EFI™ WHITE PAPER SERIES

Direct digital UV imaging

for deep-draw thermoforming

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1. Introduction

When it comes to commercial development of decorated industrial and consumer products, the thermoforming market faces significant limitations in process efficiencies. As is so often the case today, decorating thermoformed plastic is accomplished primarily through post-forming decoration with decals, self-adhesive labels, air brushing, etc. Not only is this approach costly from a labour and waste perspective, but often also implies the use of custom pre-pigmented sheeting stock and the inventory management challenges that accompany it. Pre-forming decoration (applying graphics to sheets before forming) removes the time-consuming, manual steps required in traditional decoration processes.

More technically savvy formers have implemented pre-forming decoration using analogue screen printing inks, but that still has significant limitations. Now, with new advancements in ink chemistry, large-format digital inkjet printers can offer the image quality and time-saving benefits of pre-forming decoration while eliminating the full-colour imaging challenges that analogue screen printing presents.

Pre-forming decoration using screen printing has rightfully found a place in the thermoforming market because, compared to post-forming decoration, it can certainly save time, labour, and effort. But compared to other printing process, screen printing can still be time consuming and costly, and it can be very wasteful. Screen printing requires an extended makeready process, where sheets of expensive substrates, such as ABS, are printed as waste just to get inks to stable levels for saleable product. The more ink colours a decoration requires, the longer the makeready process.

One typical example is a pre-forming decoration process observed at a thermoforming facility. The company had at least €5,000 invested in this six-colour, 60x120 cm thermoformed screen print job before a usable print came off the company's screen print device. Not only were there numerous sheets of makeready waste, the company had a small crew of staff members spend a total of approximately 60 hours doing prep labour.

Screen printing jobs of this nature typically do not become profitable to produce until the up-front prep costs are amortised across a large quantity order, perhaps 500 or more pieces. Makeready waste, which is often 10% or more of the entire number of sheets printed, figures into this calculation as well.

SCREEN PRINTING'S LARGE UP-FRONT INVESTMENT COST (ESPECIALLY WITH MULTICOLOUR WORK) MAKES DIGITAL PRINTING AN ATTRACTIVE OPTION.

Thermoforming materials are not cheap compared to other substrates used for printing, and the higher the cost, the higher the run length needed to preserve profitability.

Screen printing's large up-front investment cost (especially with multicolour work) makes digital printing an attractive option. On the six-colour printing project mentioned above, for example, prep time could take as little as one to two man-hours using a digital inkjet printer. There is also little to no makeready waste with inkjet pre-forming decoration, as the printers do not need to run a large number of sheets before the inks and colours are stable.

On some larger, more expensive thermoforming projects the costs associated with makeready waste in full-colour screen printing would be difficult, if not impossible, to absorb. In cases like these, digital may be the only decoration option outside of manual methods.

2. Bringing digital printing to thermoforming

Inkjet printer manufacturers have talked about this type of advantage with screen printing firms for years, but mostly in relation to two-dimensional signage applications. Inkjet inks historically could not handle the heat and stress of the forming process.

Recent developments in inkjet ink chemistry have yielded the first stable, high-quality inkjet inks that can withstand thermoforming. EFI's VUTEk® GS-TF and EFI™ SuperDraw UV-curable inks withstand the thermoforming processes. These high-elongation inks enable deep-draw thermoforming with excellent adhesion and superb retention of hue and opacity. The EFI thermoforming inks are designed to stretch as much as the plastic on which it is printed, and can easily be implemented even in instances where the ink touches the mold.

The EFI H1625-SD printer with SuperDraw inks is available with four colours plus white standard. VUTEk GS-TF and SuperDraw inks are available for 2- and 3.2-metre VUTEk GS Pro series printers in eight colours and white.

UV-curable inks are already a popular choice in imaging applications because they are durable, adhere to a wide range of substrates, and are cured with UV lamps, therefore requiring no drying time.

With the EFI thermoforming inks, an initial cure from UV lamps installed on the printer changes the properties of the liquid ink film so it acts like a thermoplastic. At that point, it exhibits a glass-transition temperature in the range of all common thermoplastic materials and will stretch without smearing or swirling.

While the adhesion of the ink is high after the initial cure, it remains somewhat softer than traditional UV-curable inks used in other inkjet printing applications. However, as the printed part proceeds through the thermoforming process, the heat of thermoforming changes the ink so it has a hard, glossy surface with excellent adhesion and scratch resistance.

