



Pros and Cons of DeviceLink technology

or...

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at AIDO 8th International Colour Congress 2008



**... how to predict the quality of
colortransformations in digital graphic
arts workflows.**



The short version of the presentation...

Traditional colormangement workflows with ICC profiles are very flexible, but there are several cases where it is impossible to predict or even reach a defined level of quality.

DeviceLink based workflows are often unflexible, but it is possible to finetune devicelink profiles for a guarenteed level of quality in the color workflow.



The long version of the presentation...

The discussion of pros and cons of devicelink technology is always connected to the discussion how to organize digital workflows in the graphic arts.

I will look first at the graphic arts workflows with the usage of „traditional“ ICC-profiles and then discuss specialized workflow cases with devicelink profiles.



Definition of traditional ICC based color management

- ICC-profiles are a vendor- and Operating system independent format for color-profiles.
- ICC profiles are used to describe the color characteristic of input-devices, editing colorspaces for file exchange and output-devices
- ICC colortransformations from input to the editing colorspace or from the editing colorspace to output are calculated on the fly.



The flexibility of ICC based color management

- The basic concept of ICC based color management is very flexible. Profiles for input- and output devices are assigned to the devices.
- As color transformations from input to edit or from edit to output are calculated on the fly, the user can choose any editing / exchange color space he prefers.
- For archiving images, documents or PDF files, the user just embeds his preferred color space for editing / file exchange.



The success of ICC based color management

- There are two fields, where ICC-based colormangement is really a vendor- and Operating System independent defacto standard with no alternatives:
 - referencing the color for the file exchange of images and PDF-files via embedded ICC-profiles
 - calibrating and profiling monitors for displaying images and documents with correct colors.



Areas with heavy usage of alternative colormangement concepts

There are areas, ICC-profiles could be used, but often other colormangement concepts are widely used:

- Closed workflows from Camera RAW color to an ICC-based Editing space like e.g. Adobe RGB or sRGB.
 - colorprinting via standard printer drivers (inkjet and color laser printers)
 - High-End colorservers with DeviceLink-profiles
 - High End proofing solutions with DeviceLink profiles.
- (the last two points will be discussed later in detail...)



Quality control in ICC based color management workflows

- The flexibility of ICC based colormanagement is based on the concept, that the color transformations between documents and devices are always calculated on the fly.
- **The enduser is responsible to validate the quality of EVERY ICC based color transformation in his workflow.**
- This is a quite complex task, as the user is free to choose every profile he wants for editing and file exchange.



