Kodak's Photo CD takes an all-encompassing approach to scanning: Scan the image once and use that same scan for a wide range of applications (from thumbnail proofs to television display to video/multimedia to print). To do this, Kodak employs a clever bit of file management that allows them to pull lower resolution scans (for use in video or whatever) from the original high resolution data. This is a very ambitious approach. To supply everything that everyone needs from a single scan covers a lot of ground. Kodak ran into two specific problems on the high resolution print end:

• Will the resolution and quality be high enough for print?

• Will the Photo YCC™ format be widely accepted?

To answer those questions, we will have to take a closer look at some specifics about Photo CD, namely image-packs and Photo YCC.

Acronyms

Because this article contains so many acronyms, a reference list has been added to page 14. For a more complete list, please refer to Appendix A of the 1993 note-book, or, the Linotype-Hell Acronym Resource (a self-running Macintosh program containing acronyms and definitions).

Image packs

When an image is scanned for Photo CD or Pro Photo CD, multiple files result (see chart). These files are referred to as an **image pack**. The multiple files in an image pack can be condensed in two ways to get smaller files than those shown in the chart below. For one, there is a great deal of redundancy between any of the files in a given image pack, and therefore it is not necessary to store each file entirely separately. This, in conjunction with some compression, allows Photo CD files to be stored at a relatively reasonable size. (For more information on how Photo CD stores these files, please refer to the article entitled Photo CD which appears in the 1993 Linotype-Hell Technical Information notebook.)

Image pack components

	Type	Format	Resolution	Use	File size
	Base/16	YCC	128 lines x 192 pixels	Thumbnails	72 KB
	Base/4	YCC	256 lines x 384 pixels	Low resolution	288 KB
	Base	YCC	512 lines x 768 pixels	TV quality	1.12 MB
	4 Base	YCC	1,024 lines x 1,536 pixels	HDTV	4.5 MB
	16 Base	YCC	2,048 lines x 3,072 pixels	Photo CD	18 MB
	64 Base	YCC	4,096 lines x 6,144 pixels	Pro Photo CD	72 MB

(Pro Photo CD spans all six rows; Photo CD spans the first five rows.)

Photo YCC

Image packs for Photo CD and Pro Photo CD are stored in a format called Photo YCC. Photo YCC (usually called just YCC) is the color space that Kodak developed for use with Photo CD. YCC is particularly well-suited for the compression that Kodak applies to the image packs. It is also well-suited to television and video applications. Unfortunately, it is not as well-suited to print. In the print world, ultimately everyone needs CMYK, and, many prepress systems have been built around a CIE color space like CIELAB (which is used in LinoColor™).

Print Photo CD

In August of 1993, four companies, Linotype-Hell, Crosfield, Dainippon Screen, and Scitex signed letters of intent to work with Kodak on a new Photo CD disc format called Print Photo CD. The intent of Print Photo CD is to address some of the issues mentioned above, and then to go even further.

Print Photo CD:

- Allows prepress systems from Linotype-Hell, Crosfield, Dainippon Screen, and Scitex to read and display files from all Photo CD discs.
- Has an agreed upon CMYK format.
- Makes it easier to share data between Linotype-Hell, Crosfield, Dainippon Screen, and Scitex prepress systems.
- Accepts image packs from Photo CD and Pro Photo CD discs.
- Allows input from Linotype-Hell, Crosfield, Dainippon Screen, and Scitex scanners and systems.

Authoring

Up until Print Photo CD, Kodak limited the ability to author CDs to the people who had bought authoring systems for one of the numerous types of Kodak Photo CDs (see boxed item.) This meant that only certain scanners could be used to create Photo CD images. Now, selected high-end scanners from Linotype-Hell, Crosfield, Dainippon Screen, and Scitex may also create images in the Photo CD YCC format.

[1] Kodak uses the term "Master", as in Photo CD Master, to describe a Photo CD that was mastered from a film original (like a 35 mm negative) using a Photo CD workstation. Print Photo CD, Photo CD Portfolio, and Photo CD Catalog do not use the term "Master" since the source image may not necessarily come from a film original.

CMYK and TIFF

But YCC is not the only format in use in Print Photo CD. There is also a CMYK format (cyan, magenta, yellow, black). The CMYK file format in Print Photo CD is based on TIFF-IT and TIFF 6.0 specifications. (TIFF-IT is a TIFF format developed by an ANSI IT-8 committee. TIFF 6.0 is the latest version of the Aldus TIFF specification.)

In order to get a good quality color separation, those currently working with Photo CD or Pro Photo CD must take the YCC format supplied and convert it to TIFF CMYK, EPS, or DCS/ICS. Some page layout programs, QuarkXPress 3.2, for example, are able to make a separation from Photo CD RGB input, but generally this function is only used for low resolution proofing or FPO (for position only placement). However with Print Photo CD, TIFF CMYK and DCS/ICS are directly on the Print Photo CD along with the YCC format.

