# Digital print for food contact – The corrugated challenge

*In this exclusive white paper for HP, Smithers Pira examines the challenges and market opportunities for food-safe printed packaging*


**September 2017**

# Introduction

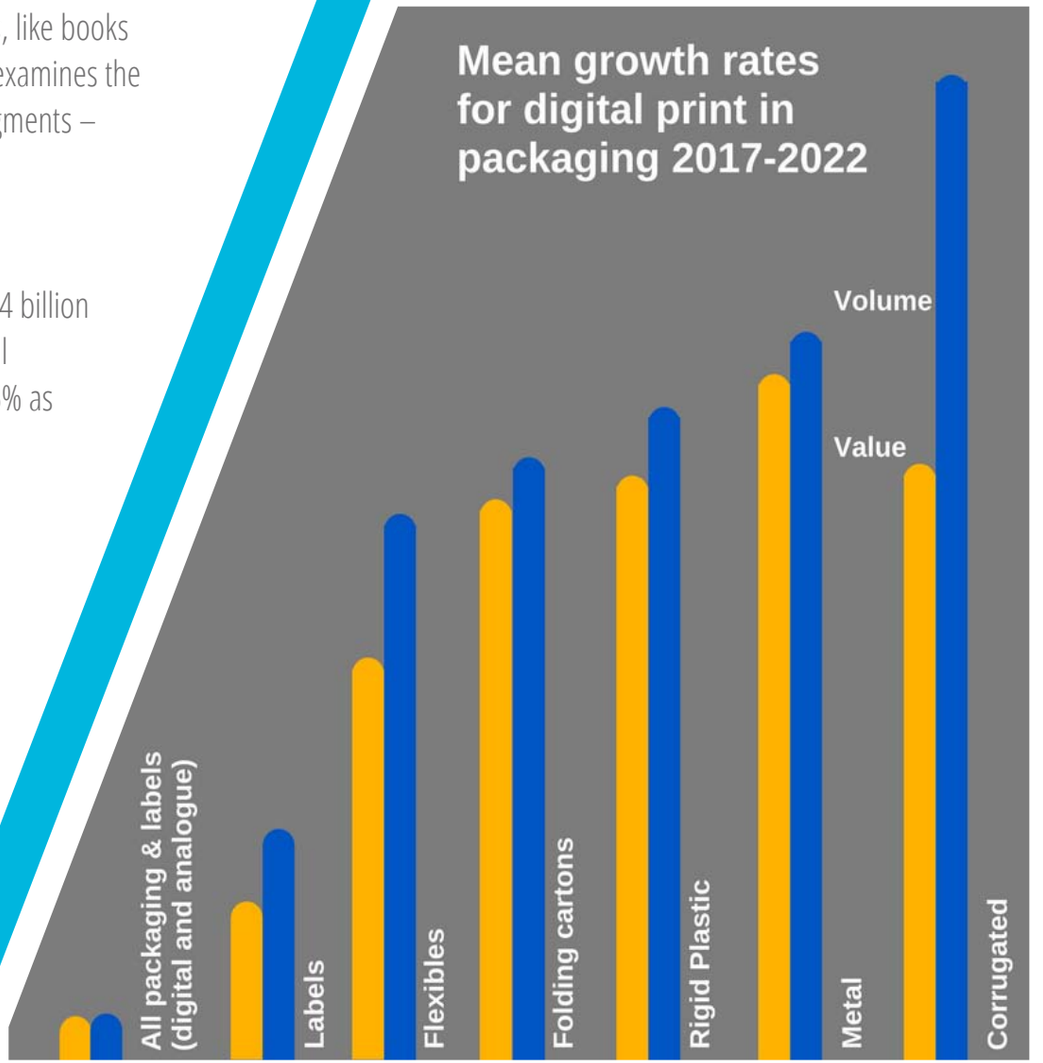
Packaging presents a compelling prospect for companies at all stages of the print supply chain. It will continue to demonstrate robust growth into the next decade, even as some more traditional products, like books and newspapers decline in real volumes. In this exclusive white paper for HP, Smithers Pira examines the challenges and market opportunities for food-safe digital print in one of its highest value segments – corrugated packaging.