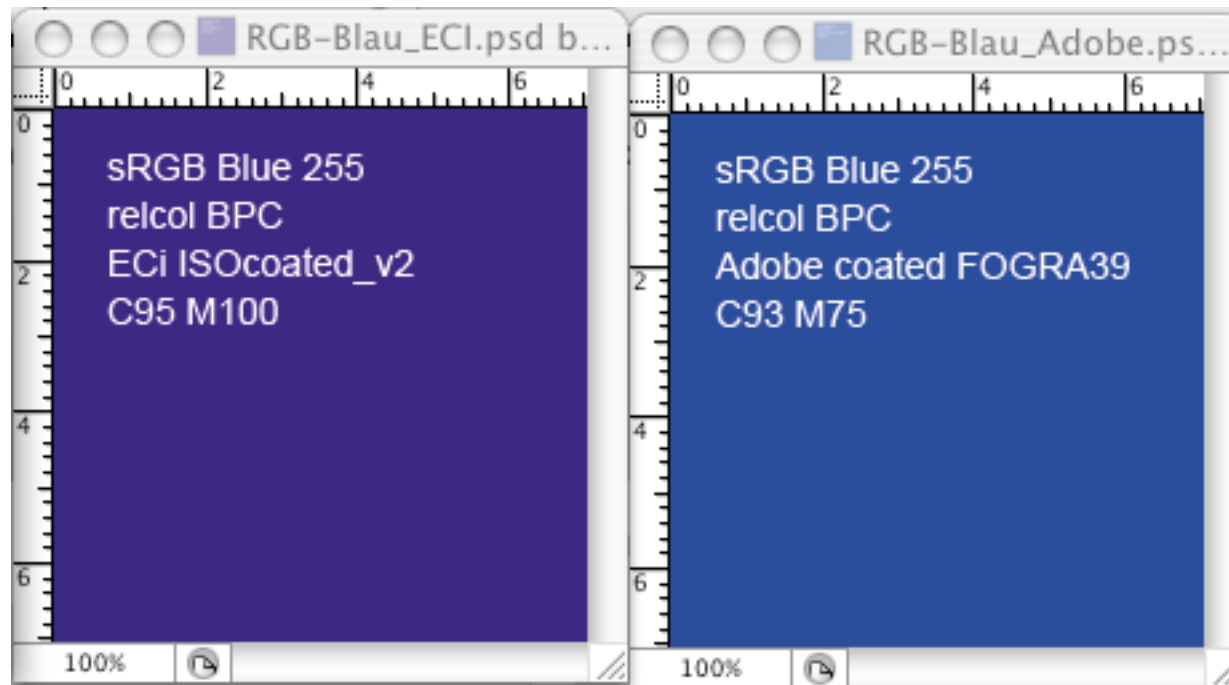
Some unsolved ICC quality topics

- no vendor independent standard for out of gamut mapping
- no definition of a „Color OK“ for RGB-data
- Huge problems of colormanagement for CMYK- and Gray data
- no guidelines for colormanagement of vector graphics
- No assurance for the smoothness of a complete color transformation.
- no ICC / ISO TC 130 guidelines for the color interaction between applications, Operating System and the printer driver.



Out of gamut mapping for FOGRA39 / ISOcoated_v2

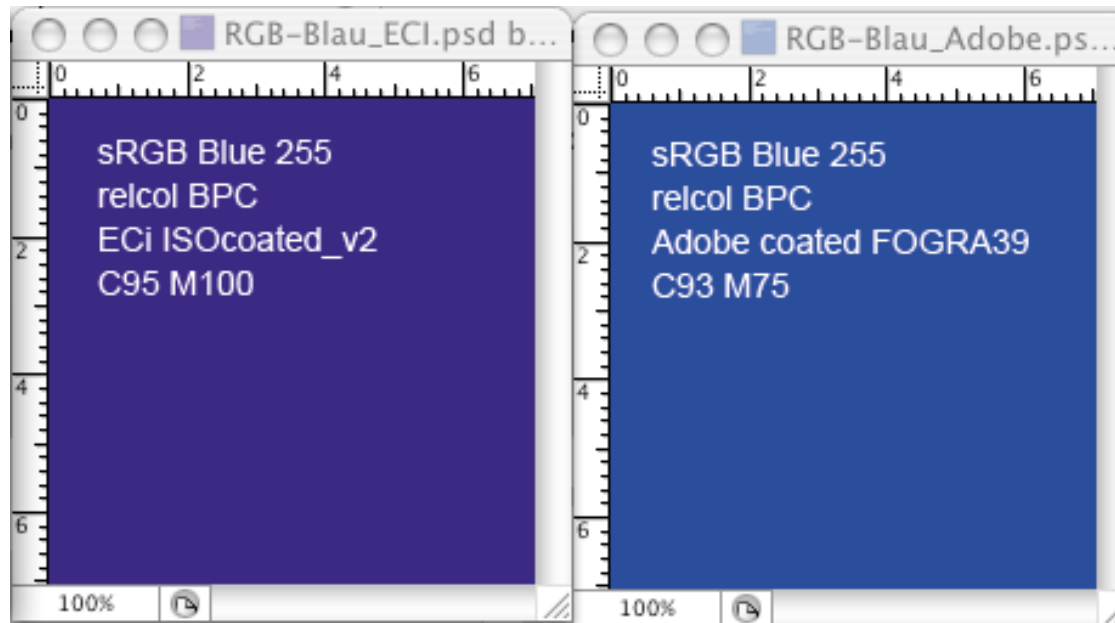
The example shows the separation of a pure sRGB Blue from Powerpoint or from a webpage with an ECI and Adobe Profile representing the FOGRA39 printing standard





No defined „Color OK“ for RGB-data by ICC

Converting RGB to CMYK can be quite different depending on the used profiles. So it is hard to define a „Color OK“ for RGB-data independent from the profiles used for separation.





Huge problems with ICC colormanagement for CMYK and Gray data

Color transformations with ICC-profiles are always using $L^*a^*b^*$ as connection space. Because of this, ICC based colormanagement can't preserve the black channel characteristic and can't preserve pure CMYK colors.

As result, the standard color settings in layout-programms like Adobe InDesign have disabled colormanagement for placed CMYK content and the standard PDF-workflows at the printers side strips off embedded CMYK profiles in PDF content.

Gray is often ignored by ICC colormanagement or transformed to CMYK.