To summarize, Print Photo CD allows three kinds of image data storage:

- YCC (may also be called the Photo CD directory)– Allows current and future CEPS (color electronic prepress systems) to capture Photo CD images

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> **Photo CD Master**[1]
> - Provides 35 mm capabilities
> - Resolution is 2K x 3K
> - 6 second scanning
> - Cost-effective desktop production
>
> **Pro Photo CD Master**
> - Provides digitization of professional film formats of up to 4 X 5
> - Resolution is 4K x 6K
> - 90 second scanning
> - Copyrighting of original image
>
> **Print Photo CD**
> - Provides digitization of 8 x 10 and greater film formats
> - Allows CEPS (color electronic prepress systems) to create Photo CD discs
> - Provides the ability to rewrite edited images in image-pack format
> - Allows storage of CMYK data on file linked to image-pack
>
> **Photo CD Portfolio**
> - Multimedia application for voice, text, and graphics
> - Input from multiple sources
>
> **Photo CD Catalog**
> - Lower resolution images only
> - Holds up to 6000 images

and stored them in Print Photo CD format. It doesn't matter whether the data comes from a scanner, a color electronic prepress system, or from existing Photo CD Master discs. The YCC component of the Print Photo CD refers to the image pack discussed earlier.

• CMYK (may also be called the standard directory) – Images may be stored as CMYK. These files may then be easily shared among systems from different manufacturers. Kodak, Linotype-Hell, and the other vendors continue to work on specifications for storing additional color spaces and page elements on the Print Photo CD disc.

• Vendor-specific data (or vendor specific directory) – Print Photo CD will accept data files specific to the CEPS system used to create the disk, will include a TIFF/IT tag that describes the type of data included in the file, as well as the resources needed to work with the data.

Black generation

It is important to note that the Photo YCC format does not contain any information regarding the generation of the black plate. This means that factors like UCR and GCR must be applied in a separate step. To address this, Kodak supplies print tables for use with desktop publishing applications like Adobe Photoshop.™ Most high end scanner operators will not want to use these tables because they can apply UCR and GCR (as well as many other functions) as part of the scanning process. This is another reason why Print Photo CD is so important: it allows users to retain the black plate generation information.

LinoColor 3.2

At present using LinoColor® 3.2, Photo CD images in the YCC color space may be converted directly into the CIELAB color space. This conversion is accelerated using the MacCTU. (For more information on the MacCTU, please refer to the article entitled Color Management which appears in the 1992 Linotype-Hell Technical Information notebook.) This conversion can be done in a batch mode, and, automatic image improvement may be achieved using ColorAssistant.

Data stored on the Print Photo CD can be stored in both YCC (at the resolutions described above) and at any resolution as CMYK. The CD then serves as a means of communicating information to a customer (i.e. a digital job jacket), or it can also be used as an inexpensive way of archiving data. A future version of LinoColor will support archiving data in CIELAB.

Print Photo CD will not only be supported by LinoColor 3.2, but also by the DC 3000 line. Print Photo CD will provide a bridge to multimedia for Linotype-Hell customers.

CD-ROM issues

There are some important considerations regarding the player you choose to read Photo CDs. In general, the player should be what is known as "Photo CD compatible." This relates to a number of different CD-ROM standards:

• The ISO 9660 standard allows Macintoshes®, PCs, and some UNIX® workstations to share data on CD-ROMs. (Otherwise this is only possible if the manufacturer of the disc includes two complete sets of data on the discs, once for the Macintosh and one for the IBM PCs and compatibles.)

• CD-ROM XA (extended architecture) is a standard that allows a PC CD-ROM player to read multimedia discs. (Photo CD requires this.)

• CD-I is an interactive multimedia CD format developed by Phillips. Both CD-I, and a format called 3DO allow users to display Photo CD images on television screens.

Almost all CD-ROM drives sold today are Photo CD compatible. However, older players may not be able to read Photo CDs, or, they may only have a limited ability to read Photo CDs.

A CD may be written in a single session or in multiple sessions. Many early players are only able to read the first session that is written to the CD. Any later sessions are not accessible. Considering that Photo CDs can hold up to 100 images, it is likely that many Photo CDs will have multiple sessions written to them. It is vital therefore that the CD-ROM player be able to read these multiple sessions.

Reading Photo CDs requires software applications that can open and read the appropriate formats. Kodak calls programs that can open and read YCC image-packs "Photo CD-enabled." Adobe Photoshop™ 2.5.1 for the Macintosh is Photo-CD-enabled. Kodak also offers a variety of programs for use with Photo CD.

CD-ROM performance is also an interesting issue. Many people don't use CD-ROMs for storage because access to the data is generally pretty slow. This is a function of access speed and transfer rate. Access speed is measured in milliseconds, and represents the average time it takes a CD-ROM player to locate a piece of information on the CD. Transfer rate is measured in kilobytes per second, and represents the time it takes a CD-ROM player to transfer data to the computer. Access time is more important for those who refer constantly to the CD (for example if you have a dictionary or encyclopedia on the CD). Transfer rate becomes more important if the files that you access are large (as is the case with most image files).

Considerable performance improvements have been achieved recently through the use of a technology called "dual speed."

Finally, if you intend to access a file frequently, the performance of that storage device is more critical than if you are archiving a file which will not be accessed often.

Conclusion

The important features of Print Photo CD are as follows:

• Color images can be stored in Photo CD YCC format (up to 16 Base) and in CMYK (TIFF CMYK) at any resolution.

• Storing images as YCC 64 Base and CIELAB will also be possible in a future version.

• Since Print Photo CD is based on the file system and the access routines of Photo CD, it is compatible with the CD players used to read Photo CD.

• It is also possible to store other related information on the Print Photo CD, including: page layouts, color management data, copyright information, etc.

Acknowledgements