophotometers are normally more expensive than colorimeters. Even spectrophotometers do not guarantee accurate results if they do not sample the spectrum accurately enough. Especially the red phosphor reflection spectrum is very irregular. As a recommendation: use moderately priced colorimeters with accurate CIE defined filters, if you only measure monitors. Consider spectrophotometers if you want to profile both the monitor and the printing process with the same measuring device.

A typical calibration interval is reached after 200 hours of usage. A too short interval will in practice lead to overlooking of the procedure. The RGB values are adjusted either analogically after the D/A conversion or digitally inside the display control board, before the D/A conversion takes place. The latter reduces to the dynamic range of the picture.

In soft proofing systems the basic procedure to characterise the monitor with a colorimeter or a spectrophotometer includes several steps [Berns, 93]. A user-friendly system should perform most of these operations automatically.

Most high-class monitors have an automatic continuous calibration. The beam intensity is continuously measured and the measurements control the current status of the beam cathode (beam current feed back). This has a significant stabilising effect, because monitors tend to fluctuate at least with their luminance values [Bar].

3.3 Colour matching methods used by the system

Good colour matching requires that the printing process is colour characterised, i.e. profiled. A Colour Management System (CMS) carries out the profiling. A CMS has three main tasks [IFRA, 96]:

- Provide and handle colour profiles of different devices.
- Colour gamut mapping bringing the colours recorded with the input device into the gamut of the output device. For soft proofing this is fairly easy, because the input space (= the printing process) fits almost totally into the output space (= monitor).
- Colour space transformations between the device dependent (RGB, CMYK) and device independent (CIE) colour spaces. Matrix transforms, look-up table based interpolation and colour mixing equations (such as Neugebauer) are the most used algorithms.

The International Colour Consortium (ICC) has standardised the colour profiles. Most commercial CMS software products recognise ICC profiles. The ICC profiles use the CIEXYZ space as a so called Profile Connection Space (PCS). The Colour Management Module (CMM) executes the colour transformations according to the algorithms mentioned above.

The profile of a *colour monitor* may consist of only 9 values, because the conversion from RGB to XYZ with a 3 x 3 matrix is fairly exact (see above). The measurement device measures typically RGB gamma, white point, phosphors, and in some cases ambient light.

The printing process profile is more complex and typically contains a LUT with up to a thousand entries obtained by measurements of as many CMYK patches as are on a test print chart. The test print chart may be standard, such as ISO 12642 or proprietary. A spectrophotometer robot reduces the workload of measuring such an amount of patches.

The CMS software may include *default* profiles representing the device under factory-calibrated conditions. When used in practice, the device may deviate from these conditions and, therefore, requires a *customised* CMS profile obtained through repeated calibration. Especially an unstable newspaper offset printing process needs a quick and fluent recalibration, which ideally demands remeasuring only a part of the about 1000 colour patches on the test print. In customisation, special profile *editors* can be useful.

3.3.1 Matching the colour spaces of monitor and print

The colour matching, that is gamut mapping, is performed according to three methods:

1. Using the colour engine of the operating system (Macintosh: ColorSync 2, Windows 95: ICM)
2. Using a third party colour engine (for example from Linotype-Hell, Kodak)
3. Other (for example using Photoshop)

The main task of a colour engine (called *CMM* in the terminology of the ICC) is to perform a transformation between colour spaces. Colour engines should preferably parse third party standard profiles and choose so called *rendering intents* [ICC]. The rendering intent is an instruction code for gamut mapping. It tries to degrade the image quality degradation gracefully if the colour gamut of the original image exceeds that of the printed images. The rendering intents supported by the ICC standard are:

1) Perceptual
2) Relative Colorimetric
3) Saturation
4) Absolute Colorimetric

Perceptual rendering is in most cases the preferred method. It compresses or expands the gamut of the input device to fill the gamut of the destination device. It preserves the grey balance, but not necessarily the chromatic values. However, ICC rendering definitions are not fully satisfactory. Proprietary colour management systems and their colour engines could extend the ICC capabilities [Sch, 96]. These proprietary systems can be added as so-called private sections to the CMM module. The perceptual intent is based on a selection of psychophysical criteria, which are widely accepted in the graphic industry. Those are (in order of importance) [Stone, 88]:

1) The grey tones of the input image should be preserved.
2) Maximum luminance contrast is desirable.
3) Few colours should lie outside the destination gamut.
4) Hue and saturation shifts should be minimised.
5) It is better to increase than to decrease the colour saturation.

The relative importance of these criteria may change as the content and purpose of the image changes. Colour rendering is more a problem in reproduction than in page visualisation, except if the colour gamut of the monitors is exceptionally small. Still, there can be difficulties in rendering the cyan region of the newsprint. In addition, the dark tones might disappear, if the viewing conditions do not follow the standards or if the monitor black level is incorrect.

Relative colorimetric transformations force the input and output devices to the same white point. The saturation intent preserves the saturation at the expense of accuracy in hue and lightness. The absolute colorimetric intent renders the output colours identically to the input colours, cropping those values that do not fit into the output gamut. This is why this intent is used for all proofing methods.

3.4 Viewing conditions

Viewing conditions are usually overlooked in soft proofing. Ambient light is reflected both from the printed page and from the monitor screen. The main effect on the screen is that the display loses in contrast. Although some press operators use a standard viewing booth for inspecting the printed page, monitors are placed practically at random.

Viewing booths in the graphic industry are standardised in ISO 3664 [ISO, 75b]. The standard defines the colour temperature of light (typically 5000 K), maximum and minimum illuminance and viewing geometry.

For softproofs, the illuminance level of the viewing booth should be set so that the light intensity of the monitor white equals the reflected light from the blank paper. It is better to adjust the illuminance level of the booth than the luminance of the monitor, because the latter will decrease the dynamic range of the page simulation. Therefore, a viewing booth with illumination control is preferable. The walls and ceilings should be painted in neutral grey and windows should be covered.

3.5 Page description formats accepted as input

3.5.1 PostScript

Adobe PostScript is by far the most frequently used page description language. It models the page document as a set of drawing commands making it resolution-independent. The importance of the PostScript is growing as the pagination is becoming more and more fully digital and as the pages are transmitted to the printing locations in PostScript form instead of as facsimile pages. PostScript has two standardised levels: Level 1 and Level 2, whereas Level 3 is announced. Level 2 includes several extensions compared to Level 1, among which the support for CIE based independent colour and image compression are most important for proofing purposes. Modern RIPs and imagesetters accept Level 2. The typical EPS format (Encapsulated PostScript) includes a low-resolution viewing file in raster format (TIFF or PICT), which however is too crude both in spatial and colour resolution for proofing. PostScript Level 3 offers advanced page processing, enhanced image technology (for example handling of the full colour spectrum), increased networking and remote printing over Internet.

