



## Thermal Transfer Overprinting (TTO) vs. hot stamp printing for coding on flexible packaging materials



Both Thermal Transfer Overprinting (TTO) and hot stamp printing apply a variety of information onto flexible packaging materials. However, there are significant differences between the technologies, especially in regards to cost and efficiency. This white paper will compare the two technologies and provide considerations to keep in mind when selecting one of these coding options.



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# It's an ongoing challenge for manufacturers and co-packers to meet today's package coding requirements while reining in operating costs.

One simple way to achieve greater printing capabilities on flexible packaging while actually reducing costs is to upgrade from analog hot stamp printing to digital thermal transfer overprinting (TTO) technology.

Immediate cost reductions can be so significant that some companies may realize a return on investment in as little as three months. However, it is best to fully evaluate the printing application and printer options before making a purchasing decision.

# Technology comparison

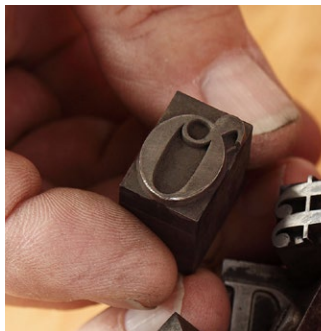


## Understanding the technologies

Both hot stamp printers and thermal transfer overprinters are designed to transfer ink from an inked ribbon onto a thin, flexible substrate such as synthetic films or labels. However, operationally, the two printers are very different.

### Hot stamp

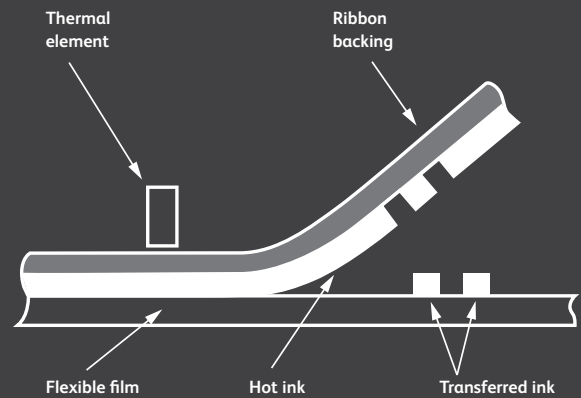
A hot stamp printer works much like an analog printing press. An operator manually sets metal dies, or type, which are then heated. Next, an inked printing ribbon sits between the type and the substrate. The heated type presses onto the ribbon, melting the ink onto the substrate. Hot stamp printers are well-known for their durability and low initial cost. Historically, hot stamp machines have been sufficient for printing static information onto flexible packaging in intermittent motion applications. Hot stamp systems can address applications in both continuous (the film does not stop during printing) and intermittent (the film stops during printing) applications.



Hot stamp type

# Thermal Transfer Overprinting

is a printing process that applies a code to a flexible film or label by using a thermal printhead and a thermal ribbon.