# Print on packaging

Data from Smithers Pira show that the 2017 global packaging and label market is valued $394 billion out of a total $785 billion print market. Thus, printed packaging comprises just over half of all production print, up from 45% in 2012. By 2022, packaging's share is expected to grow to 56% as manufacturers introduce higher throughput machines and innovative technologies.

Within packaging print, the leading industry trend during this period will be the deeper penetration of digital systems– both inkjet and toner. This mirrors a wider trend in print for all end-use segments. Digital, and especially inkjet, is increasingly displacing established analogue processes as the unit cost of digital work falls and the average run length of work in key applications declines. The trend is especially pronounced in packaging.

A variety of new packaging-focused digital printing presses and integrated solutions were unveiled at drupa 2016. Across 2017-2022, volumes of digitally printed packaging will increase by 28.6% year-on-year as these systems complete beta tests and see their first commercial installations. For digital label work, the growth is less spectacular at 12.4%.




Source: Smithers Pira

# Food packaging

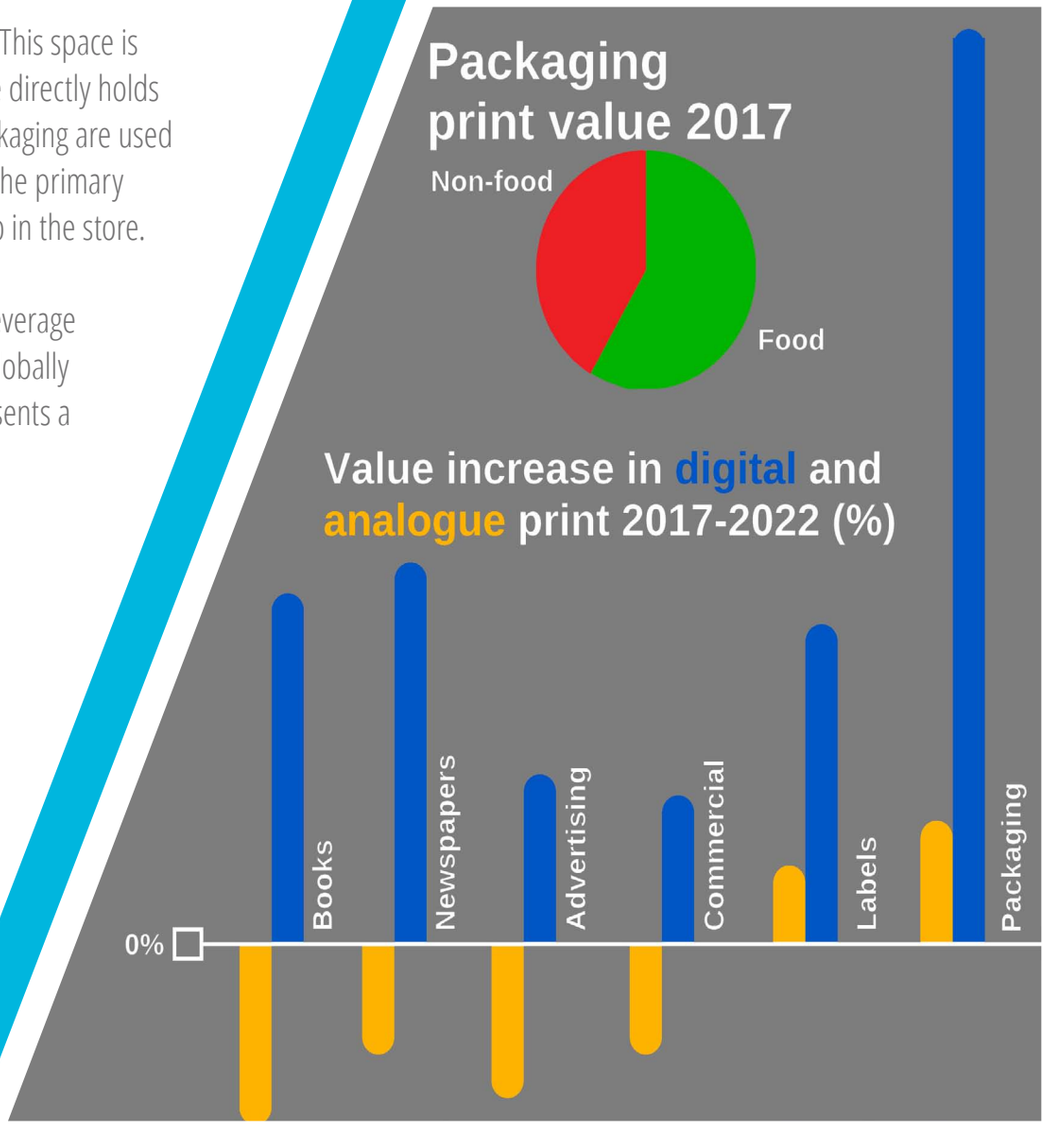
Within packaging, the food and beverage segment represents a huge array of applications. This space is comprised of primary, secondary and tertiary packaging. In primary packaging, the package directly holds and protects the packaged product on the grocery market shelf; secondary and tertiary packaging are used to protect goods during transit. Secondary packaging may be retained to hold and present the primary packaging on the shop floor, but tertiary packaging is discarded before the product is set up in the store.