Because PostScript is a programming language and not a static data structure, a Raster Image Processor (RIP) converts its drawing algorithms into a viewable or printable data file. Even if there are several soft RIP programs on the market, the problem for proofing is that these programs do not necessarily simulate the production RIP.

CIP3 production information data are PostScript comments.

3.5.2 Portable Document Format

Adobe has developed its PostScript language into a *Portable Document Format* (pdf). The Adobe Acrobat software generates the pdf format from any PostScript file. The Acrobat Reader program displays the pdf document on the monitor at all major computer platforms (Windows, Macintosh, Unix). The document shows up exactly in the same form on monitor as on paper, because fonts can be embedded in the pdf document. Compressing the images reduces the file size. The Reader contains several tools for convenient viewing (thumb-nails, bookmarks, zoom, article threads) as well as antialiased grey-level fonts to make small text clearer. The viewing can even take place inside an internet browser like Netscape. The pdf document can contain annotations (links, comments).

The recent version 3 of Acrobat has support for colour that has been missing from earlier versions. As a result, the conversion from CMYK to monitor RGB performed in the encoding phase produces fairly correct colours. In USA, CGATS (Committee for Graphic Arts Technology Standards) has chosen Acrobat as the transfer format for advertisements Dun, 96.

The embedding of the pdf technology in monitor proofing systems has still to be done. Even if there are common features (for example thumbnails), the Acrobat Reader must be considerably extended to include the layout and retrieval features of current page monitor proofing systems. In spite of these difficulties, such systems are likely to emerge over the next years as the popularity of the pdf format continues to grow.

3.5.3 TIFF/IT

TIFF/IT is a format for ripped bitmaps that RIPs or CEPS repro systems produce. The format is based on the common TIFF (Tagged Image File Format). It was initiated in USA by DDAP (Digital Distribution of Advertising for Publications) and standardised by the American standardisation body ANSI. Its main use is in the digital distribution of advertisements. Even if it is an open question how successful this format will be, it is beneficial for a monitor proofing system to be able to handle it.

3.5.4 Other formats

Current monitor proofing systems use a mix of standard formats and proprietary page image formats. In addition to TIFF, TGA (initially a format of Truevision) and Microsoft's BMP are common image formats. The proofing systems typically use modifications of the standard formats, that make it difficult to export the images outside of the application.

3.6 Input devices of final pages to the system

The monitor proofing systems used in newspapers should show the final page after it has been put together. The information needed for the monitor proofing includes visual information on the appearance of the final pages (= the page image) as well as product and page identification information.

Page information is accessible from several places across the production chain (see figure 8).

3.6.1 Imagesetter

The RIP unit takes the PostScript data and converts it into bitmaps for outputting. The RIP is often integrated into the local Imagesetter. A convenient way to get the monitor proofing information is to utilise the ripped pixel maps that some RIP/imagesetter combinations provide (b).

3.6.2 PostScript

A pixel map is not available from all output devices. In this case, the only way is to use a parallel RIP that "simulates" the functions of the real RIP (a). The problem is that abnormalities (for example missing fonts) in the "real" ripping are not necessarily simulated. The handling of parallel page versions is also a bit cumbersome. The simulating RIP can also be a considerable cost factor. A low-cost solution is to convert PostScript into the Acrobat page description language (pdf) which is soft-ripped as a part of the viewing operation in the Acrobat Reader (or Acrobat Exchange). The pdf page format can also drive the production RIP, because more and more RIPs are accepting pdf as input. In this case, no parallel versions of the page have to be created. However, the pdf format has several problems as it comes to handling of colour and page identification data that make current implementations difficult (see chapter 5).

3.6.3 Facsimile equipment

The page information can also be tapped at certain page facsimile senders as screened two-level bitmaps (c). Alternatively, the bitmaps may be available from a wide area network, like WydeNet from Crosfield, that connects the RIP and the page facsimile sender. In both cases, the screened bitmaps must be converted into grey-level pixels before the page image is displayed on the monitor. This conversion usually averages the bitmaps.

In remote printing plants, the information can be obtained directly from the page facsimile receiver as screened bitmaps (d).

3.6.4 Film/plate scanner

Film and plate scanners (e) offer additional locations to tap the page information. They are used in the production

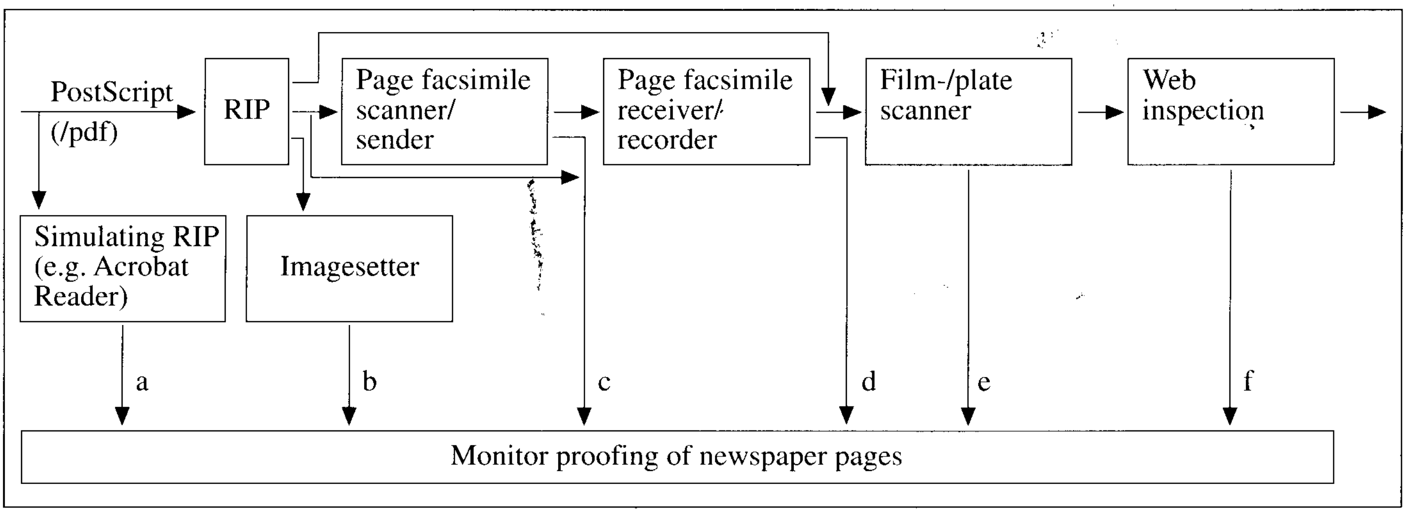


Figure 8. Input devices to a soft proofing system.