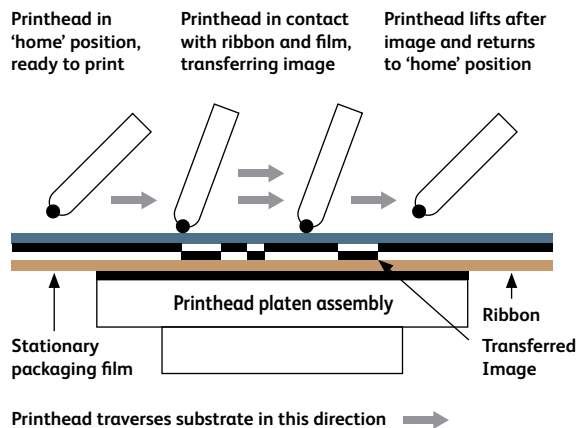


## Thermal Transfer Overprinting (TTO)

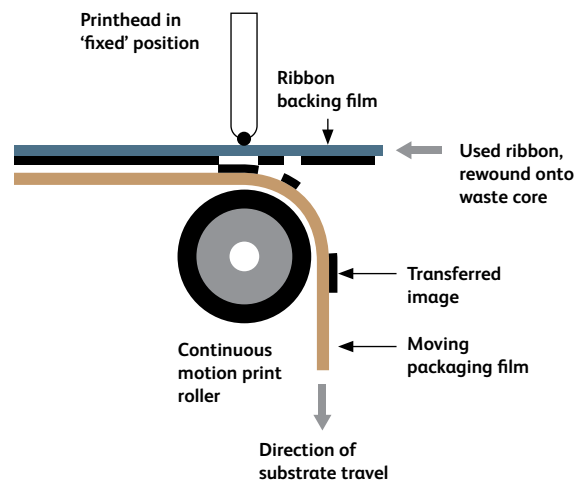
TTO technology features a thermal transfer printhead and ribbon that make contact with a flexible substrate (such as synthetic films and labels). Miniature printing elements located under a glass coating are precisely heated, then presses against the ribbon to transfer ink to the target substrate. Print elements are program-controlled to create digital, real-time images, including high-resolution bar codes, text and graphics. TTO systems can also address applications in both continuous and intermittent applications.

TTO printers typically cost much less to operate and provide variable data printing capabilities that are necessary for today's track and trace requirements. Such capabilities are well-suited for applications in the snack food, bakery, confectionery, frozen and refrigerated foods, bagged fresh vegetables and dried fruits, beverage, meat, coffee and pharmaceutical markets.

### Intermittent motion TTO



### Continuous motion TTO



# Cost of operation

The capital expense for a hot stamp printer and fixtures is generally 50% less than the initial investment of a TTO system because a TTO contains electronics. However, TTO often costs less to operate.

## Consumables

Ribbons are a major portion of the operating expense when printing on flexible packaging. Ribbons are made of polyester material with a layer of ink on top of it. Hot stamp ribbon is thicker than TTO ribbon as it must be durable enough to withstand the contact and temperature involved in the hot stamp process. As a result, ribbons tend to be more expensive for hot stamp compared to TTO, particularly recently where rising chemical costs have caused ribbon prices to increase.

TTO systems consume less ribbon than hot stamp printers because TTO technology provides tighter control of the ribbon movement, which maximizes ribbon usage. Generally, hot stamp printers leave large gaps between print images, which results in wasting a large portion of the ribbon. Digital technologies such as TTO allow for cost savings through enabling ribbon save features that minimize the gap in between prints and result in reduced ribbon use. Hot stamp ribbons also are more prone to break – on average 1 to 3 times per shift – causing downtime and waste while the ribbon is replaced.

Hot stamp type (usually made of brass or steel) must be replaced periodically due to wear or lost pieces. Individual characters are often small (1/4 to 3/8 in.), which makes them hard to manipulate and easy to lose. It is most common to have to replace a full set of type when only one character may be needed. TTO prints digitally, so there are no type expenses involved, however, TTO printheads must be replaced periodically.

## Labor and downtime

Ribbons for hot stamp printers tend to be much shorter than TTO ribbons (300m for hot stamp versus up to 1,200m for TTO). Combined with a larger gap between every print, hot stamp lines are typically down much more often for ribbon changeovers.

Plus, the process of setting up or changing hot stamp type is cumbersome compared to making changes digitally with TTO. Hot stamp operators must wait for type to cool down so it can be handled or risk being burned. Then they manually replace the type, make sure the type is facing the correct direction and heat it up to operating temperature again before the system can print. This process can take approximately 15 to 20 minutes. To make a change with a TTO system, the operator simply makes adjustments on the screen and printing starts again, which can take a few seconds. This minimizes downtime and allows operators to work elsewhere on the line instead of spending time maintaining the printer.

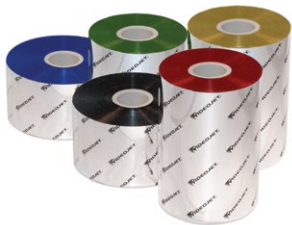


TTO Ribbon Save feature (0.5mm between prints)



Hot stamp ribbon waste (6mm between prints)



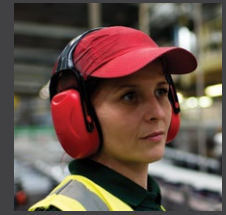


# Operating costs and ROI

Consider a packaging application that produces 12.6 million products per year on one line. They might accomplish this by running 60 packages per minute, 5 days a week for 50 weeks a year with 2 shifts running a total of 14 hours per day (this figures about an hour per 8 hour shift is spent on film changes, production worker breaks and other line stoppages). In a single day, a company may run four different products and want to change the lot number for each new product. The operating costs for this scenario using hot stamp printing and TTO can be calculated as follows. In this case, the downtime with the hot stamp results in nearly 7 weeks of time by an employee that could be utilized in other ways.