No guidelines for colormanagement of vector-data

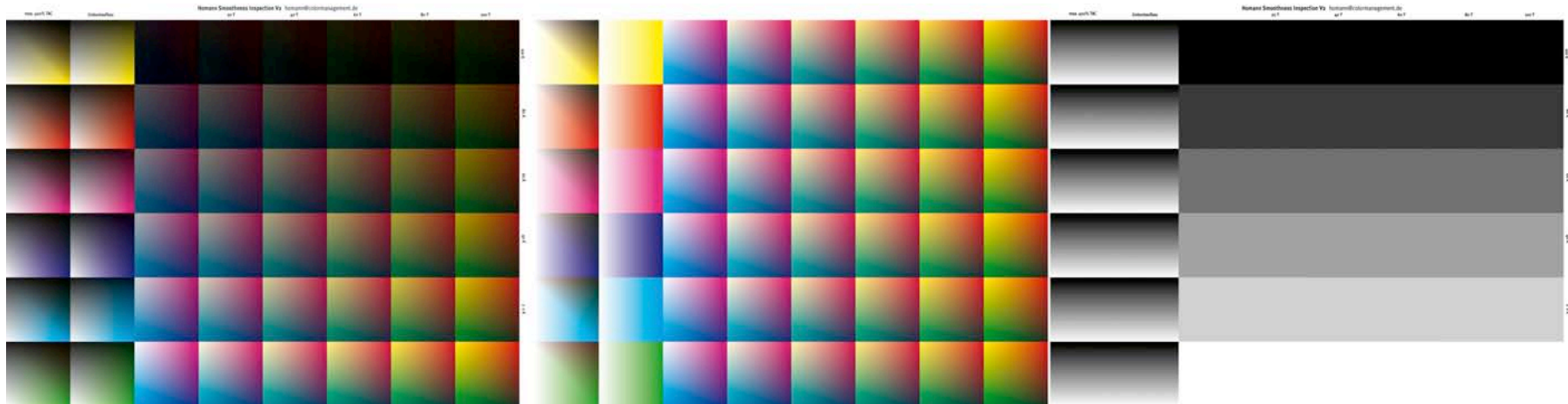
The colormanagement of vector-data is not adressed by colormanagement with ICC-profiles. This is mainly the case of bad quality for ICC based CMYK to CMYK color transformations.

Mandatory for the colormanagement of CMYK vector data are smooth colortransformations wich are preserving pure colors.



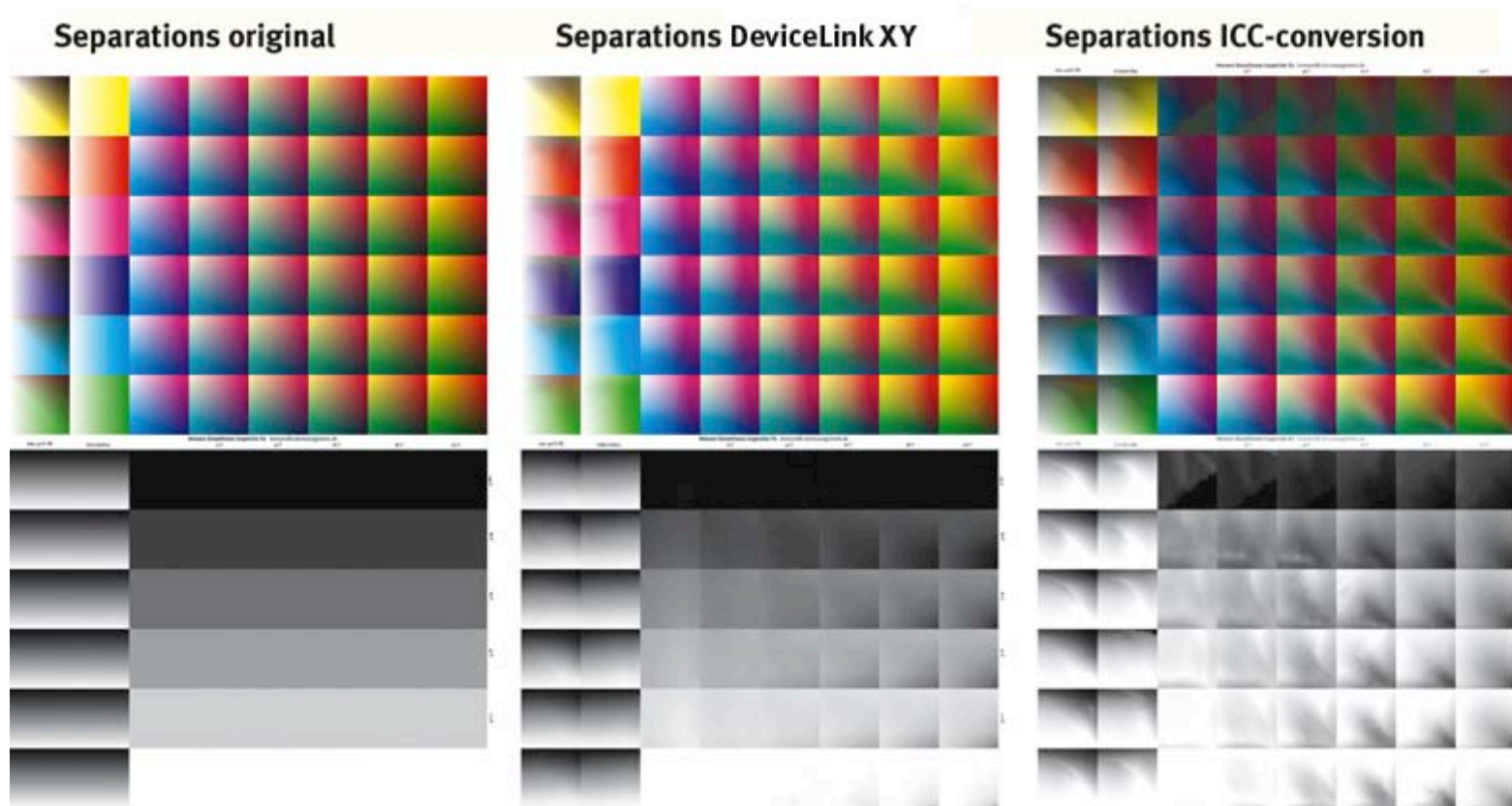
No assurance for the smoothness of a complete color transformation