chain at many newspapers in order to provide ink consumption information for presetting the ink keys of the press. These scanners can fairly easily be modified to provide also image data for proofing purposes. The proofing system scans the films or printing plates as monochrome images and combines them into colour images. The combination handles the shifting and rotations between the separations. This is because the films or plates do not pass the scanner at exactly the same positions or at an identical orientation. The system reads the page identification from the codes included on the film or plate (possibly through the press management system).

3.6.5 Web inspection cameras

The last phase to obtain page information is by imaging the running printed web with cameras (f). Web video and register-density control systems have been on the market for some years for quality control. In theory, these imaging devices could deliver information for proofing. In practice many technical problems must be solved before on-line imagers may provide sufficient geometrical and accurate colour information for proofing. An on-line proof could complement the proofs obtained from the sources (a)–(e). On the contrary, soft proofs could guide the camera of a web inspection system [Söd, 96]. With this concept, a closed loop control based on prepress information would be achieved.

3.6.6 Colour space of input device

Currently, the input devices listed above deliver the page information as a set of monochrome colour separated images; Cyan (C), Magenta (M), Yellow (Y) and Black (K = Key). The number of separations can be one (black and white page), two (black + one process colour), three (black + two process colours) or four (CMYK colour page). In addition there is a clear need for the soft proofing systems to handle spot colours that are not printed with the standard CMYK colour inks [IFRA, 90]. However, none of the systems currently on the market can handle these "real" spot colours.

PostScript (source a in figure 8) is the only source that is able to deliver the images in another colour space than CMYK. PostScript Level 2 and 3 support CIE spaces and therefore device-independent colour.

3.6.7 Resolution delivered by input device

The spatial resolution varies from about 400 x 600 pixels from certain plate scanners up to thousands of pixels per side from RIP units. The RIPs convert the vector graphics (text, line art) into pixel maps of an arbitrary resolution. The facsimile equipment delivers screened bitmaps, whose resolution decreases in the conversion to grey-level pixels. Typically the conversion averages binary areas of the size of 8 x 8 dots or 16 x 16 dots causing the spatial resolution to decrease correspondingly.

The colour resolution, also called pixel depth, varies from 1 bit per pixel of the screened bit maps up to the usual 8 bit/pixel per colour separation. In the future, the pixel depth will grow to 12 and even 16 bit/pixel. High-end colour scanners in prepress and also in systems for automatic inspection and control already use this accuracy.

3.6.8 Other information delivered

To be able to retrieve and display the proofing information, the system needs *product* and *page identification*. The product identification includes product name and number/date, edition name and number/date, printing location name and number. The page identification includes page number and colour separation (CMYK). A useful additional information is the time of generation of the page image, which for example tells when the page was received on the fax or when the plate passed the plate scanner.

The product and page identification codes are normally positioned on the upper edge of the page. The coding, which typically resembles a bar code, is positioned outside the printable area but is present on the film and plate. A pattern recognition program interprets the code. The code typically varies from one newspaper to another, which requires the recognition algorithm to be customised to suit a certain installation.

An elegant way to deliver the identification data to a monitor proofing system is to use a standardised digital format, like CIP3 (International Cooperation for Integration of Prepress, Press and Postpress) CIP, 95 or PressScript Pre, 95. The CIP3 format embeds the product and page structure information in PostScript as comments. Thus, this format is suitable for the case when the source of the proofing information is a PostScript file (source a in figure 8). A more general format is IFRAtrack IFR, 95b, that enables the processing devices to exchange production status information. The proofing process could use this information. At this writing (March 1997), no monitor proofing system has yet applied these communication formats.

3.7 Workflow and working practices

The press operator is the main user of a full page monitor proofing system, but also the editor and advertiser are potential users. Correspondingly, the equipment is used in the editorial department, in the repro, at the fax receiver, in platemaking and in the pressroom or at remote locations in the advertisement agency. It should be possible to enhance the proof with annotations at different stages. These annotations may include tools for signing the proof or parts of it as a signal to start the production.

3.8 Page visualising software

Because computers with different operating systems (Windows, Macintosh, Unix) are used in newspaper production, it is a benefit if the proofing system can be used cross-platform. The visualising program is normally proprietary, because standard pagination programs like PageMaker and Quark Xpress are not designed for convenient page proofing. The program should include several visualising properties like thumbnails, display of CMYK components separately, product categories, editions, history and production control data. They may also have auxiliary properties like calculation of ink settings of the press and production tracking. Support for hardcopy devices is a natural property.

3.9 Usability

The software should handle changes of printing process parameters (ink, paper) in two ways:

- by changing colour settings in software,
- by printing a new test sheet and measuring the values (recalibration).

The system should be fast enough – typically the system response should be shorter than 3 seconds. The system should be dimensioned for peak production with a maximum number of pages and products. The user should be assisted by on-line help and preferably by a help-line. The technical manual should be in the native language of the user. The vendor should provide system training and technical support. The system should be easy to use also by personnel not skilled in computers. This is possible by designing the user interface around the use of the mouse.

4. Testing criteria for a monitor proofing system

The testing focuses on the colour matching between screen and print, which is critical for monitor proofing. The recommended tests both include objective measurements and subjective assessments. In analysing the test results, the relations between the objective and subjective evaluations should be considered. Because the procedure requires special equipment and computer programs not available to the typical system buyer, testing services of research laboratories are one possibility to elvaluate a soft proofing system. The system manufacturer should be urged to supply results of their own testings.