Primary food packaging accounts for 30% of the world' packaging market by value, while beverage packaging represents an additional 11%. Print for food packaging is valued at $221 billion globally in 2017, and is 58.4% of total world value and 66% of total output volume. As such, it represents a major market opportunity for any relevant high-volume print technology.

This potential is mitigated by some unique challenges – specifically the need to ensure that no materials from the packaging or ink printed on its surface enter the food or drink contained therein and which could subsequently be consumed. This issue is referred to as migration.

A high-profile case of this occurred in 2005. Unreacted components of the photoinitiator ITX in the UV ink on the exterior of Tetra Pak milk cartons was found to be contaminating liquid baby milk products produced by Nestlé. The brand owner had to recall 30 million litres of products from supermarkets across Europe.

It is estimated that Nestle lost €1.6 million worth of products during the affair, as well as uncalculated damage to brand reputation for both it and Tetra Pak, especially at the scandal's epicentre in Italy.




Source: Smithers Pira

Thus, there is a direct onus from customers and regulators to demonstrate that any new print process is safe for food contact packaging applications. This can be challenging, partially because specific regulations are rare for printing inks in food contact packaging. Given the high priority, and in the absence of wider regulations, formulators and converters often use industry initiatives or national laws as *de facto* standards to demonstrate compliance, such as:

- The Swiss Ordinance on Printing Inks
- Nestlé's Guidance Note on Packaging Inks
- European trade association Eupia's Good Manufacturing Practice (GMP) for Printing Inks for Food Contact Materials.

Germany has also been working on its own law, which is now likely to be superseded by an EU Regulation on printing inks for food contact, with the first drafts due in mid-2018.

## Non-label substrates

The choice of packaging media or substrate directly affects the rate at which migration will happen. Certain materials like aluminium or glass allow no migration, except when used in very thin layers. For other materials – principally paperboard – migration is more of a problem. It can lead to converters needing to add other protective solutions like internal coatings or liner bags, which create a 'functional barrier' to migration and keep it below an accepted, very low level. Due to the cost implications of adding functional barriers to packaging, it is increasingly common for ink companies to market ink sets as low migration, even though no universal definition for low migration does or can exist.

Electrophotography (toner) and inkjet printing are already used widely in one packaging segment – labels. Migration is less of a concern in label formats as these are mostly affixed to the exterior of a package – like a glass jar or PET bottle – that is already demonstrated to resist migration, so a 'functional barrier' can be said to be in place. The challenge for digital now is to find an ink solution that can match the performance of existing analogue processes and give safety assurance where no such functional barrier naturally exists. Some solutions marketed as 'low migration' still presuppose the presence of a barrier of some type, such as plastic.

*Showing any new print process is safe for food contact applications can be difficult, because specific regulations for printing inks in food contact are rare*

## Customisation in packaging

From a cost perspective, digital is more expensive than most analogue processes, except at lower print runs. This is because the time and consumable use for making a digital press ready are relatively minor compared to that of an analogue press. The adoption of digital presses for more work is strengthened by a wider trend among print buyers to request shorter runs of work on a tighter turnaround. Significant business potential of digital printing is related to its ability to deliver variable data print and mass customisation as a value-adding option.

