3-2004

Thermal-Transfer Printing: A Better Way to Print Library Labels

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Thermal-transfer printing, a technology borrowed from the manufacturing sector, offers libraries a flexible method for printing durable, accurate, legible, and attractive labels that reliably adhere to most book surfaces. When guided by an electronic program customized to meet a library's particular needs, a thermal-transfer printing system offers virtually limitless variations in font, format, and functionality. It can print labels directly from the online catalog, thereby guaranteeing that call numbers on labels match what patrons see in the catalog. This article explains thermal-transfer printing and how it compares with other printing technologies, briefly explores applications in both the manufacturing and library environments, and describes in detail how Utah State University Libraries and a few other libraries use it to improve the accuracy, appearance, and durability of their spine labels.

It is no secret that libraries often make use of technology first developed and tested in the business and manufacturing sectors. A well-known example of this borrowing is bar-coding technology; a more recent but lesser-known example is the automated storage and retrieval system (robotic retrieval of densely stored materials) being incorporated in some of the newest library buildings. Now libraries have another opportunity to capitalize on a technology developed and tested by companies and businesses—thermal-transfer printing.

As described in this article, Utah State University Libraries (USUL) uses thermal-transfer printing to print better labels via a system combining thermal-transfer printing technology with an electronic program that formats and prints data directly from the library online catalog. Because a program instructs the printer how to print the label, the possibilities for variations in font, format, and functionality are virtually limitless. The program automatically sets font type and size according to data length, moves data around on the label, translates codes into text, prints batches of a single label with or without incrementing enumeration, and prints label sets, among other things.

USU's printing system was created in 2000–2001 in collaboration between USUL and a label vendor, Computype. Shortly afterward, the label vendor worked with the online catalog producer Dynix to make this printing technology available to other libraries. Several other libraries' printing systems also are briefly described in the following paragraphs. Because of the flexibility of these thermal-transfer printing systems, each library's setup and experience is different.

Background

Like many libraries, USUL has searched a long time for a way to efficiently print attractive, legible labels that endure rather than fade, smear, or simply fall off the book throughout its years of use. Providing such labels seems simple, and yet all of the different ways of creating library labels that were tried in the past proved unsatisfactory in one way or another.

In the early part of the twentieth century, USUL, like many others, manually wrote call numbers and other vital elements on book spines using a stylus pen and *library hand,* a standardized form of handwriting taught to aspiring librarians in library courses. While this method created durable text on the spine, its legibility depended on the vagaries of handwriting skills while its accuracy depended on the diligence of the writer. Superceding the stylus, typewritten labels improved legibility by adding the consistency of a typewritten font, but unfortunately suffered the same potential for errors as their predecessor along with introducing new flaws: a tendency for the text to fade and the label to peel over time. Another promising method yielded a very durable label. The Selin label used heat to *cook* the label onto the book but proved inconvenient, expensive, labor-intensive, and not very attractive or flexible.[1] Dot-matrix printed labels, while easy to create, suffered from various shortcomings associated with inked-ribbon technology (misalignment, dried out ribbons) as well as text that smeared or faded and label stock that was only as good as the adhesive used. While font adjustments were possible, they were not easy to effect, usually requiring multistep routines.[2] More recently laser printing—with its crisp letters, flexible fonts, and word-processing capabilities—showed great initial promise but then disappointed with text that smeared and label stock that eventually peeled and only came in inconvenient sheets of fifty-six labels.[3] All of the above printing methods shared a certain potential for errors in call numbers and other text because labels did not print directly from the online catalog's item records where users see the call numbers. Call numbers displayed in the online catalog were thus not guaranteed to match the call numbers printed on spine labels, a serious, persistent problem that resulted in books that were misshelved or missing.

During more than one hundred years of operation, the libraries at USU tried all of the aforementioned

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traditional label-printing methods with unsatisfactory results. Indeed, if one walks through Merrill Library's long stacks of books, label inadequacies are clearly evident: labels faded so badly they can hardly be read, labels peeling off the spines, and fonts that are difficult to read. For a number of years, typewritten, dot-matrix, or laser labels were covered with a clear layer of glue to help labels adhere to the book. But this was messy and time-consuming; while the label lasted longer, it often originated with print that was too light or contained typos, depending on the label creator and type of printer. More recently, label protectors replaced glue but also added another cost to the process.