As a result of the changes made for these formulations, these inks withstand heat forming, cutting, and routing without cracking, chipping, or losing adhesion, with moisture resistance and a durable life resulting in long-lasting graphics. Additionally, the use of EFI's Armor UVT high-performance roll-enhancement coating helps protect decorated parts in more robust applications where greater abrasion resistance, fade resistance, and chemical resistance are needed. The Armor UVT coating offers three- to five-year weathering in direct outdoor environments, and is available in matte and gloss finishes.

EFI thermoforming inks' elongation capabilities are enhanced by their high opacity on a broad selection of materials, including PETG, acrylics, polycarbonates, polystyrenes, and ABS, plus derivatives and mixes. This makes it ideal for applications such as outdoor electrical signage, point-of-purchase displays, backlit vending/gaming panels, automotive/RV recreational parts, consumer products, packaging, and industrial product decoration.

The ink is used successfully in applications with 60 cm of draw, greater than 1,000% elongation, extremely high aspect ratios (<50:1), and very tight radii of curvature. The cartop carrier shown is one of the first pre-forming decorated parts made with the ink, and it is printed on 3 mm thick ABS, has more than 33 cm depth of draw with 30:1 aspect ratio in certain areas.

See how to produce thermoforming applications

Produce thermoforming applications extremely fast and efficiently with the EFI H1625-SD printer and EFI SuperDraw UV Inks.

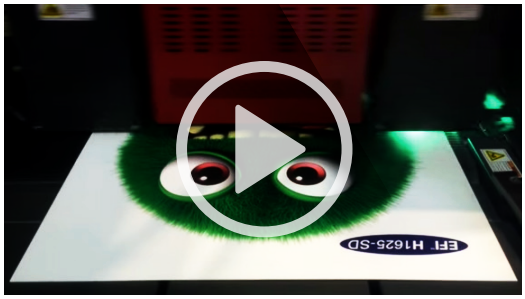
DIRECT-PRINT THERMOFORMING MADE EASY

1. Print direct to substrate
2. Heat the substrate
3. Form and create 3D images
4. SuperDraw inks stretch with your imagination

Other examples of pre-forming decorated objects produced with the ink to date include 3 mm thick ABS or Styrene with the image printed on the top surface, as well as 3 mm thick PETG, acrylic and polycarbonate, with the image printed on the bottom surface where the ink comes in direct contact with the mold. Those sample jobs had 33:1 aspect ratios and 80 mm radii of curvature.

Another sample produced with the ink incorporated drape forming on parts made of 152 mm styrene, showing excellent retention of hue and opacity at extreme percentages of elongation, greater than 1,000%.

Test users decorated bath enclosures and produced cowlings, shields, bumpers, and deflectors for cars, trucks, all-terrain vehicles, boats, snowmobiles, and trailers using the ink. There are many, many additional applications in development as thermoformers look to address unmet product decoration needs.



resources.efi.com/thermoforming

3. The key to short-run, on-demand signage

For thermoformers, signage companies, and other industrial manufacturers, the advent of a thermoformable inkjet ink presents financial advantages in colour and response time. As mentioned earlier, pre-forming decoration eliminates many time-consuming methods, including hand air brushing, a process that prohibits full-colour imaging and requires time-consuming masking steps. Inkjet technology makes pre-forming decoration a possibility for markets that have low-quantity requirements or specific customisation and just-in-time fulfillment needs.

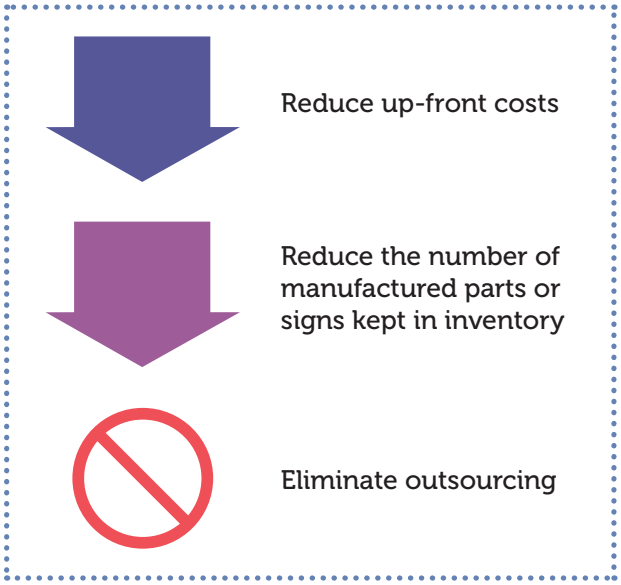
In today's signage market, many thermoformed signs, such as fast food or service station monument signs, use simpler, one- or two-colour logos because of the prohibitive cost of multiple- or process-colour decoration. This happens despite a great deal of evidence that full-colour imaging drives higher revenue and response across nearly any form of advertising.

