A set of reference ICC profiles for commercial offset reproduction

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Abstract

A set of profiles have been created from reference printing measurement data for a number of different media. These profiles have been tested to ensure good colorimetric accuracy and (when the perceptual rendering intent is used) should result in reproductions of colour images that meet the objectives of skilled image creators.

Introduction

Colour management using ICC profiles has become widely accepted as a means of transporting images between creator, publisher and producer sites and ensuring consistent colour reproduction without having to resort to closed loop methods. However, in current workflows problems can still arise. Two particular cases are where an image creator wishes to supply an aim print or proof showing the desired appearance of an image prior to reproduction work by prepress house or printer; and when a producer anticipates that image data will be supplied in CMYK, but the image creator has prepared the image in another colour space (normally RGB). If the characteristics of the image data and the reproduction process can be communicated, then it is possible to ensure that these objectives can be consistently met; but this does not always happen and then the final reproduction may not match the desired appearance.

One approach to this problem is to define a set of transformations in the form of ICC profiles such that when proofs or aim prints are correctly made, the resulting prints represent both what the image creator is willing to accept and what the printer is able to produce. This match between expectation and 'reproducability' is fundamental to the approval process in the graphic arts.

In this project, the Colour Imaging Group was commissioned to produce a set of such profiles for the major commercial offset printing processes.

Selecting the data source

Standards exist for process control in offset printing [1,2], but in practice commercial printing processes operate within quite broad tolerances. A single printed target will only represent a unique setting of a single press, and will be unlikely to be representative of the performance of a process over time. To characterize a single press it is necessary to make a number of prints of the target over a period of time and average the measurements, and this will have the effect of smoothing out local variations. The greater the variation in the performance of the process, the more important it is to base the measurement data on a number of samples, since if the targets measured are not fully representative of the process, there is a danger that the resulting profile will perform poorly and have undesirable effects such as restricting the gamut available [3, 9]. If one is attempting to create profiles for a whole class of presses, it becomes necesary to measure prints made at a number of different sites to obtain a data set

that represents the class. Averaged data sets for different printing processes have been produced by a number of organizations, including FOGRA, IFRA and SWOP. Many of these are publicly available at the characterization registry at the ICC web site www.color.org.

The substrate makes a significant contribution to the appearance of a colour printed by any process, and a profile represents the colorimetric performance not of a device but of the combination of reproduction process and substrate. This combination is often referred to as a medium.

To create a set of profiles for commercial offset printing processes we selected data sets that represent the most common categories of commercial print media. These data sets were averaged from measurements of the ISO 12642 characterization target (also known as IT8.7/3) [4] printed by a wide range of printers, which nominally met the aim points and tolerances of the ISO 12647 standard. Since ISO 12647 was itself based on data obtained from a large number of printers on the solid colours and tonal value transfer (dot gain) that they could achieve using widely-available ink sets (as defined in ISO 2846), we are confident that these data sets represent the reproduction of CMYK that can be achieved by the printing industry. Such data sets define what is increasingly referred to as a 'reference printing condition'. [5,6]

It is important to recognize that a reference printing condition does not guarantee that any one press run will match the averaged data, but rather that the data represents an average of printing performance in the industry and thus will minimise the likelihood of large variations between the expected result and the actual prints made.

The media and data sets selected were as follows:

Media	**Originator**	**File name**	**Working**
Gloss coated	FOGRA	FOGRA1.txt	Positive
Matt coated	FOGRA	FOGRA2.txt	Positive
Heat-set light-weight coated	FOGRA	FOGRA3.txt	Positive
Uncoated	FOGRA	FOGRA4.txt	Positive
Newsprint	IFRA	IFRA02.xls	Negative

It can be noted that specifications for the reproduction of solid colorants and tints of these media are included in ISO 12647, making it possible for a given print to be tested for conformance with the printing condition for which the profiles were created.

Profile creation

Profiles were created using GretagMacbeth ProfileMaker, which in our experience produces consistently accurate profiles. It performed well in a recent comparative test of commercial profiling packages [7].