Desired Specifications

In 2000, as Head of Cataloging at USUL, the author began working with the bar-coding and labeling company Computype to design a label-printing system driven by an electronic program based on the library's needs and specifications.[4] The following desired attributes were specified:

- the ability to print from any workstation;
- low-maintenance equipment;
- dark, crisp print;
- the ability to print either single or paired labels, without wasting labels;
- text that would not smear;
- a font that would clearly distinguish between all letters and numbers;
- a scalable font to fit the label, automatically increasing or diminishing according to the length or width of the call number;
- the ability to print directly from the item record in the online catalog to ensure that the label on the book always matched the call number in the online catalog;
- the ability to translate the library's various location and collection codes into understandable label headings;
- affordability; and
- label stock that adhered well to most book surfaces.

To meet these numerous criteria, a printing technology that manufacturers used extensively but which libraries had only recently discovered was selected: thermal-transfer printing. The proposed system would use a second small component called a LabelMorphor to integrate the thermal-transfer label printer with the library's online catalog.

What Is Thermal-Transfer Printing?

Thermal-transfer printing found wide acceptance in Japan about twenty years ago because of its flexibility in printing complex kanji characters.[5] About eight years ago, United States companies discovered its usefulness in printing compliance labels and bar codes, especially for situations where printed labels were exposed to harsh manufacturing or environmental conditions. Avon Corporation, the well-known cosmetic company, moved from inkjet printing to thermal-transfer printing to improve its inventory tracking. It integrated Zebra IOSS thermal printers into its warehouse-management system and production lines. An Avon packaging-quality engineer reported that the use of bar codes and the new printing system expedited the flow of goods shipped and reduced errors. "We know we have less chance for errors since the system requires less data input," he said.[6] Another company, Selectron Corporation, switched to a high-resolution thermal-transfer printer to print tiny circuit-board labels. The labels had to withstand high temperatures and a water bath as part of the manufacturing process. The flexibility of the new thermal-transfer printers with their varying font sizes eliminated the need to stock many different label sizes and reduced label wastage by 90 percent.

Thermal Transfer versus Direct Thermal

There are actually two kinds of thermal printing: thermal transfer and direct thermal. Both use a thermal printhead containing two hundred to six hundred heating elements (dots) per linear inch (dpi), but while direct thermal applies the heated print head directly to chemically treated paper, thermal-transfer printers apply the printhead to a ribbon that transfers the image or text to the label material (called a substrate).[7] Thermal-transfer printing has several advantages over direct-thermal printing. Printheads last much longer in the thermal-transfer process because the ribbon serves as a buffer between the label and the printhead. While thermal-direct printers have the advantage of not requiring ribbons, they are limited to special chemically treated paper, whereas thermal transfer permits a wide variety of label materials such as paper and various synthetics, including vinyls (polyolefin, polyethylene, polypropylene, polyvinylfluoride, etc.). Unlike direct thermal's chemically treated paper that fades as it ages or blackens when exposed to heat or sunlight, thermal-transfer materials can endure even harsh environmental conditions such as extreme heat, cold, and moisture. Fortunately, libraries do not require the endurance of Kapton labels, which can withstand up to 1,000 degrees Fahrenheit (but only for a few seconds) and are used for printed circuit-board production. Instead, libraries can use a less expensive material such as polyethylene that is of moderate stiffness, yet flexible enough to curve and adhere to a book spine.

Thermal-transfer printing also has distinct advantages over more popular printing technologies such as impact (dot matrix), laser, and ink-jet printing. While multipart forms require impact printers, these break down more, require ribbons that are subject to drying out, provide poorer image quality, and are limited in the materials on which they can print. Laser and ink jet printers likewise provide poorer image quality, less durable print, and fewer label-material options than thermal-transfer printers. Ink jet printers have the further detriment of taking longer to print.[8]

The Printer

When using thermal-transfer printing, print quality depends on the printer, the ribbon type, and the label stock, and how well these work together. The printer's printhead controls the resolution of the print which is measured in dpi (dots-per-inch) or dots/mm (dots-per-millimeter). On the low end, thermal-transfer printers have a resolution of 203 dpi or 8 dots/mm (for example, Allegro 2, Sato CX200, Zebra 160S). Printers in the mid-range offer 300 dpi or 12 dots/mm (for example, Datamax's DMX- I-4308, Zebra 105Se). Recently Sato released a new ultra-high resolution thermal-transfer printer, the M84pro, with a resolution of up to 600 dpi or 24 dots/mm.[9] USU Libraries' Zebra 105Se has 300 dpi resolution, which has been found to be very satisfactory. One of the label formats includes very small text and a small bar code; even at this size, the text is quite legible and the bar code scans with no problems. An easily overlooked thermal-transfer printer attribute that ought to be considered is the amount of noise it produces as it prints. McClean pronounces thermal printing "silent" compared to other printing processes, though USUL's experience belies his assertion.[10] The Zebra 105Se produces quite an aggravating screech, especially when printing a long string of labels. However, library staff have become accustomed to the noise and those who work in far-flung areas of the department benefit from hearing the confirming sound of the printing in operation. An especially critical feature to check when considering a printer is whether it can provide the desired font type, size, and scalability.