Estimated for North America in USD	TTO	Hot Stamp
<b>Summary</b>		
Capital investment depreciation	\$2,400	\$1,200
Total predictable labor costs and downtime	\$3,733	\$11,968
Total unpredictable costs and downtime	\$147	\$7,400
<b>Total Annual Cost of Ownership</b>	<b>\$6,280</b>	<b>\$20,568</b>
<b>Total Cost of Ownership (5 years)</b>	<b>\$31,400</b>	<b>\$102,840</b>
<b>Total Savings (5 years)</b>	<b>\$71,440</b>	
<b>ROI</b>	<b>595%</b>	
<b>Payback Period (months)</b>	<b>2.02</b>	

# Planned/ unplanned costs and downtime



Planned/predictable costs and downtime	TTO	Hot Stamp
<b>Capital investment — equipment and accessories</b>	\$12,000	\$6,000
Annual depreciation (5-year depreciation period)	\$2,400	\$1,200
<b>Ribbon expense for 8 mm high image</b>		
Ribbon length (m)	1,200	300
Cost per roll of ribbon (standard black, 55 mm)	\$33.00	\$13.00
Waste/unused ribbon between prints (mm)	0.5	3
Total rolls of ribbon per year	89	462
<b>Annual ribbon expense</b>	<b>\$2,945</b>	<b>\$6,006</b>
<b>Costs for replacement parts</b>		
Printhead cost	\$800	–
Cost of printheads per year (200km life expectancy)	\$424	–
Hot stamp type cost	–	\$500
<b>Annual replacement parts cost</b>	<b>\$424</b>	<b>\$500</b>
<b>Total annual cost of supplies and parts</b>	<b>\$3,369</b>	<b>\$6,506</b>
<b>Cost/time for ribbon changes</b>		
Number of ribbon changes per year	89	462
<b>Time to change ribbon</b>	1 min	3 min
<b>Annual downtime due to ribbon changes</b>	<b>89 min</b>	<b>1,386 min</b>
<b>Cost/time for changing print image data</b>		
Number of image changes per day	4	4
Time to change the image and prepare printer	1 min	15 min
<b>Annual downtime due to image changes</b>	<b>1,000 min</b>	<b>15,000 min</b>
<b>Total predictable downtime</b>	<b>18.2 hours</b>	<b>273.1 hours</b>
<b>Total planned/predictable cost (\$20/hour labor rate)</b>	<b>\$3,733</b>	<b>\$11,968</b>



## Seamless integrating with your line

TTO machines are small, lightweight and easy to install into a wide variety of packaging equipment. Specialty brackets and accessories can be supplied to help ensure a simple and neat installation.



Unplanned/unpredictable costs and downtime	TTO	Hot Stamp
<b>Costs for printer ribbon breaks</b>		
Number of breaks	1 per month	1 per shift
Time to fix ribbon break	1 min	3 min
<b>Annual downtime due to ribbon breaks</b>	<b>12 min</b>	<b>1,500 min</b>
<b>Costs for line stops due to printing an incorrect code</b>		
Number of line stops	2 per year	2 per month
Time to change the image and prepare printer	1 min	15 min
Total production downtime/rework before error is caught	15 min	15 min
<b>Annual downtime from printing an incorrect code</b>	<b>32 min</b>	<b>720 min</b>
<b>Total unpredictable downtime</b>	<b>44 min</b>	<b>2,220 min</b>
<b>Total unpredictable cost (\$200/hour lost production rate)</b>	<b>\$147</b>	<b>\$7,400</b>
<b>Total downtime per year</b>	<b>19 hours</b>	<b>310 hours</b>
<b>Total downtime cost per year</b>	<b>\$511</b>	<b>\$12,862</b>
<b>Total annual cost of ownership</b>	<b>\$3,880</b>	<b>\$19,368</b>

With TTO, it's fast and simple to get codes right. It can be practically impossible to get them wrong.