Coding and marking of barcodes is an established market; and a niche segment has developed for personalised labels with the receiver's name in gifting, such as with bottles of whiskey at Christmas. Mass-market appeal has been illustrated best via Coca-Cola and its 'Share a Coke' campaigns, engaging consumers by adding the 100 most common forenames to BOPP labels on its 500ml bottles. To ensure consistency for continent-wide campaigns Coca-Cola put together coalitions of printers using HP Indigo WS6600 digital presses and had a special toner set that matched its existing brand colouring formulated.

## New growth with new substrates

While world output on label substrates is set to increase at nearly 10% year-on-year across 2017-2022, annual growth rates of over 20% are forecast for other substrates:

- Corrugated board
- Folding cartons
- Flexible packaging
- Rigid plastics
- Metal.


Source: HP

Value growth figures are slightly less, largely due to the introduction of higher throughput machinery. This lowers the per unit cost of digital printing, which is allowing the new generation of machines to continually encroach on medium run length work previously produced on analogue presses.

In response, many print service providers are operating inkjet or toner presses in tandem with other printers and progressively transitioning jobs to the newer equipment. This trend is strengthened by the increasing availability of inline finishing systems for digital print systems.

## The corrugated challenge

Toner systems are not suited to printing on corrugated, as liner boards are typically too thick for these paper transport systems. A number of flatbed inkjet systems exist and have been used for some corrugated packaging and related formats – like point-of-sale displays.

Bobst has built a sheet-fed corrugated press using Kodak Prosper inkjet printheads, with an output of 200 metres per minute (m/min) and a maximum width of 1.3m. It has had two beta installations, but was absent from drupa 2016 and so far has no reported commercial sales – though Kodak and Bobst are said to be working on a reel-to-reel version.

Growth in corrugated digital print is dependent on a new generation of inkjet presses specifically designed for corrugated substrates. In early 2017, EFI announced the installation of its first Nozomi C18000 single-pass post-print press in testing at a printer in Spain, while Durst's Delta CP130 also began beta testing in 2017.


Source: HP

HP's PageWide Industrial Division is taking a lead with its 1.07m HP PageWide Press T400S and 2.8m HP PageWide Press T1100S selling into the corrugated pre-print sector. The PageWide T1100S, with throughput capacity of up to 30,000 square meters per hour, was developed in collaboration with KBA. Several PageWide T1100S installations in Europe and North America followed the first installation at UK corrugated converter DS Smith in 2015-2016. HP will enter the single-pass digital post-print space in 2018 with the commercial availability of the HP PageWide Press C500. HP's extensive portfolio gives converters the choice of different models and capabilities.

HP's PageWide presses benefit from its industrial field-proven thermal inkjet (TIJ) printhead technology the company has developed over three decades. With 1,200 nozzles per inch, these printheads deliver nozzle redundancy for quality and reliability. Dr. Nils Miller is HP's senior scientist responsible for ink development from environmental and food packaging compliance perspectives. He says: 'HP is well positioned to pull off the massive analogue-to-digital transformtion of corrugated packaging with its scalable thermal inkjet printhead technology. This TIJ architecture can be scaled up for other markets quite easily compared to other systems that use piezo inkjet technology. HP has the background to deliver on a large scale – [and] has been doing this for 30 years with high-speed office equipment and true water-based ink chemistry.

'From a cost perspective to the converter, another particular HP advantage is the ability to print on uncoated media while giving the attractive appearance of print on coated media.'

## Inks for paperboard

One of the key differentiators for printed packaging work is the ink used. In food contact applications there are four broad types available:

- Monomer-based UV curable (which includes the majority of low migration UV curing platforms)
- Water-based (which includes both 'genuinely water-based' and 'water-based UV curing' inks)
- Oil-based

Source: HP

- Solvent-based.

Solvent- and oil-based inks are not widely used in inkjet. Even in other processes – like litho and flexo – converters are switching away from these inks for safety and environmental reasons. Most of the new inkjet print systems targeting the segment are using monomer-based UV curing inks.