The Font

Finding a thermal-transfer printer that would support a suitable font was difficult for USUL because library staff had stringent requirements. Of course attractiveness, scalability (the ability to adjust size vertically and horizontally), and crisp, dark letters were desired. But another requirement was that all letters and numbers be clearly differentiated, especially the letters i versus l versus the number 1, the upper case B versus the number 8, and the lower case b versus the number 6. Clearly differentiated characters are critical for getting books reshelved correctly. After a few months spent evaluating font samples provided by the vendor, the process was reversed, sending the vendor several fonts that were *known* to work and asking them to find a printer to support them. The company found a printer, the Zebra 105SE, that supported the most desired font, Century Schoolbook.

The Label

Selecting a label stock involved finding an appropriate durable material and an adhesive well suited to book surfaces. Since the company specialized in creating labels and bar codes, there were no limits in the choice of different label stock and adhesives. An adhesive was selected that chemically bonds with book surfaces within twenty-four hours. The decision was made to use Computype's TS503 label stock. A custom-order version of this label stock was requested, consisting of 1" x 1.5" labels of 2.8-mm white polyethylene in continuous rolls of one thousand labels. The adhesive on this label has a very aggressive initial tack (it sticks well when first applied) as well as a good chemical bond that develops subsequently. At 1.1 mm, it is thicker than a normal adhesive, giving better adhesion to books with a textured surface. According to Computype, the rubber-based adhesive has been age-tested with good results; it is the same adhesive used at the library with excellent results for an outsourced retrospective project in 1997–98.

Previously, pairs of labels were used, one 1" x 1.5" label for the spine and a larger inside-label that provided the author, title, and call number. Having these two different-sized labels resulted in some wastage when only a spine label (without the inside label) was needed. By taking advantage of font scalability, the size of the font was reduced and the printing turned sideways (landscape) so author, title, and call number could fit on the same 1" x 1.5" label used for the spine (figure 1). Another element—the bar code—was added, and it was discovered that the printer could print a scannable bar code on the former inside label, thus making this second label useful for inventory purposes. With this in mind, the decision was made to move the inside label to the outside back cover of the book to facilitate inventory scanning.

Creating a Formatting Program

Working with Computype's programmer via phone and e-mail, specifications were created to manipulate data from the library's online catalog so that it formatted and printed correctly on the label. Data streams generated by the online catalog's print-label command were captured and sent to the programmer to analyze. A data stream is simply the electronic message sent from the online catalog to the printer telling it how to format the label and what data to print. To generate these, an item record was called up in the catalog, a label was formatted using regular database commands, and then instead of choosing a printer to send the data to, “Generic, Text Only” was selected and the data was saved as a file that could be read using Notepad. These were then sent off to the programmer as e-mail attachments.

During a dialogue with the programmer that lasted several weeks, system-printing parameters were adjusted in the online catalog as well as the printer’s program specifications. The company ran the program through its own testing regime and then sent the library an EPROM chip that was installed into the LabelMorphor for a test run. The EPROM chip is the brain behind the thermal printer; it contains the electronic program that transforms the data in the online catalog data stream into the desired label format. Library staff tested it for a month or so, requesting two programming changes that were accommodated simply by the company mailing new EPROM chips that staff installed with no problem. Total time for development of this printing system from its inception to final testing was about eight months; cost for the programming work was $1,700. Later, after using the program for a while, it was felt a batch-printing feature needed to be added; the library contracted with the company to add this enhancement for an extra fee of $250.