# Variable or static printing

Before choosing between hot stamp and TTO, it is important to determine whether the printing application requires variable, real-time data.

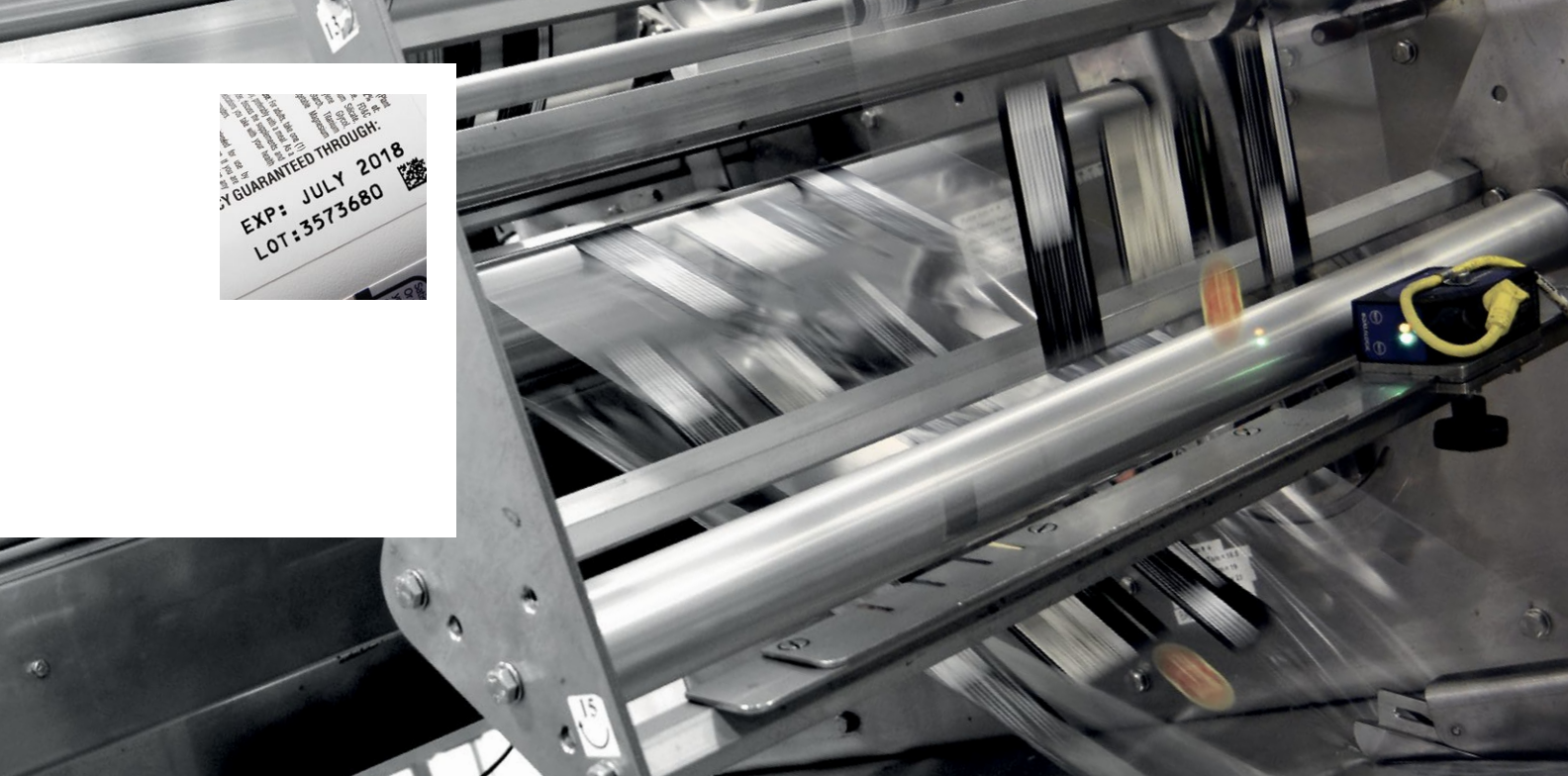
**Hot stamp printers are analog, so they can print static information such as lot codes or expiration dates. This information may be manually updated for every line change, shift change or even daily.**

**TTO automatically provides variable data such as time stamps and unique codes that change for every package. Variable data is necessary to have certain information – such as time of production – on every package that many companies require.**