**HP is uniquely positioned to offer a genuinely water-based solution for inkjet printing of packaging, employing a chemistry type that is already familiar to flexo and gravure print technology users. HP's ink is accepted as inherently low migration as water is a common component of many foodstuffs. HP's 'true' water-based ink contrasts with the emerging water-based UV ink class, which retain some of risk of unreacted components migrating, especially from porous substrates.**

Critically, HP is able to leverage its existing water-based inkjet expertise to the packaging segment to allow high-speed printing with excellent quality. HP A30 and HP CV150 water-based inks offer some specific advantages for converters looking to transition into delivering digital print to corrugated.

Dr Nils Miller says: 'Packaging converters and brands already have experience with the traditional water-based inks used in flexographic printing. The 'true' water-based technology used in HP's PageWide packaging presses extends that reassuring experience into the digital space by avoiding the use of UV-reactive chemistries – monomers and photoinitiators – while delivering high productivity and maintaining print quality.'

## Water-based difference

To successfully compete with and displace existing flexo and offset litho processes, the print performance from any inkjet printing system must deliver comparable quality. This encompasses several key parameters, including drying time, print quality, and durability. For corrugated work, substrates must withstand aggressive finishing processes and repeated handling in transit conditions, making durability a primary concern.

*Customers want flexibility and media versatility, so the ability for a single press to print on coated and uncoated media with a single ink set helps distinguish HP*

*Dr Nils Miller, Senior Scientist, HP*

With proven durability and other performance attributes, HP is confident that its water-based technology gives unique advantages compared to monomer-based UV curing as its customers look to take on corrugated packaging jobs with a print quality comparable to offset.

The risk for packaging converters and food brands is that unreacted ink components - monomers and photoinitiators - can migrate readily through board packaging as happened with ITX in 2005. This is acceptable in some secondary applications, like die-cut shelf-ready boxes, where the corrugated board holds goods that are already wrapped and protected. Concerns over migration will continue to inhibit use in other food applications however, like boxes that hold loose fruit and vegetables or other primary packaging examples.

The UV-curing process should react all the photoinitiators and bind the monomers into a solid ink film. Achieving a very high degree of curing can be difficult on porous, absorbent substrates like paper liner board, since the ink will penetrate and be less accessible to the UV energy. This challenge becomes even more acute at the higher print speeds that high-volume packaging productivity requires, as the printed media spends less time under the UV curing unit.

Dr Miller adds: 'Fundamentally, if you survey all the technologies available, a true water-based ink solution is the best one for the digital inkjet platform. [Monomer] UV curing is limited for any application in packaging that is related to food. Water-based UV solutions are starting to enter the market. This may be a small step forward as it presumably reduces the monomer issue, but retains the challenge of finding a set of photoinitiators that combine high print speed and Swiss/Nestlé compliance.'

The alternative – interior barrier materials – represents a time and financial cost to the converter. While photoinitiators that can cure at high speed do exist, not all of these are fully qualified to the Nestlé Guidance Note and Swiss Ordinance, according to Miller. He adds that with HP's fully water-based inkjet system, 'we do not have a monomer issue and we do not have a photoinitiator issue. Instead, our 'true' water-based technology relies on highly engineered polymeric binder dispersions that provide the necessary durability – rather than putting the packaging converter in the role of 'polymer chemist' performing a conversion of monomers into a polymeric film.'


Source: HP

One developing application in digitally printed corrugated packaging is pizza boxes. Digital print enables take-away pizza shops to switch from generic delivery boxes to custom-printed designs with promotion codes and unique graphics – and in smaller quantities. Other new opportunities are emerging, including in food service ware as the industry moves away from less sustainable materials like expanded polystyrene (Styrofoam), and ecommerce packages with bespoke promotional messages and designs.

## Digital on corrugated

The market potential of variable data print for packaging is now being pursued by early adopters of digital corrugated printing presses. One such innovator is Ghelfi Ondaluti, a leading Italian corrugated packaging converter that purchased an HP PageWide T1100S press in Q3 2016. Ceradini, a leading Italian grower of kiwi fruits, used this potential in early 2017, commissioning two short-run designs of open produce boxes for Valentine's day using the platform's water-based food-compliant inks. The company was able to engage with potential customers for its premium-line fruit by showing the two box designs at the 2017 Fruit Logistica trade show in Berlin.