4.1 Evaluation of the colour matching accuracy

The deviations between monitor proof and print are measured as ΔE_{Lab} differences calculated over all patches of the IT8.7 test target. The following steps are recommended:

a) The IT8.7 test slide is scanned, colour separated, output on film or plate and printed by the potential buyer as part of the normal production procedure.
b) The CIE values of all 289 colour patches of the test print are measured with an accurate measurement device. A spectrophotometer is recommended.
c) The processed test target is input to the monitor proofing system as a digital CMYK file (PostScript, bitmaps) and displayed on the monitor.
d) The colour patches displayed are measured with an accurate measurement device. A spectroradiometer with dense sampling is the ideal device for this.
e) The ΔE_{Lab} differences for all IT8.7 patches are calculated and the result is given as[1]:
   - average ΔE_{Lab}
   - standard deviation of ΔE_{Lab}
   - maximum ΔE_{Lab}

The average ΔE_{Lab} calculated in this way should be smaller than 3 units. The standard deviation of ΔE_{Lab} should be smaller than 1 unit. The maximum error should be smaller than 6 ΔE.

This accuracy enables the monitor proof to reveal and visualise the colour fluctuations during the print run. The best European newspapers print with an average colour error[2] of 8.9 ΔE units [IFRA, 94]. The fluctuations for the IFRA Colour Quality Club member newspapers are 7.1-13 ΔE [ibid.]. This requirement is also in line with the standard for offset inks [Ros, 94] [ISO, 75], that allows tolerances of 3-5 ΔE units for CMYK process colours. The human eye perceives colour differences depending on hue; from 0.3 (grey) to 5.0 (yellow) ΔE units [Bas, 95].

This requirement can be covered by current technology. The best monitors on the market reproduce the IT8.7 target colours within 1 ΔE [Wan, 95]. Current profiling (CMYK to XYZ, XYZ to RGB) and gamut mapping algorithms have an accuracy of 1 ΔE [John, 95]. The gamut mapping is fairly exact in monitor proofing of newspaper prints, because the printed gamut is almost completely inside the monitor gamut.

Of course, the fulfilment of these requirements has to be considered against its costs. Therefore, the final accuracy is a matter of agreement between the customer and the system supplier.

4.2 Visual assessment of colour matching accuracy

A group of people evaluates the colour matching accuracy between monitor proof and print. The following test pictures are recommended:
- the IT8.7 test target
- four photographs

The evaluation is made under controlled surrounding illumination conditions that resemble those of production. The printed proof should be examined either in production-like illumination or in a viewing light booth with standard light. The latter is recommended if a viewing light booth is used in calibration and operation of the system.

[1] In a more exact analysis, the *DE* values are calculated separately for light, middle and dark tones, see [Wan, 95].
[2] Calculated on the basis of 72 colour patches of the IT8.7 target.

5. Evaluation of existing soft proofing systems

Existing soft proofing systems on the market are evaluated below according to the criteria developed in this report. The evaluation is based on the documentation supplied by the vendors and by interviews with users. The systems have not been tested.

The price of a typical minimum configuration consisting of 1 input interface, 1 server and 1 viewing station is about $ 35,000. The average price of an installed system is about $ 100,000.

5.1 Short description of existing systems

The following products (in alphabetical order) are evaluated:

- Data Engineering Oy: Pagevision
- Harland Simon: PRIMA
- Parascan Technologies Ltd: Paravisual
- Aqua Four Corporation: Proof Net (the monitor proofing part is licensed from WillowSix Inc.)

5.2 Evaluation of the systems

Technical data of the systems is listed in tables 1a-1d. The data is based on an evaluation questionnaire (see Appendix) that the system manufacturers have filled in. Because PURUP did not provide information about their Preview system, we could not include it in the evaluation. Mixes of different systems are possible. For example different systems can use the same kind of monitor.

Manufacturer	**Data Oy**	**Harland Simon**	**Parascan**	**Aqua Four**
Product name	Pagevision	PRIMA	Paravisual	ProofNet
1. Monitor				
Basic properties				
Monitor used	NEC XP21	Barco Reference Calibrator/Hitachi	SONY Multiscan 2002 *)	Radius, Sony, NEC, Philips, Barco, etc.
Spatial resolution	1280 x 1024	1600 x 1200	1280 x 1024	1280 x 1024
Maximum brightness	65 cd/square meter	120 cd/square meter		N/A
Colour gamut of the monitor	Medium (fig. 9)	Large (fig. 9)	Large (fig. 9)	N/A
Manually adjustable white point (á 100K)	N/A N/A	5000–20.000 K	3000–9300 K	
Monitor stabilisation and calibration				
Permanent measurement device	None	Colorimeter part of monitor)	Colorimeter (part of monitor)	Own colorimeter
Black level and contrast calibration	None	None	None	Yes
Calibration interval		300 h	600 h	720 h
Adjustment method		Analogue	Digital	Digital
Tools for aligning several monitors	No	No	No	Own patented method
Spatial uniformity compensation	No	No	Yes (81 points)	No
Notice to user about calibration need	No	Yes	No	No
Continuous autocalibration (beam current feed-back)	No	Yes	Yes	N/A
Colour consistency over time and between monitors	N/A	DE 1.5–3.0	N/A	N/A
*) based upon the Paravisual system at Los Angeles Times				

Table 1a. Comparison of the monitors of commercial soft proofing systems for final pages. The information is based on evaluation sheets filled in by the manufacturers.

2. Monitor colour/print colour matching				
Matching method	Measurement/ visual comparison	Under development	Visual comparison *)	Visual omparison
Test print	Standard, e.g. IT8.7	Under development	Standard, e.g. IFRA *)	Own
Number of colour patches on test print	> 250	Under development	> 200	500
Colour Management System	Proprietary	ICM under Windows (planned)	Proprietary	Proprietary
Photoshop used for matching	Yes	No	Yes	Yes
Separate Printing process profiling	Yes	Under development	No	No
Using measuring device	Spectrophotometer			
Using default values	Yes			
Separate monitor colour profiling	Yes	Under development	Yes	Yes
Measurement device	Colorimeter		Colorimeter	Own patented colorimeter
Number of measurement fields shown in sequence	Adjustable: 12-764, (W, K, different grades of RGB)	N/A	5 (W, K, R, G, B) *)	5 plaques (grey, 2 x white point, black point, grey balance)
Measured units (in addition to luminance, phosphor)				Ambient light
*) based upon the Paravisual system at Los Angeles Times				