The thermoformed signage market, as compared to most other forms of printing, is a low-volume market; orders might be for a single sign or for very small batches produced on demand.

A small, independent hotel, for example, might require a single, branded, thermoformed backlit panel with its name and logo for an entry sign or a vending machine in its lobby.

In these types of circumstances, analogue printing of thermoformed graphics is unprofitable and unaffordable for signage providers. Companies that go the digital print route for pre-decoration can economically offer run sizes of one.

Beyond that, companies that want to reduce their up-front costs, or eliminate outsourcing, can move to pre-forming inkjet decoration to reduce the number of manufactured parts or signs they keep in inventory. Everybody in the supply chain can therefore manage toward Just-In-Time inventory control, whether they need one copy this week or 100.



4. Creating new market opportunities

Initial reaction to the ink reflect the momentum possible to develop new markets in thermoformed graphics.

EFI's introduction of thermoformable UV-curable inks, and the machines in which to use them, offers printers new opportunities for bringing digital printing's strengths to a broad range of innovative applications. This means that printers can offer customers high-impact, short-run, versioned, and customised imagery with an added dimension that appeals to the increased desire for personalised products.

Businesses that use thermoformed parts but currently avoid product decoration altogether can also consider decoration as part of a personalisation, branding, or advertising strategy. A manufacturer of hunting blinds, decoys, calving huts, and portable structures saw a new opportunity in its low-volume business, using pre-forming inkjet decoration to create structures that can feature a dairy farm's logo, trademark, brand name or some other decoration.

This is one of the more promising scenarios, as it shows how the ink can not only replace costlier options, but also grow the decoration market.

Advancements in thermoforming ink and pre-decorating systems offer, at a minimum, cost savings and business-model advantages similar to those experienced by the portion of EFI's traditional commercial graphics customer base that has converted from screen to digital printing. However, for some, the savings will be even greater with the elimination of extremely labour-intensive methods, such as post-process hand airbrushing, and the ability to profitably print short runs and on-demand jobs.

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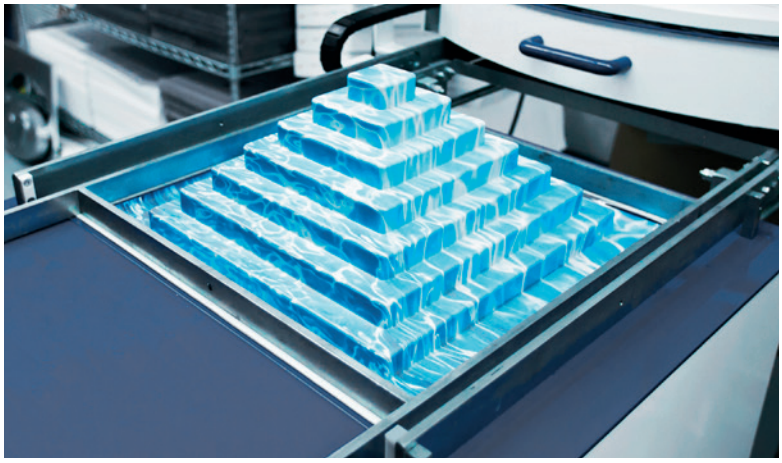

THERMOFORMING SIGNAGE DECORATION WITH FEWER PROCESS STEPS

- Ability to image direct to substrate prior to forming eliminates screen printing setup costs, or hand-painting and vinyl-lettering process steps.
- Superior elongation characteristics support deep-draw thermoforming while maintaining opacity on various plastics, including PETG, acrylic, polycarbonate, polystyrene, and PVC.
- Inks are developed to withstand heat forming and cutting without cracking, chipping, or loss of adhesion.
- Water and moisture resistance enable durable, lasting images.

Watch how Jones Sign evolved their signage opportunities with thermoforming

John Mortensen, Jones Sign's owner and president, discusses how the addition of direct to formable substrate printing capability with the EFI VUTEk GS3250x Pro printer and thermoforming inks will help them go after national accounts with formed face-sign programmes, and how it will drive higher margins.

resources.efi.com/JonesSign

EFI fuels success.

We develop breakthrough technologies for the manufacturing of signage, packaging, textiles, ceramic tiles, and personalised documents, with a wide range of printers, inks, digital front ends, and a comprehensive business and production workflow suite that transforms and streamlines the entire production process, increasing your competitiveness and boosting productivity. Visit www.efi.com or call 0808 101 3484 (UK only) or +44 (0)1246 298000 for more information.

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