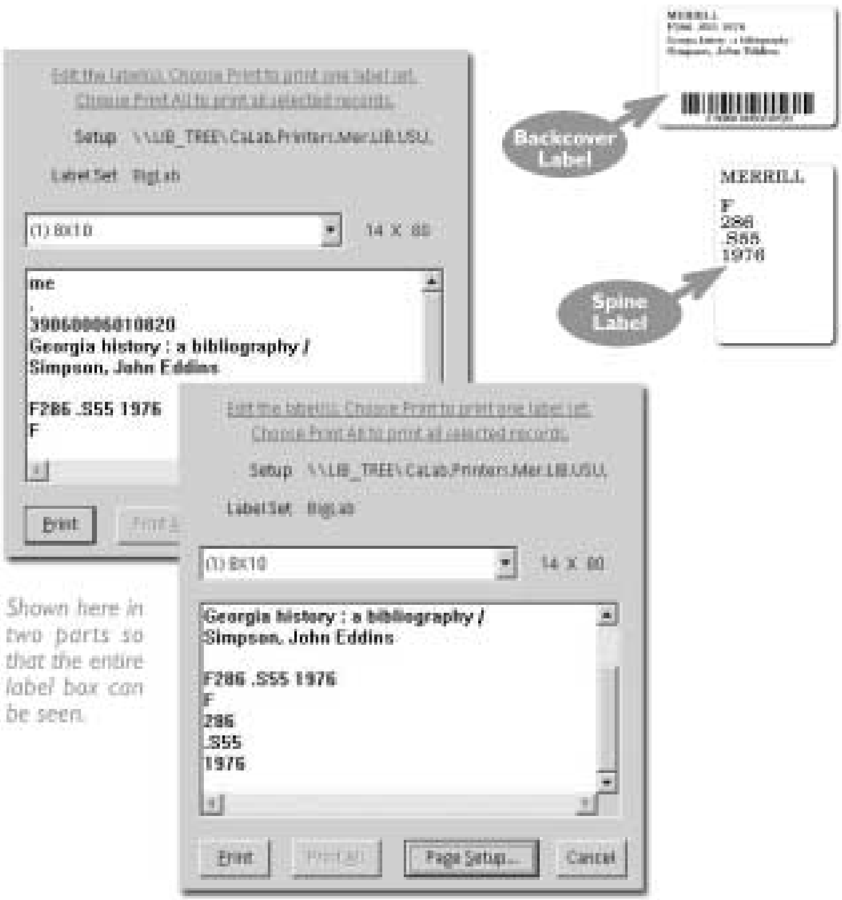

Figure 1. The one label format in the online catalog generates the two different labels above. The period (.) in the second line of the Print Spine Label box instructs the printer to leave the collection area of the label blank.

Batch Printing

The batch-printing enhancement enables more than just batch printing; it also can automatically increment the volume enumeration (volume 1, volume 2, and so on). On the volume-enumeration line that normally contains volume text such as “volume 1,” the word “BATCH” is entered followed by a space, colon, space, and then a number indicating the desired number of labels. To increment volume enumeration, ++ is appended to the volume number (figure 2). Thus, to create ten labels for volumes 1 to 10, the statement: BATCH : 10 : v. 1++ is used. The program accommodates multiple levels of volume enumeration, but only the last level changes numbers incrementally. So, for volume 1, parts 1 to 3, the statement reads: BATCH : 3 : v. 1, pt. 1++ . To generate one hundred labels that were exactly the same, the statement is simply: BATCH : 100.

Other Functions

In addition to providing batch-printing capability, the printing system gives options such as a choice of printing spine labels alone or paired with accompanying back-cover labels (figure 3). To maximize font size, the printer uses a fairly large default font size, but if any line in the call number exceeds six characters, it automatically reduces the font for the entire call number. Extra long titles and author lines automatically wrap around. The program translates the library catalog’s location codes into readable headings. For example, the location code “me” would generate the text “MERRILL” at the top of the label to indicate that the Merrill Library housed the item. Likewise, collection codes are translated into recognizable collection names using the online catalog’s label parameters. The location code “me” and collection code “mref” for reference books in the Merrill Library, for example, cause the label to print with the location “Merrill” on the top line and the collection “Reference” on the second line.

The thermal-transfer label printing system has worked flawlessly in the two years it’s been in operation. Staff can print labels from any location in the library because the printer is accessible via the library network. The labels are consistently clear and dark. They stick so well to most book surfaces that there is rarely a need to use label protectors. Several online catalog upgrades, one of which was very substantial, have occurred, with no adverse effect on the printing capability.