Table 1b. Comparison of colour matching

3. Page description formats as input				
PostScript	Yes	Yes, with RIP option	No	Yes
Portable Document Format (pdf)	No	No	No	Yes
TIFF/IT	Yes	Yes	Yes	Yes
Other formats	At least 16	At least 6	Bitmaps	
4. Input devices to the system				
Imagesetter (including RIP)	Yes	No	Yes	Yes
PostScript RIP	Yes	Yes	Yes	Yes
Facsimile equipment	Yes	No	Yes	Yes
Film/plate scanner	Plate scanner	No	No	Video from film
5. Identification delivered by input				
Product identification (in addition to name/edition)				
printing location	Yes	Yes	No	Yes
print date	Yes	Yes	No	Yes
Coding of identification				
physical	Yes (from plate)	No	No	Yes (from film)
digital	Yes	File name	Yes	Yes

Table 1c. Comparison of inputs

6. Page visualising software				
Product name	Pagevision	PRIMA	Paravisual	ProofNet
Operating system	Windows, Macintosh	Windows	Windows	Windows, Macintosh
Visualising program	Proprietary	Proprietary	Proprietary	Proprietary
CMYK components separately	Yes	Yes	Yes	No
Product categories, editions, history	Yes	Yes	Yes	Yes
Production tracking data	Yes	Yes, Expected/ received; job information from management syst.	Yes	Yes
Calculation of ink settings of press	Yes	No	Yes	No
Marking of comments on the proof	No	Yes, text and voice	No	No
7. Usability				
Human interaction mode	Only mouse, no keyboard		Only mouse, no keyboard	Mouse
Ink and paper settings		Under development		
By changing colour settings in software	No		No	Yes
By recharacterisation (printing test sheet)	Yes		Yes	Yes
System speed (fastest response time)	1-9 seconds	1-4 seconds	2 seconds	1-2 seconds
Peak production (max. pages, products)	No limitation	No limitation	400 pages, 100 products	No limitation
On-line help	No	Yes, also helpline	No	Yes
Number of language versions of user manual	5	4	3	English

Table 1d. Comparison of page visualisation software and usability

The colour gamut of the systems is evaluated from the graph in figure 9. It can be seen that the Paravisual and PRIMA gamut covers almost all the printing colours, whereas Pagevision has a slightly smaller gamut.

Table 2 lists the strengths and weaknesses of the commercial proofing systems. The factors distinguishing the systems from one another are stressed, not the common ones. As can be seen, the choice of the Barco monitor puts the PRIMA system in the forefront with regard to the monitor. On the other hand, this monitor is the most expensive one. The spatial uniformity compensation used by the Sony monitor in the Paravisual system is a clear strength. The gamut of the Sony is also as wide as that of Barco. Pagevision uses a monitor without stabilisation and with restricted gamut and brightness, which are clear weaknesses.

As regards the matching of monitor colours to print colours, only Pagevision measures test prints in addition to visual comparison. Paravisual and ProofNet use solely visual comparison combined with Photoshop for carrying out the matching. ProofNet applies a common measuring device to align monitors to each other, which is a clear advantage. All systems use sensors to measure the monitor colours. ProofNet measures even ambient light, which allows the balancing of monitor brightness and ambient light. ProofNet is the only system to include black level and contrast adjustments in the calibration scheme.

Most systems accept a variety of page description formats, Pagevision having the largest repertoire. Notable is that ProofNet is the only system that accepts the Acrobat format, that is becoming more and more important. Paravisual does not include any RIP, which means that it

Manufacturer	Data Oy	Harland Simon	Parascan	Aqua Four
Product name	Pagevision	PRIMA	Paravisual	ProofNet
1. Monitor	– – no stabilisation – gamut, brightness	+ + + colour fidelity + + stabilisation + resolution – price	+ + spatial uniformity + accurate white control + gamut, brightness	
2. Monitor colour/print colour matching	+ + measures monitor, print + accurate monitor profiles	N/A (under development)	+ accurate visual matching – no measuring of print	+ accurate visual matching + aligning of monitors + measurement of ambient light + black level, contrast – no measuring of print
3. Page description formats as input	+ + many formats	+ several formats	– no PostScript	+ pdf
4. Input devices to the system	+ + + all relevant devices	– only RIP	+ + all, except film/plate scanners	+ + all, except fax receiver
5. Job identification	+ + extensive – multiple dates missing	+ extensive – no physical	– print location, dates, physical missing	+ physical
6. Page visualising software	+ multiple platforms + calculation of ink settings	+ text, voice annotation + expected values from management system	+ calculation of ink setting	+ multiple platforms
7. Usability	+ + easy operation (mouse) + manual in several languages	– only English manual	+ + easy operation (mouse) + + fast response	+ + easy operation (mouse) + + fast response – only English manual

Table 2. Strengths and weaknesses of commercially available soft proofing systems; the analysis is based upon table 1.

does not accept PostScript. Pagevision has interfaces to all relevant input device categories – RIP, imagesetter, facsimile sender/receiver and plate scanner. Paravisual and ProofNet are almost equally well interfaced. PRIMA only interfaces to a RIP. PRIMA acquires job identification information needed in retrieval fairly extensively, even if there are clear weaknesses. Print location and dates are missing in Paravisual and ProofNet, whereas Pagevision does not make a distinction between different dates (production, publishing). Only ProofNet and Pagevision read physical coding from film, respectively plate.

The ProofNet and the Pagevision software are multi platform, as they run on both Windows and Macintosh. Paravisual and Pagevision calculate the ink settings for the press. PRIMA is the only to offer annotation capabilities like text and voice. PRIMA also compares received and expected values by using a link to the job management system. As regards usability, the systems are easily operated solely by mouse. Paravisual and Aqua Four have the fastest response time. Pagevision offers its manual in most languages.