## Recalls

In the event of a recall, digital technologies such as TTO allow users to more precisely isolate a product down to a certain time range, which can be as targeted as a range of minutes or seconds. Users of analog systems such as hot stamp would likely change the code after every shift, which could mean as much as eight hours of production that is considered 'bad' would need to be isolated. Such a broad time range would result in potentially scrapping or recalling a larger amount of product, even if the entire batch wasn't compromised. In addition to sustaining significant recall costs, a company may suffer damage to the brand due to negative publicity. Real-time, variable data can help pinpoint when a problem occurs to minimize the scope and impact of a recall.

The truth is that coding errors happen so often they are commonplace.



## Counterfeiting and diversion

**The challenges and importance of ensuring product integrity are magnified by the flood of counterfeit products and diversionary activity (unlawful distribution of a product) today. Though manufacturers understandably may not be willing to disclose the actual financial impact of counterfeiting and diversion, it is believed to be in the billions of dollars annually.**

As effective as a package's structure and graphic design are in demonstrating a brand's attributes, they provide limited protection from counterfeiting and diversion. The repetitive and commonplace nature of packaging and labeling make a product vulnerable to duplication and fraud, and also do not prevent unlawful distribution. As a result, manufacturers are being forced to add multiple layers of protection against these threats. These layers of protection have various goals in mind, the most important of which are verifying the authenticity of a product and tracing its pedigree from authorized start to end. Printers that provide variable data marking and coding can play a key role in providing those added layers of protection that help ensure the authenticity of a brand and reduce potential product liabilities. One common use of TTO for this need is printing dynamic 2D bar codes.



Increasingly, governing bodies have placed the responsibility to ensure product and supply chain integrity on manufacturers.

# Regulatory compliance

For some levels of regulatory compliance, static information may be all that is necessary. However, other regulations may require variable data printing capabilities in order for companies to be in compliance.



“Anecdotal evidence indicates that many retailers are asking or requiring their suppliers to pre-label products”