Each label order includes printer ribbons and cleaning solution. Thermal printers should be cleaned every ribbon change to avoid problems such as unwanted lines and blank spots caused by dust on the platen or printhead.[11] Unlike dot-matrix printer ribbons, thermal-transfer ribbons neither dry out nor do they blacken fingers as they are changed. Because ribbons come with the labels and there is no longer a need for label protectors, ongoing label costs at the library are actually less than with the old dot-matrix printing system. Label stock, complete with ribbons and cleaning solution, costs 3.6 cents for each pair of labels; fifty thousand labels are ordered at a time to obtain this low price. By contrast, the former label stock entailed the following costs: 3.8 cents per pair of labels, plus 2.9 cents for a label protector, plus ribbon costs, for a total exceeding 6 cents per pair of labels. According to Computype, an economy version of this system has been developed for smaller

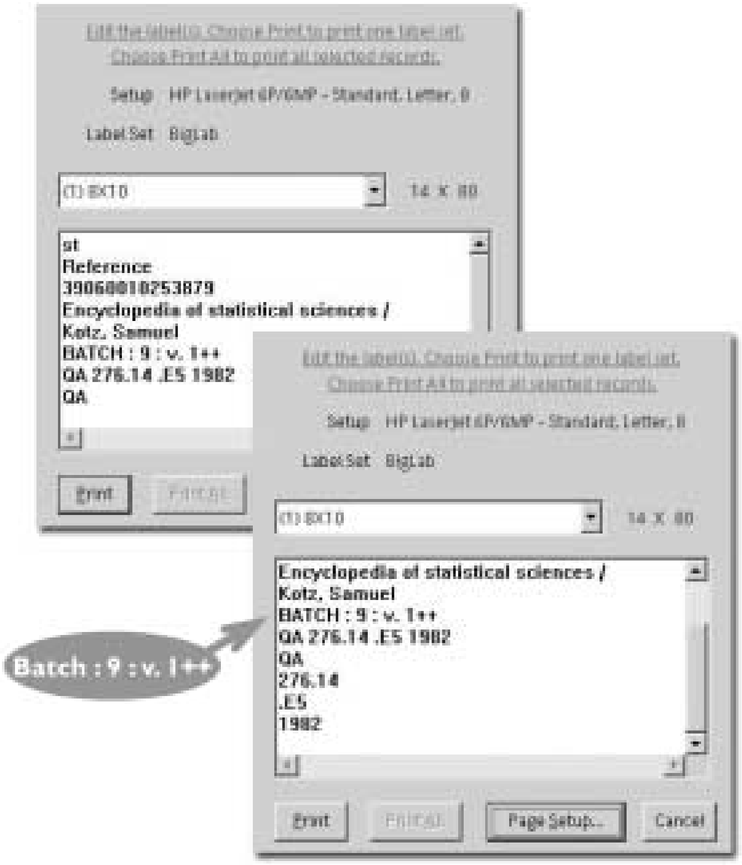

Figure 2. Adding instructions to print a batch of nine labels beginning with volume 1 and ending with volume 9.

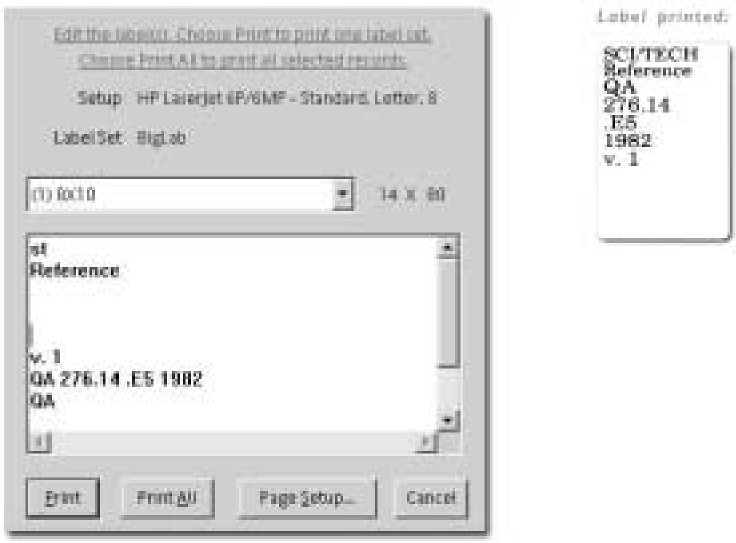

Figure 3. Deleting lines 3 to 5 from the label format instructs the printer to omit printing a back cover label.

libraries that have less demanding label requirements and workloads as well as smaller budgets. The technology is the same but a smaller, lower-resolution printer is used.