Currently, it is impossible to predict, if an ICC color transformation from source to destination delivers a smooth result.





Smoothness for ISOcoated to ISOuncoated





Unsolved topics of quality control in ICC workflows

The (theoretical) strengths in ICC workflows lies in the flexibility of profile usage. As profiles for content and devices are independent, it is possible to output content with any profile on devices with any profile.

As the separation between profiles for content and devices is a core concept of ICC based colormanagement, it is more or less impossible to predict the quality of a complete color transformation from content to device.

It's up to the end user to validate the quality of every color transformation from content to device in his workflow.



Mixed color vesus flat color documents

- Colormanagement for individual images or complex documents is fundamentally different !
- An image can contain only one profile.
- A mixed color document can contain hundreds or more profiles for every placed object
- A flat color document contains only one profile valid for all objects of the document.
- Converting mixed color documents to different destination profiles mostly don't allow systematical quality evaluation of every colortransformation from embedded profiles to the destination profile.



The promotion of mixed color documents by ICC / ISO

- A lot of users, vendors and colormanagement evangelists believe to the myth of mixed colored documents
- Every layout application allows to build mixed colored documents
- PDF as leading file format allows easily mixed colored documents
- ISO 15930 PDF/X-3 promotes the exchange of mixed colored documents for the graphics arts
- Till today, neither ICC nor ISO TC 130 has defined a workflow how to build complex mixed colored documents, which can be converted with predictable and pleasant results to different output colorspace.



Conclusion for „traditional“ ICC colormanagement

- Concentrate on a small number of ICC profiles as possible in the workflow
- If RGB data are separated to different printing conditions, all separation profiles should be from the same supplier (e.g. ECI, Adobe...) to remain harmonical gamut mapping.
- avoid ICC based colormanagement for vector-data
- Control carefully CMYK to CMYK conversions for images
- Avoid exchange of mixed color documents or PDF files.

- **With traditional ICC workflows, it is may impossible to convert complex documents (images, vector graphics, flattened transparencies) to different destination color spaces.**



Definition of a DeviceLink Profile

A DeviceLink Profile represents a tailormade color transformation for a well defined use case.

The two most important fields for the usage of devicelink profiles are:

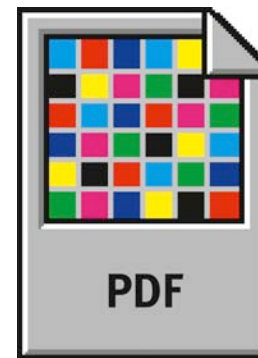
- high end proofing of reference printing conditions (FOGRA, GRACoL, SWOP)
- PDF colorserver for the color optimization or color conversion of complex documents (images, vector graphics flattened transparencies).