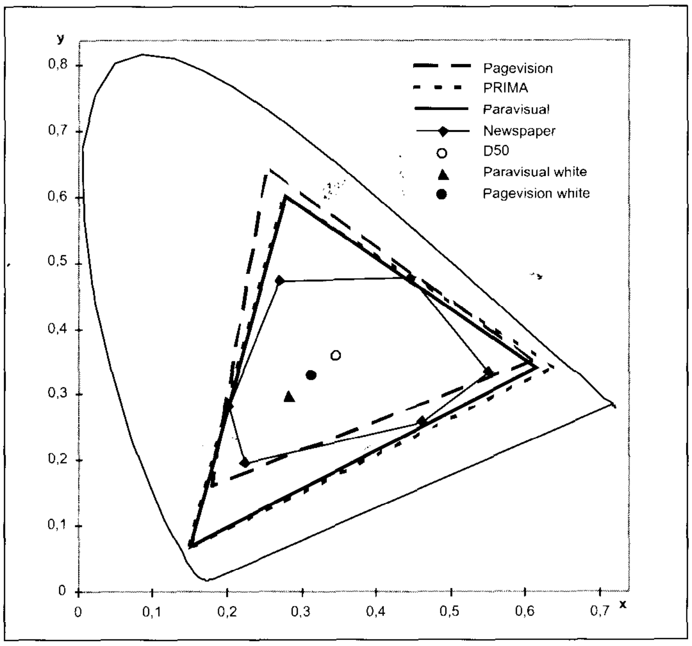


Figure 9. The colour gamut of three soft proofing systems in the CIE xy space.

6. Practical experiences and advices

Expert users from the following newspapers have been interviewed to give practical experiences of soft proofing systems:
- Helsingin Sanomat (FIN)
- Aftonbladet (S)
- Los Angeles Times (USA)
- Berlingske Tidende (DK)

6.1 The Helsingin Sanomat Forssa printing plant – Pagevision

Plant Manager Risto Lehto.

Helsingin Sanomat publishes the daily broadsheet Helsingin Sanomat, the evening tabloid newspaper Iltasanomat and the weekend magazine NYT. The papers are printed at 3 satellite printing plants – Vantaa (near Helsinki), Forssa (western Finland) and Varkaus (eastern Finland). The pages are transmitted to Forssa and Varkaus over 2 Mbit/s lines. There are several transmission chains:

film – telecom line – film,
RIP – telecom line – film,
repro system – telecom line – film,
editorial system – telecom line – RIP – film.

Pagevision is used in both Forssa and Varkaus. In Forssa, Pagevision is connected to two parallel production lines. All production data pass the system. Two viewing stations are used in two printing control rooms.

The main use of the system is providing a visual reference for the press operators. It helps keeping the production quality constant over long production runs. Every page is checked visually. The colour match between the screen and the print is judged to be good enough. The point is that the soft proof is a stable reference over time. In addition, Pagevision functions as a colour communication device between the graphic designer and the press operator. The designers of the weekend magazine come to the printing plant to discuss the forthcoming issue with the press operators, using the Pagevision visualisations as an information source.

In some cases, ripping and transmission errors have been detected from the soft proof. The risk of ripping errors has grown, since advertisements are arriving from many sources in digital form. Also intermixing of colour separations because of erroneous or missing bar codes have been detected at the Pagevision system.

6.2 Aftonbladet – Pagevision

Technical expert Pierre Gunnarsson.

The evening tabloid Aftonbladet with its numerous supplements and editions is transmitted to 5 satellite printing plants situated around Sweden through the WydNet transmission system. Aftonbladet uses Pagevision in the editorial department in Globen in Stockholm to manage the complex transmission operation. The system has two viewing stations situated close to each other. In addition to the WydNet interface the system is interfaced to a RIP feeding a separate network for transmission of magazines to gravure printing plants.

The production managers use Pagevision to check that correct pages go to the right printing plants. The check takes place before, but also after the transmission. The high transmission speed – 1 page per 20 seconds – makes it impossible to check everything in advance. However, Pagevision makes it easier for the editorial personnel to discuss the quality of the films that the plant operators observe to be erroneous.

Pagevision detects errors like missing page elements, missing images, wrong or totally missing pages, interchange of pages, wrong pairing of tabloid pages, shifting of pages. At present, Aftonbladet sees no need for any closer colour matching between screen and print, because the colour quality is not checked at the sending site. The resolution of Pagevision is not sufficient for reading normal text, but this is not considered to be any problem, either. Pagevision is not meant for proofreading.

6.3 Los Angeles Times – ParaVisual

Quality director Niko Ruokosuo.

Paravisual viewing stations are installed at all press control points (15 monitors), in all plate preparation departments (3 stations in three printing plants), in all repro departments (3 stations) and in the editorial department. Los Angeles Times developed a Photoshop based colour matching scheme in co-operation with Parascan. The developed matching scheme is now part of the Paravisual system.

Before the Paravisual system was installed, the operators at Los Angeles Times proofed all colour pages in all printing plants, which required a lot of labour and material. Material costs alone were tens of thousands dollars a year. With Paravisual, physical proofs are made only in the repro departments. The printing plants get the monitor proofs immediately after the fax transmission, that is before the printing starts. The press operators can familiarise themselves with the pages in advance, which makes the printing process easier. The users have reacted very positively to the system.

The viewing environment is set to 5000 Kelvin. The lighting is sufficient for simultaneous viewing of monitor and print, but not too bright in order to avoid reflection from the monitor screen. Diffuse light and a cap covering the upper edge of the monitor reduces reflections. The walls and ceilings are painted in a neutral grey.

At the moment only page fax input is in use, but in the future more input devices will be considered as well as new data formats like pdf. No signing of monitor proofs is used or planned. Signing requires that the elements are available early enough before printing starts, which is not the case with page proofs.

The user interface is very good, but the system maintenance is a bit difficult in its current version . A weakness is that spot colours are not handled in the system. The measurement of spot colours with densitometers is difficult as well as their analogue proofing. Therefore monitor spot colour proofing is required.

6.4 Berlingske Tidende – ParaVisual

Manager Eric Christensen.

Berlingske Tidende publishes three newspapers, the daily broadsheet Berlingske Tidende, the tabloid BT and the weekly edition Weekend Avisen. Parascan WYDNET (formerly a Crosfield product) transmits the pages from the editorial department in the centre of Copenhagen to one printing plant in southern Copenhagen and to another one in Jylland. Six ParaVisual viewing stations are in use in the editorial department, 4 in the Copenhagen printing plant and 3 in the Jylland plant.

The Paravisual stations are connected to WYDENET. The Faxlink interface unit forms the input image by averaging 16 x 16 binary pixels of the transmitted page. In the printing plants Faxlink and Imagemaker deliver the setup values for the ink feed to the printing press control system.

The main advantage of Paravisual is that it provides the editorial personnel a visualisation of the digitally composed page. It gives an assurance that all page elements are in place and that the RIP process has been successful. In the printing plants, the soft proof also assures that the fax transmission has succeeded. It also gives the presetting values for the ink feed – a feature that has shortened the make-ready time of the presses considerably.