**Agricultural Marketing Service of the  
U.S. Department of Agriculture (USDA)**

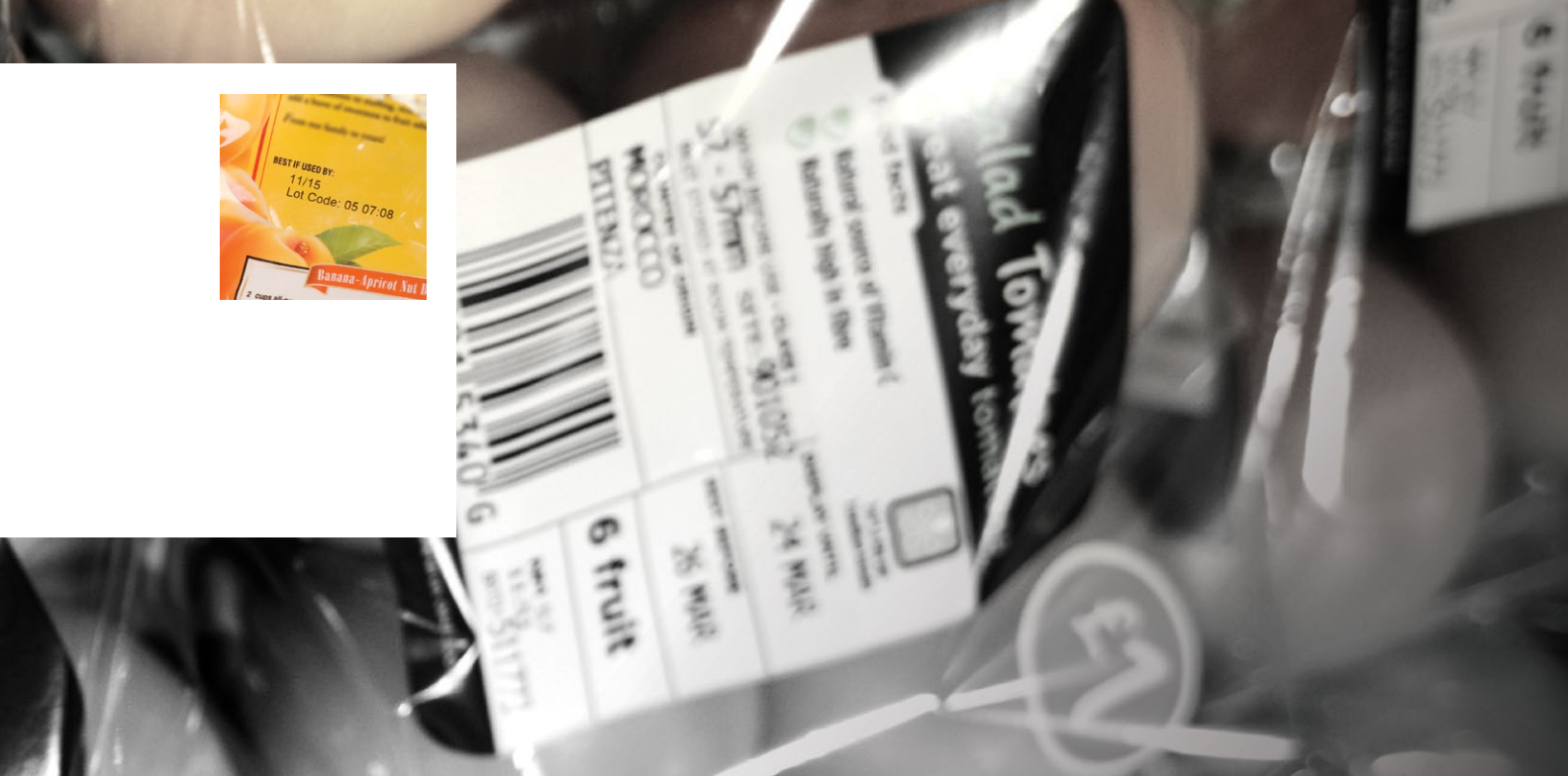
## Country of origin

The Country of Origin Labeling (COOL) law requires that perishable food sold in the United States be accompanied by information noting where it was produced. The law mandates that retailers make the information available to end consumers. However, COOL also may affect information that food manufacturers and co-packers mark or code on products or packaging –particularly in instances in which a retailer mandates pre-labeled products.

According to the Agricultural Marketing Service of the U.S. Department of Agriculture (USDA): “Anecdotal evidence indicates that many retailers are asking or requiring their suppliers to pre-label products”. This means that suppliers may be required by their retail customers to ensure individual products are labeled with country-of-origin information in a manner appropriate for retail.

In many instances, because the information is not being changed very often, a hot stamp printer should be sufficient to comply with COOL. However, it is important to determine the print area needed in order to add the COOL information. Typical hot stamp printers have a smaller standard print area (maximum 2 in. by 2 in.; usually ¾ in. x 1 ½ in.). Comparably, TTO process allows a larger print area for providing a greater amount of data. A typical TTO system in continuous mode has a print area of 2 in. by x 6 in., while a TTO system in intermittent mode provides a print area of 2 in. x 3 in.





## E-pedigree and serialization

**Regulatory compliance is a fact of life in most consumer product manufacturing segments. Compliance with legislation has forced manufacturers to gather information about their products electronically, culminating in an electronic pedigree (or e-pedigree). Concerns about counterfeiting and diverting also are driving the development of e-pedigree technology.**

For example, California's e-pedigree law (enacted by the California Department of Consumer Affairs Board of Pharmacy) states that for all prescription drugs, wholesalers and pharmacies must provide an electronic form containing information about each transaction in the supply chain, from manufacturer to the point the drug is distributed (wholesaler, repackager or pharmacy). Companies must have 50 percent compliance by 2015 and the remaining 50 percent compliance by 2016. An important part of this e-pedigree information is a unique identifier (serialization number) that is placed on the smallest saleable container. This unique code must be applied using a variable data printing technology, such as TTO.

In addition to the United States, many countries have their own regulations for product serialization and e-pedigree to protect consumers. Brazil, China and Korea are leading the way in defining and implementing e-pedigree-like requirements. Most of these regulations involve a symbology, like a unique bar code or 2D DataMatrix code, which cannot be printed with hot stamp or any static coding system.