The unflexibility of DeviceLink based color management

- For every combination of source and target colorspace in the colormangement workflow, a precalculated DeviceLink must be available.
- If users are free to choose every colorspace for editing and file exchange, it is impossible to maintain colormangement workflows with precalculated DeviceLink profiles.

For succesful usage of devicelink profiles, it is mandatory that all users in the production chain agree on color standards / references for flat color file exchange.





Quality in DeviceLink based color management

- DeviceLink profiles are tailor made color transformations for a given use case.
- Because of this, it is possible to control and optimize the DeviceLink profile to deliver the expected level of quality for the given use case.

Current softwares for calculation and editing of devicelink profiles are adressing more or less ALL quality problems we have with traditional ICC color conversions.

But for some use cases (e.g. converting ISO offset to PSR gravure), the creation of high end DeviceLink profiles is not just a „push the button“ task.



Vendor optimized DeviceLink profiles

DeviceLink profiles can represent:

- a standard ICC color transformation (Source- and destination profile, rendering intent)
- a standard ICC color transformation with additional edits only valid for this combination of profiles and the given use case
- a color transformation which is calculated with special settings according to the use case
- manual color corrections

Because of this universal approach, DeviceLink profiles are preferred format for several vendors representing tailor made color conversions and optimizations for specified use cases



Use cases for vendor optimized DeviceLink profiles

Looking to available solutions in the graphic arts market, we have following use cases, where different vendors are offering workflow solutions including vendor optimized device link profiles:

- **proofing solutions for reference printing conditions**

- **PDF color server with following features**
 - Conversion of PDF/X-1a files representing standard offset coated to other reference printing conditions
 - limiting the TAC (total amount of Color) for PDF/X-1a files
 - normalization of GCR for PDF/X-1a files / Ink optimization

Proofing solutions for reference printing conditions

For highquality proofing of reference printing conditions, the proofing solution must have a calibration procedure, which is independent from profile optimization.

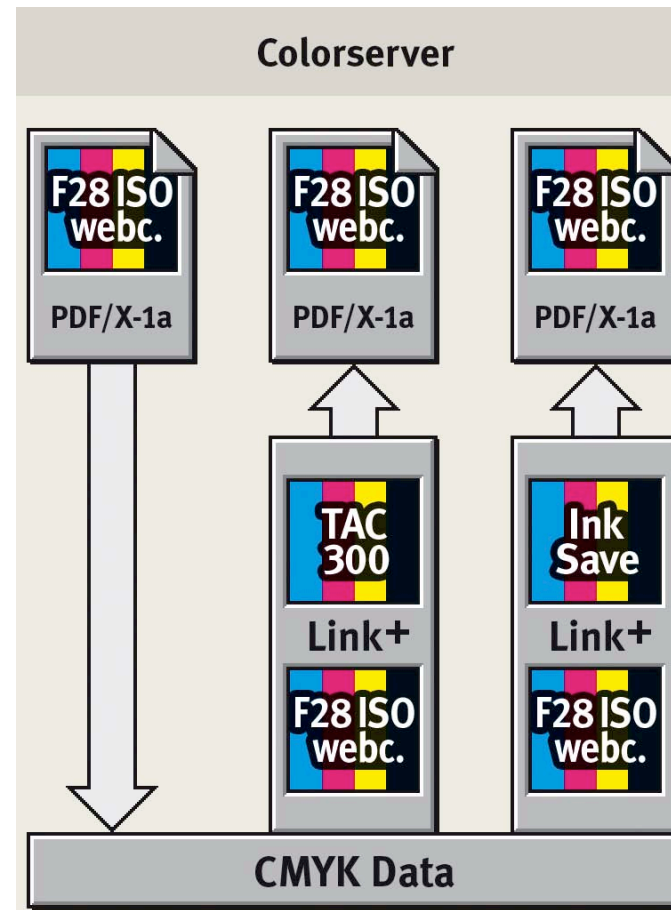
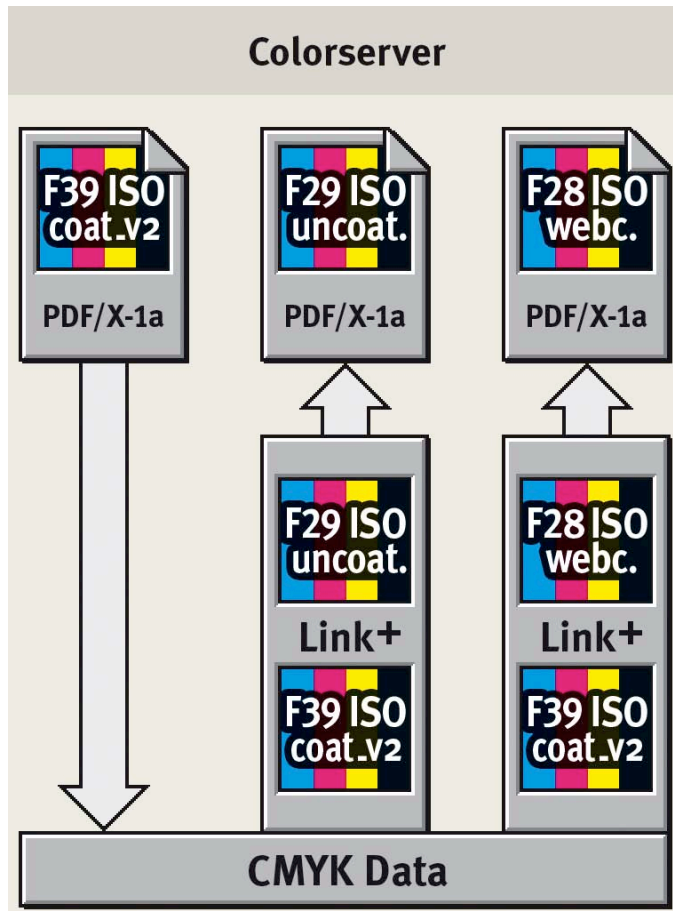
For calibrated output on standard proofing media, the vendor should deliver optimized devicelink profiles for the reference printing conditions (e.g. ISO/FOGRA, GRACoL, SWOP)