The new colour matching module – Colour Manager – is not yet installed and therefore the colour match between screen and print at the moment is not corrected by the colour values of the paper shade. The system indicates spot colours, if the user has properly set up the system. Both CMYK and spot colours are dealt with. The spatial resolution allows reading of the body text, but this is not considered to be a purpose of the system.

The system has continuously developed as a result of the co-operation between Berlingske Tidende and Parascan.

7. Conclusions

As the main use of soft proofing is to provide a colour reference for the person operating the press, an accurate simulation of the printed colours on the screen is a vital requirement. Using colorimetry, this accuracy demand can be stated in numerical terms. The average difference between the monitor colours and the print colours must not exceed 3 ΔE units as calculated over all patches of the standard test target IT8.7.

To meet this requirement, a high-class monitor must be used. To maintain accurate colour values over time the monitor must apply autocalibration (beam current feed back) as well as enable regular manual measuring of the monitor colours. In addition, the monitor phosphors should be individually measured at the factory. It is also important that the monitor has a sufficient large colour gamut to embrace as many of the printing colours as possible.

A good monitor is not enough. The colour fidelity also requires good colour matching algorithms that use colorimetric measurements to profile both the monitor and the printing process. One crucial element is the gamut mapping method that handles out-of-gamut colours. Current commercial proofing systems do not reach the colour fidelity requirements stated in this report. In spite of this, they are useful, as their numerous installations show.

In addition to better colour fidelity, there are several other improvements to be done to the systems currently on the market. They should be able to handle additional colour separations in addition to the conventional CMYK process separations. In the colour transforms special notice has be paid to reproduce critical spot colours more accurately than the average process colours. There should be possibilities to easily simulate paper and ink changes by changing parameters in the software. It should be possible to view the pages in detail, even down to the screening structure.

The product identifications should cover all distinctions needed by the editorial and production personnel. Handling of the Acrobat data format should be included. Annotations to the proofs, both as text and voice, should be possible. The annotation tools should include procedures for signing.

Current systems, which start at a price of about $ 30,000, do not include facilities like light booths enabling controlled viewing conditions. Even if the user can arrange such conditions, the solutions should be an integral part of the proofing system. Further more an integration with the various production control systems of the newspaper is needed. This would enable utilisation of production information attached to the digital page file like in the emerging CIP3 standard, as well as visualising process tracking information like IFRAtrack. Information about the expected job structure can then be shown to the user. Integration with the press control system enables an automatic display of the page, for which the ink settings are prepared.

8. References

Bar — Barco: Reference Calibrator. Product brochure, 12 pp.

[Berns, 93] — Berns, R. S., Motta, M. J., Gorzynski, M. E., CRT Colorimetry. Colour Research and Application, Vol. 18, Num. 5, Oct 1993, pp. 299-325.

[Bas, 95] — Bassemir, R., Costello, G., DiBernardo, A., DiPiazza, J., Kuna, D., Paulius, K., Rybny, C., Zawacki W., A Comparison of Visual and Spectrophotometric Evaluations of Paired Colour Prints, The 1995 TAGA Proceedings, Vol 1, Rochester, New York, pp. 558-578.

[CIE, 96] — Expert Symposium '96, Colour Standards for Image Technology.

Dat — Data Oy: Presetting measurement and page previewing. Product brochure, 4 pp.

Dau, 95 — Daun, S., Lucas, G., Schönhut, J., Specification of the CIP3 Print Production Format. Version 1.0. International Cooperation for Integration of Prepress, Press and Postpress. Fraunhofer-IGD, May 1995, 39 pp. + Appendices.

Dun, 96 — Dunn Report, Volume 14, Number 3, 1996.

GAT, 96 — GATF and R. R. Donelley & Sons Apply for Patent for Flat Panel Display for Colour Proofing System. GATF News Release, March 1996, 4 pp.

[ICC] — ICC Profile Format Specification, Version 3.2 November 20, 1995, International Colour Consortium.

[IFRA, 96] — Colour Management Systems. IFRA Special Report 2.18, June 1996, 20 pages.

IFR, 95a — IFRA newspaper techniques. Special issue on colour management, March 1995.

IFR, 95b — IFRAtrack: a recommendation for the interchange of status information between local and global tracking systems in newspaper production. IFRA Special Report 6.19. Darmstadt, 1995. 26 pp.

[IFRA, 94] — IFRA Colour Quality Club, Evaluation 1994.

[IFRA, 90] — The production of spot colours in newspapers from process colours. IFRA Special Report 3.13. Darmstadt, 1990, 36 pp.

[ISO, 75a] — ISO 2846:1975. Set of Printing Inks for Offset Printing – Colorimetric Characteristics, 5 pages.

[ISO, 75b] — ISO 3664:1975. Photography – Illumination Conditions For Viewing Colour Transparencies and Their Reproductions, 4 pp.

[Joh, 95] — Johnson, T., A Complete Colour Reproduction Model for Graphic Arts, TAGA Proceedings 1995, vol. 2, Rochester, New York., pp. 1061-1076.

Kon, 95 — Konrak-Helm, J., Colour proofing: Is it real, or an illusion? Newspaper & Technology, April 1995, 1 p.

Mael, 97 — Joel Maelfeyt, personal communication, February 1997.

Par — Parascan, System ParaVisual, product brochure, 4 pp.

[Poynton] — www.inforamp.net/~poynton poynton@inforamp.net

Pre, 95 — PressScript, Version 1.0, Draft Language Specification, RIT Research Corporation, June 21, 1995, 16 pp.

[Ros, 94] — Rosenberg, A., Reasons and Ways for the Revision of the International Standard for Four Colour Offset Printing, TAGA Proceedings 1994, Rochester, New York.

[Sch, 96] — Schläpfer, K., Widmer, E., How to Test a Colour Management System, TAGA 96.

[Sch, 88] Schläpfer, K., Shao Y., Braun, R., Bewertung von Farbmonitoren, UGRA-Bericht 103, St. Gallen, December 1988, 50 pages.

Sey, 95 Willow Six goes after soft-copy proofing, Seybold Report, February 1995, pp. 32-33

[Stone, 88] Stone, M. C., Cowan, W. B., Beatty, J. C., Colour Gamut Mapping and Printing digital Colour Images, ACM Transactions on Graphics, Oct. 1988, Vol. 7, No. 3, pp. 249-292.