## Food Safety Act

The U.S. Food and Drug Administration (FDA) Food Safety Modernization Act provides the FDA with more authority to mandate recalls of unsafe food. It also enhances the way the FDA tracks and traces domestic and imported foods for the purpose of controlling foodborne illness outbreaks. Variable data codes and package serialization will likely be a part of this regulation's implementation, requiring manufacturers to apply unique codes to products.

# Printer capabilities

When evaluating the differences between printing technologies, an important step is to determining current and future printing needs in a variety of areas.

## Packaging types

Does the printer need to be used on multiple production lines? If a printer will be used on different packaging lines that have a combination of hard and flexible materials (paperboard, plastic and films), a hot stamp printer may be a good solution. Although less than an ideal application, hot stamp printers can also be used to print on hard rubber or plastic parts.

A TTO system is intended for printing on flexible materials such as plastic and foil films or paper labels. For printing on more delicate film, such as low-density polyethylene (like shrink wrap), TTO works best. A hot stamp printer can melt through thinner materials causing product contamination because it delivers more heat over a larger area and is in contact with the film longer. A TTO printhead has small resistors that heat the print area precisely and with a fast on/off action, so it is not in contact with the substrate long enough to impact the package integrity.

## Substrate motion

Packaging lines may have a stop and go motion where the printing occurs when the substrate is stationary (intermittent printing) or they may flow continuously while the printing occurs (continuous printing). Hot stampers operate in an intermittent printing mode only. TTO systems have the ability to print in both intermittent and continuous modes.

## Quick changes

Code changes may be necessary for a variety of reasons. Some products have short runs, requiring lines to switch often. Also, product packages and industry demands experience periodic changes (such as ingredient or nutritional information) that dictate a change in the way they are marked. If quick changes between flexible packaging lines are a necessity, digitally-based TTO systems allow operators to make coding changes easily and quickly with minimal line disruption. A larger available print area also lets TTO users print more data on packages to meet requirements that may vary widely by product or client.

When making code changes, a TTO operator uses a digital interface (controller) to adjust the code or access pre-programmed codes. This process typically takes one to two minutes. Adding new graphics and logos to a TTO system can be completed almost instantly by uploading the images to the printer and positioning them appropriately on the package through print locations on the controller. In contrast, a hot stamp printer must have its type manually changed by an operator. To add new characters, logos or other marks to a hot stamp printer may require ordering new type that may need to be custom machined. This can take days for completion.

For further quality control during code changes, a TTO system can minimize operator error by restricting access to the code. A TTO system can block operators from making unauthorized changes to a code, preventing accidental mistakes due to incorrect date codes or other information. A hot stamp printer cannot provide such safeguards and relies on an operator to accurately place manual type during code changes.





## Print resolution

Print resolution can impact the readability of a code and become an extension of a product's brand. The ink layer on a hot stamp printer ribbon is thicker and has more colorant, delivering a darker, more opaque print. This can be particularly important when printing on darker backgrounds (green or black) with a lighter colored print such as yellow or white. However, hot stamp's thicker ink layer results in prints with blurrier edges, lower resolution and has a tendency to flake (small pieces of ink come off the ribbon backing or printed substrate). TTO provides sharper edges and a higher print quality over hot stamp printers. A TTO printhead has 12 thermal printing dots per millimeter to deliver a print resolution of 300 dots per inch.

## Networking

Networking printers can streamline printer set-up, help track production and provide central management of coding specifications for each product – even if a product changes production lines or is coded by different printers within the facility. Because TTO systems are digital, they can be networked; hot stamp printers do not have this functionality. By networking a group of TTO printers, messages can be sent directly to the printers from a central location. Apart from the convenience of managing job changes for all printers and monitoring their performance, it also supports efforts on code integrity by removing operator intervention.

Networking also facilitates convenience for line operators. For example, a company may require a simple two-line date and lot code but have different production lines with different coding technologies to suit the packaging used: one using a thermal transfer overprinter and one using continuous inkjet. The same product could be coded on any line, so the plant can utilize networking and message management software to ensure coding consistency, regardless of the technology used to print the information.

Similarly, there may be secondary or tertiary coding equipment on the same line (such as a print-and-apply labeler or a case coder), which is required to label or directly print information or a bar code on the case to match the product. The line operator would need only to call up the assigned product code on whichever product line he or she is working on, and the pre-installed message would be accessed from the network.