Based upon the success of this collaborative venture, Computype worked with the library's database producer Dynix to make this labeling system available to all Horizon and Dynix database users. Other database producers Computype has worked with include TLC, Innovative Interfaces, Inc. (III), and CARL Systems, Inc. (CSI); it currently is working on projects with Sagebrush, SIRS Mandarin, and SIRSI. Each library gives its own twist to its printing system. One library prints labels using three different colors of label stock. It has three identical printers lined up side-by-side with different colors and sizes of label stock. The LabelMorphor reads the data stream, determines which printer needs to be used, reformats the data per the requirements of the library, and then sends the data through an electronic switch box that directs it to the correct printer. All of this happens in less than a second. Another library creates a three-label set for their books using this same system. Its LabelMorphor creates all three labels simultaneously from one data stream coming from the online catalog.

Davis County Library in Utah uses a smaller, more economical Zebra printer. As one of the first Dynix users to install this thermal-transfer printing system, it took the library more than a month of working with Computype programmers, sending data streams and label samples back and forth, to set up the system. After making some program adjustments and figuring out how to load and operate the printer, they are pleased with the system and claim it has saved them "a surprising amount of work." Previously, staff were using a secondary program that necessitated extra steps in their workflow to enter and print out labels; now they just "spit them out" using print commands in their Dynix module during the regular cataloging process. While loading ribbon in the big Zebra printer used by USUL is an easy task, apparently it is not so easy for the smaller printer, according to Jerry Meyer of Davis County Library; he would prefer to have the ribbon provided in a cartridge for easier loading.

Orem Public Library in Orem, Utah, has designed an especially sophisticated system that accommodates about twenty-five different label formats for their various collections and media types. Because of the complexity involved, it took about three months to design and program their system. But the time was well spent: they now can print 160–250 labels in ten minutes compared to only twenty to forty labels using their old system. Once they have their printing system networked, they expect the process to be even faster. They use an electronic switchbox with two printers, one of which uses a 1.5" x 1.0" label while the other uses a 2.5" x 0.75" label. When the cataloger creates a label for a book, she or he decides which label size is needed, depending on the size of the spine. If the regular spine label is too large for the book, the text is sent to the other printer with narrower label stock. Text prints onto this narrower label using landscape mode so that the entire call number will fit on the label in such a manner that the label will run along the spine rather than across it. This flexibility has greatly reduced the need to put call number labels on the front or back of the book due to lack of spine width. Audio-visual labels use the same printing system. The LabelMorphor interprets the data stream coming from the online catalog to determine the type of item and type of label based on the preset formats created by the library.

Conclusion

Thermal-transfer printing technology is an affordable, effective solution for libraries looking for a way to create legible labels that both look good and endure. While requiring some initial investment of time and effort to design and write a program to fit each library's unique needs, the addition of a programmable LabelMorphor to interpret and format data from an online catalog results in a highly customizable printing system that will print accurate, legible, and attractive labels. While this article focuses on libraries using a customized program to integrate label printing with their online catalog, other off-the-shelf options employing thermal-transfer printing exist such as TAGPRINT PRO or Label Matrix, both of which advertise that they work with Windows and support thermal-transfer printers.[12] A search of the Web for companies offering thermal-transfer printing equipment and services yields many sites with useful information.[13] Whether a library is looking for a turnkey printing system or one customized for its use, thermal-transfer printing is an option worth exploring.

References and Notes

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7. Several Web sites offer detailed descriptions of thermal-transfer printing technology. See E-Labeling LLC, (www.e-labeling.net/FAQ.htm) and American Printing Converters (www.apclabels.com/TTRibbonProductInfo.htm).

8. For a chart comparing thermal printing with other printing, see American Printing Converters' Web site (www.apclabels.com/TTRibbonProductInfo.htm).

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11. "Getting the Best Out of Your Thermal-Transfer Printing System," *Automatic I.D. News* 14, no. 4 (Apr. 1998): 26–27.

12. TAGPRINTPro (www.connectworld.net/bulkcable/identification4.html); Label Matrix (www.barcodes.com/htmlprod/class?83.html).

13. For example: Bar code Logics (www.barcodes.com); Computype (www.computype.com); Electronic Imaging Materials (www.barcode?labels.com/pagelib.htm); Label Match (www.labelmatch.com); Label Specialties, Inc. (www.labelspec.thomasregister.com); Lancer Labels (www.lancerlabels.co.uk); Product Identification, Inc. (www.prod-id.com/thermaltransfer.htm).