[Söd, 96] Södergård, C., Launonen, R., Äikäs, J., Inspection of Colour Printing Quality. International Journal of Pattern Recognition and Artificial Intelligence, Vol. 10, No. 2, 1996, pp. 115-128.

Wan, 95 Wandelt, M., Large Screen Monitors. PrePress, Number 10, 1995, pp. 4-8.

Wil Willowsix Inc., MonitorRightproof, Prepress Monitor Proofing and Colour Monitor Calibrator, Introduction & Guide, product brochure, 25 pp.

9. Appendix: Evaluation check list for soft proofing systems

Monitor used

Technical properties			
Basic technology (CRT, LCD)	CRT	LCD	
Size (monitor size vertically and horizontally)	Horizontal	Vertical	
Type of shadow mask	Shadow	Slot	
Dot or aperture pitch of shadow mask? (e.g. 0.28 mm)	mm		
Bandwidth (MHz)	MHz		
Spatial resolution (e.g. 1024 x 768 pixels)	Horizontal	Vertical	
Colour resolution (bits/RGB channel)	Bits		
Refresh rate (e.g. 80 Hz noninterlaced)	Hz	Interlaced	Noninterl.
Maximum brightness (candela/m2)	Candela/m^2		
Electromagnetic emissions (MPRII and TCO standards)			
Proofing properties			
Contrast ratio (luminance of black / paper white)			
Colour gamut of the monitor (CIEXYZ)			
Red primary	X	Y	Z
Green primary	X	Y	Z
Blue primary	X	Y	Z
Monitor white point	X	Y	Z
Warm-up period (e.g. 4 hours)	Hours		
Estimated lifetime (e.g. white page hours)	Hours		
Colour consistency over time and between monitors (e.g. ΔE_{lab})	ΔE_{lab}		
Manually adjustable settings (parameters: colour temperature)			
Screen finish (antireflecting) properties			
Calibration procedure			
Calibration measurement device (colorimeter/spectrophotometer)	Colorimetric		Spectrophot.
Measured units (luminance, phosphor characteristics, ambient light)			
Calibration interval (e.g. every 200 hour of usage)	Hours		
Adjustment method (analogue / digital, inside the graphic board)	Analogue	Digital	
Tools for aligning several monitors (e.g. by a common measurement method)			
Automatic calibration (= stabilisation)			
Continuously / user triggered			

Colour matching methods used by the system

Default Colour Management System (OS-CMS, Proprietary)	Default	Proprietary	
How is the printing process profiled? (= characterization)			
Customized CMS profile by measuring test print			
CMS (ICC standard, proprietary)	ICC	Proprietary	
Type of test print (ISO/ANSI standard, own, other)	Standard	Own	Other
Number of colour patches on test print			
Number of reference points used by interpolation of final values			
Measuring device and accuracy (Average ΔE_{lab})	Device	ΔE_{lab}	
How often is the measurement repeated? (= profile maintenance)	Hours		
How many patches have to be measured in maintaining the profile?			
Software program used, e.g. profile editor			
Other (e.g. using Photoshop printing ink set-up values)			
How is the monitor profiled? (= characterisation)			
Default profile (ICC standard, proprietary)	Default	Proprietary	
Customised profile by measuring colour fields displayed by monitor			
CMS (ICC standard, proprietary)	ICC	Proprietary	
Number of measurement fields			
Number of reference points used in interpolation of final values			
Measurement device (product name, accuracy)	Name	ΔE	
How often is the measurement repeated?	Hours		
Software program used, e.g. profile editor			
Calculated characteristics			
RGB primaries			
RGB gamma	RGB	Same gamma	
White point			
Ambient light			
Other (e.g. using Photoshop monitor set-up values)			

How are the colour spaces of monitor and print matched?

Using the colour engine of the operating system		
Macintosh: ColorSync 2		
Windows 95: ICM (Inter Color Matching)		
Other		
Using a third party colour engine (e.g. Linotype-Hell, Kodak)		
Other (e.g. using Photoshop)		

Viewing conditions

Preferred environmental illumination		
Maximum and minimum illuminance (e.g. 10-40 lux)	Max	Min
Colour temperature	Kelvin	
Type of lamps		
Other environmental factors		
Painting of walls and ceiling		
Monitor outlook		
Framing		
Colour		
Is a special viewing light booth needed in the calibration and operation of the system?		
Booth size		
Illumination control (colour temperature, illuminance level)	Colour	Brightness
Viewing geometry (monitor, booth)	Monitor	Booth
Measurement of illumination		

Page description formats accepted as input

PostScript	
Portable Document Format (pdf)	
TIFF/IT	
Other formats	

Input devices of final pages to the system

Device type
Imagesetter
PostScript RIP
Facsimile equipment
Film/plate scanner
Web inspection cameras
Other
Colour space of input device
CMYK
RGB
CIE
Other
Resolution delivered by input device
Pixels in x direction
Pixels in y direction
Colour accuracy (bits/pixel)
Other information delivered by input device
Product identification
product name
edition
printing location
other
Page identification
page number
separation
Coding of identification
physical (bar code etc.)
digital (e.g. CIP3)

Workflow and working practices

Which personnel uses the system?

Editor

Prepress

Platemaker

Press operator

Advertiser

Other

Where is the equipment used?

Editorial department

Repro

Fax receiver

Plate making

Press room

Signing of the monitor proof

Who does it?

How is it arranged?

How are comments marked on the proof ?

Page visualising software

Operating system

Windows / Windows 95 / Windows NT

Macintosh

Unix

Standard visualising program

Adobe Photoshop

Adobe PageMaker

Quark Xpress

Other

Proprietary visualising program

*

*

Visualising properties

Thumbnails

CMYK components separately

Product categories, editions, history

Production tracking data

Other

Auxiliary properties

Calculation of ink settings of printing press

Other

Support of hardcopy devices (list below)

*

*

Usability

Ink and paper settings

By changing colour settings in software

By editing the colour profile

By recharacterisation (printing a test chart and measuring the values)

Other

System speed

Fastest response time(s) per display resolution

Dimensioning for peak production

Maximum number of pages

Maximum number of products

How is the user assisted?

On-line help

Other

How is the quality of the technical manual?

Number of language versions

System training and technical support

*

*

Other usability factors (list below)

*

*