Italian produce supplier Melinda also utilised Ghelfi and its HP PageWide T1100S for an innovative consumer engagement strategy. The objective of Melinda's Dedicmela campaign was to aid Italian farmers affected by the earthquake that struck the country in 2016. Consumers were encouraged to send messages of support via Melinda's Facebook page. These messages were then printed on white corrugated Melinda-branded produce boxes, choosing from three different colours and fonts using HP's water-based inks – which according to HP's third-party testing are well suited to these types of primary corrugated packaging. The growers' consortium also donated €1 for every such message printed on the boxes.

Nearly 30,000 comments were received and printed on Melinda boxes in the first weeks of the campaign. As these boxes were directed to smaller retailers in areas close to those impacted by the earthquake, Melinda was able to forge a closer relationship with the communities most directly affected. It also received positive publicity in national television reports and social media channels.

Source: HP

## Equipment versatility

To allow packaging converters to optimise the returns from new digital machinery, mechanical and software innovations are important, especially those that enable them to diversify the type of work they take on.  With the HP PageWide T1100S Press' maximum throughput of 30,600m²/hour, converters need to optimise the volume of work that can be handled by such a high-productivity digital press. HP's Multi-Lane Print Architecture (MLPA) feature splits the 2.8m wide web into several print lanes that can simultaneously produce an array of different box designs. Especially useful for short-run customised jobs, the MLPA's complexity is managed by HP's SmartStream Production Elite Print Server and PrintOS workflow solutions.

Another demand driver for digitally printed packaging is shorter turnaround times between the buyer and converter. Web-to-print platforms are increasingly common, giving the brand more direct ordering capability. For the packaging converter, there are cost savings and supply chain efficiencies not evident when simply comparing the unit cost of digital and analogue print.

## Board substrates

As with ink and equipment suppliers, substrate suppliers are designing new board coatings to enable substrates to better receive digital printing inks. For example, Iggesund has added a new digital-optimising coating to its Invercote G board line for folding cartons. Tekra has done the same for its packaging film line.

On digital print solutions like the HP PageWide T400S or C500 Corrugated Press, HP Bonding Agent can be digitally applied to the selected areas to boost optical density and reduce strikethrough on the media. HP Bonding Agent and HP Priming Agent use the same 'true' water-based fluid approach as the HP A30 water-based inks employed on its T400S and T1100S presses, as well as HP CV150 water-based inks used on the HP PageWide C500.

Dr Miller says: 'Customers want flexibility and media versatility, so the ability for a single press to print on coated and uncoated media with a single ink set helps distinguish HP.'

*Fundamentally if you survey all the technologies available, a true water-based solution is the best one for the digital inkjet platform. UV curing is limited for food packaging*

*Dr Nils Miller, Senior Scientist, HP*

An ability to work on both uncoated and coated sheets and a wide range of different substrate weights is important as it allows digital to take more work from analogue technologies. Other advantages include the ability to 'lightweight' or downgrade the weight of board – from, for example, 380gsm to 180gsm – without compromising strength or rigidity. This in turn translates into materials and environmental savings.

## Conclusion

Digitally printed packaging presents a huge growth opportunity and primary food packaging is one of its key sub-segments. Food contact compliance is a vital consideration as high-profile recalls can damage brand value. Food brand owners and packaging converters must be assured that their package printing solution is safe for use with food. There is an ongoing onus on ink formulators, converters, print service providers and brands owner to collectively develop the best and safest solution for digital printing, both for corrugated board and other packaging substrates.

HP's water-based inks do not contain UV-reactive chemistries and can more easily avoid migration risks across a wide range of food-related packaging. This differentiating advantage, combined with its numerous PageWide thermal inkjet innovations has allowed HP to offer brands and converters compelling and trusted solutions for food-safe corrugated package printing.

Dr Miller concludes: 'HP's perspective is that a truly disruptive digital packaging solution needs to achieve more than compelling quality and productivity. It needs to also enable a wide range of food packaging applications if it is to allow seamless analogue to digital conversion in a hybrid environment.'


Source: HP