The user only needs to do a regular calibration. There is no need for specialized colormanagement know how for installing or maintaining the proofing solution.

Out of the box solutions are e.g. available from AGFA, CGS, ColorGATE, GMG or Kodak



PDF colorserver with vendor optimized Device Links





PDF colorserver with vendor optimized Device Links

Several vendors are now offering workflow solutions with vendor optimized DeviceLink profiles or settings, addressing color conversions, TAC limiting and Inksaving:e.g.

- AGFA OptiInk
- Alwan CMYKoptimizer
- Callas PDF Toolbox (Server) + DeviceLink Addon
- Colorlogic / Impressed Standard DeviceLink profiles
- GMG ColorServer, GMG InkOptimizer

A lot of this systems can be tested with online colorserver or demo versions. Several print providers are using such systems for automatic optimization of printing data.



Early binding and Late Binding

The terms early binding and **late binding** are used quite different between several colormanagement experts.

My personal definitions are:

Early binding; creating PDF-files for a specified printing condition wich must be printed according the delivered printing condition.

Late binding: Automatic color conversion / optimization of incoming PDF-files from the delivered colorspace to the target printing condition at the print provider.



PDF/X-3 and PDF/X-4: the unsolved late binding issues

The current PDF/X-3 and -4 specifications are allowing the creation and exchange of mixed color PDF files with embedded profiles in every single PDF-object. Additionally it forces to specify the rendering intent for every object tagged with an ICC-profile and allows also the mixture of untagged and tagged content in the PDF-file.

PDF/X-3 and X-4 do not address the known problems for the colormanagement of gray and CMYK objects in ICC based color management workflows.

As a result, PDF/X-3 and PDF/X-4 are far away from being usable and reliable for late binding.



Late Binding, PDF/X-1a and DeviceLink profiles

Today, the color conversion of PDF/X-1a files with tailor made DeviceLink profiles is the only late binding workflow, which works in daily practice at several print providers.

The quality and predictability of Color conversions for PDF/X-1a files is only depending on the quality of the used DeviceLink profile.

Additionally, the PDF colorserver must be able to handle all the PDF specialities allowed in PDF/X-1a e.g. optimizing gray objects defined as DeviceGray, DeviceCMYK or DeviceN (Black) with the CMYK DeviceLink profile.



Conclusion

DeviceLink Profiles are a good extension to „traditional“ ICC based colormangement workflows in the fields of high end proofing and PDF colorservers.

Both Clients and printers should focus on PDF/X-1a for reliable data exchange and automatic optimization of printing data. After this, in the future they can update to „CMYKonly PDF/X-4“ for data exchange.

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