In this manner, the two-line date code would be sent to the primary coding equipment and the corresponding case code to the secondary equipment.

Packaging coding management (PCM) extends to integration of new digital marking and coding solutions within a production line when a network is already in place. New printer setup is faster and easier because the coding profiles for specific products are independent of printer type – as long as a new unit connects to the network, it can access all profiles. PCM is a seamless approach compared to redesigning hundreds of code formats for individual printers.

**A networked approach also is crucial in light of a packager's likely or potential future variable data printing applications – or in the case of a co-packager, changing customer requirements. For example, products that require date and lot codes today may require unique package identifiers in the future. Adding new data via message management and networking software is much easier because it can be done within the centralized database.**

## Conclusion

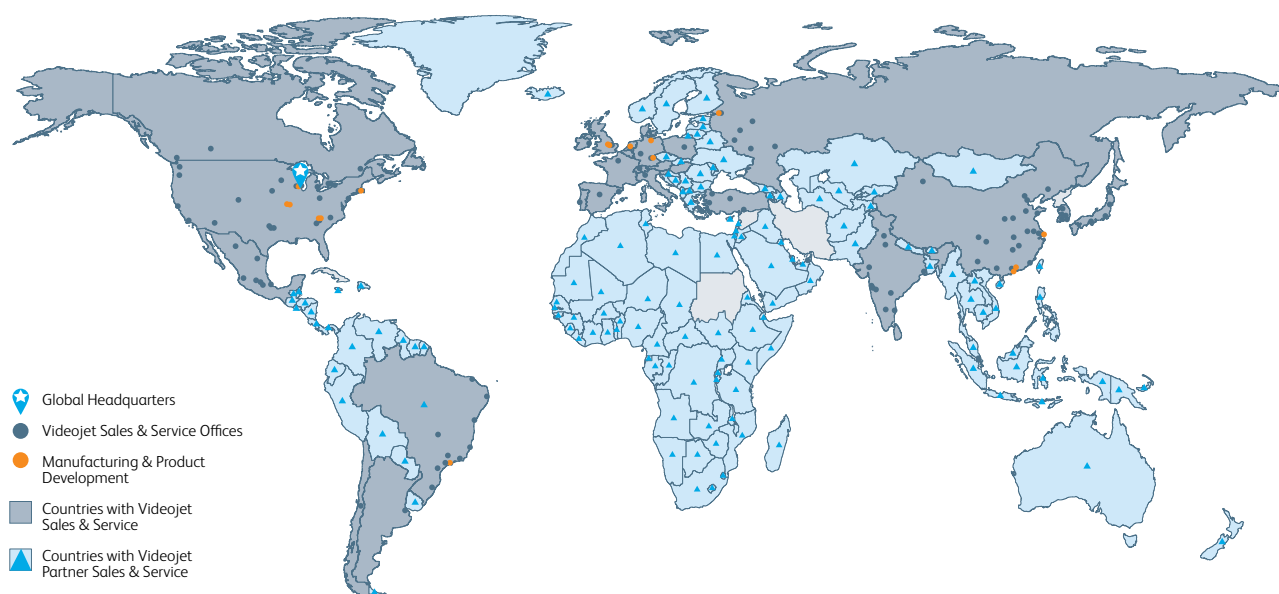
There are many things to consider when choosing a printer to put a code on flexible packaging. Although a hot stamp printer may have a lower initial cost, TTO systems are actually much less expensive to operate and can provide a short return on investment. Today's manufacturers and co-packers need to look at variable data printing as a way to stay in line with modern track and trace requirements, which ultimately protect a brand and its consumers. Long-time hot stamp users can realize immediate benefits by upgrading from static printing technology to TTO.

# Peace of mind comes as standard

Videojet Technologies is a world-leader in the product identification market, providing in-line printing, coding, and marking products, application specific fluids, and product life cycle services.

Our goal is to partner with our customers in the consumer packaged goods, pharmaceutical, and industrial goods industries to improve their productivity, to protect and grow their brands, and to stay ahead of industry trends and regulations. With our customer application experts and technology leadership in Continuous Inkjet (CIJ), Thermal Inkjet (TIJ), Laser Marking, Thermal Transfer Overprinting (TTO), case coding and labeling, and wide array printing, Videojet has more than 325,000 printers installed worldwide.

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