Black generation settings were chosen to reflect current commercial practice in the printing industry. The most important option is the maximum overprint or 'TAC'. A high level results in good contrast and rich blacks, but can create production difficulties during printing such as marking and set-off. Web presses are particularly prone to this problem, and the TAC settings were restricted to 250% for both newsprint and heat-set web profiles. A 310% version was also produced for possible use where a printer accepts such settings, but users are cautioned to

ensure that a written specification exists confirming this before adopting this profile. For the other profiles, TAC settings of 350% were adopted to maximize contrast.

Medium GCR settings were used in all profiles to maximize consistency in reproductions made for different processes. A maximum black of 95% was set for the sheet-fed coated profiles and 90% for the remainder, while the minimum black in neutrals was set to between 10 and 25% depending on the substrate.

These particular settings will not be in use in every site, but represent typical industry usage and provide a robust specification that is very unlikely to lead to production difficulties.

In the case of the newsprint data, IFRA (the international newspaper research organization) produced a profile from their averaged data in 2001. This profile has been widely adopted by the industry, and in a comparison of different profiles and reproduction methods in standard newsprint [8] this gave the best performance, so we chose to use the IFRA profile rather than create a new one from the data.

Profile evaluation and editing

Simply establishing the colorimetric accuracy of a reproduction medium does not by itself ensure that the resulting reproductions will be preferred by observers. Moreover, owing to the gamut limitations of different processes, colorimetric accuracy is only possible for those original images whose gamut does not exceed that of the reproduction medium. For all other images, a degree of gamut compression is required, and the style of gamut compression is what distinguishes different profiles whose colorimetric accuracy is equivalent.

Meaningful evaluations can only be carried out by assessing the reproduction of images, and ideally such assessments should be carried out by a number of experienced individuals who are able to define the reproduction aims of the process. We were fortunate that members of the AOP Digital Imaging Group were able to perform this assessment, and we feel that this should result in profiles that will produce optimum results for each medium across a wide range of image types.

The profiles were evaluated in three phases.

In the first phase, the accuracy of the colorimetric intent was tested, using a method described previously [9]. This demonstrated a good level of accuracy in all profiles. For two profiles the regions of maximum error were isolated and attempts made to reduce errors in these regions, by selective edits to the profiles and by creating look-up tables for pre-processing the image data before input to the profile. The improvements made by these methods were not considered significant.

In the second phase, the perceptual rendering intent of the gloss coated profile was tested by wet proofing a composite test image consisting of a selection of different image types including memory colours (foliage, skies), packaging, food, and flesh tones. This was assessed by a panel of experienced photographers, who proposed a small number of alterations.

In the third phase, a number of candidate profiles was created with edits that reflected the aims of the photographers. This set of profiles was used to convert the test image to CMYK using the perceptual rendering intent each of the profiles, then converting the resulting image to the profile of the ink jet printer using the absolute colorimetric rendering intent.

Prints were made on an Epson 980 ink jet and a second small panel then viewed these in standard viewing conditions, and comparing the prints with a reference print produced by

converting the original test image to the printer profile with the absolute colorimetric rendering intent. Final edits were made on the basis of this assessment.

Overall, the edits will increase the perceived contrast and chroma of the reproductions, and adjust the overall lightness. Selective corrections were also made, particularly to improve the chroma in greens.

It should be emphasized that these profiles have been created to give good results on colour images, and have not been tested on monochrome images or graphics. It should be possible to reproduce special colours with reasonable accuracy using the colorimetric rendering intent, but this has not been tested.

We anticipate that problems will inevitably emerge as the profiles are adopted and used, and anticipate that future versions will be able to improve them further. In particular, it has been noticed that the IFRA profile has a tendency to shift to blue in mid-tome neutrals, and in a future version we expect to either adopt an updated IFRA profile or generate a new one from the IFRA data set.

Conclusions

These profiles mark a significant step by the graphic arts industry in the adoption of standard printing conditions and the colour transformations that reflect those conditions. Although the profiles are intended for situations where a custom profile for a particular site or process is unavailable, given the advantages of reference printing conditions such as those defined in the IFRA and FOGRA data sets, we believe that the profiles created in this project will often prove to be preferable to using custom profiles.

References

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