IN-MOLD LABELING AND IN-MOLD DECORATING
STRENGTHS, WEAKNESSES AND LATEST INNOVATIONS
In-mold labeling (IML) was first used in the mid 1970’s as an alternative to decals and pressure sensitive labels. Early adopters quickly realized the benefits of in-mold labeling extend across multiple areas of the business, from enhanced design options and message durability to manufacturing efficiency and improved supply chain management. In-mold technology enabled a significant shift in the labeling and decoration of plastic products. Because parts were now removed from the injection mold fully decorated, manufacturers eliminated additional costly and time consuming post process decoration. Not only did this technology remove the necessity for a separate process, but it allowed manufacturers to move this entire process to their injection molder.

Although IML has become prolific in some industries, certain limitations have prevented some manufacturers from deploying this process. Recent advancements have lifted most of the limitations and created new opportunity for these manufacturers. In-mold technology has advanced significantly since its infancy. Current innovations in three-dimensional (3-D) in-mold labeling have expanded capabilities and opened in-mold decoration to new product types, allowing the benefits of cost savings and manufacturing efficiencies across nearly all industries. This now provides manufacturers endless options to replace metal forms, painting, dipped coatings, pad printing, and other post production decorative techniques with a durable, high quality, single step label that creates a fully decorated resin part right in the mold.

Outlined in the following is a synopsis of in-mold technology as compared to other decorative techniques. The benefits and considerations of various decoration options are defined to provide a complete view of when in-mold technology should and should not be considered from the decorative perspective.

**Definition**

In-mold labeling (IML) or in-mold decorating (IMD) is a process of decorating or labeling injection molded plastic parts or components during the plastic injection molding cycle. The label becomes an integral part of the final product, creating a fully decorated item at press.

In this process, a pre-printed label or decorated film is inserted in the open plastic injection mold and held in place via vacuum ports, electrostatic charge, or other method. When the mold is closed, plastic resin is injected into the mold, encapsulating the label permanently within the finished part.
In-Mold Labeling vs. In-Mold Decorating

While IML and IMD are often used interchangeably, the industry draws a very specific distinction between the two:

IML is most commonly used on disposable consumer packaging on products with a short life span, such as food containers, cosmetic and personal care containers and household product containers. It is employed in high speed, thin walled, multi-cavity injection mold machines. The labels are usually printed on polypropylene foils only a few tenths of a millimeter thick. Life span of the product is measured in months, not years, and the cost of the labels is low.

IMD is most commonly used on durable products with long life spans, such as appliances, toys, medical devices, automotive components, lawn and garden equipment and other durables. It is employed on thick walled, lower cavity injection mold machines. The label material varies as does the thickness in order to meet the durability requirements. Life span of these products is measured in years, not months and the cost of the label is medium. These labels enhance the product aesthetically, communicate important safety information and represent the brand.

Strengths

Combining the decoration process with the molding process adds durability, decreases manufacturing costs and creates design flexibility.

**DURABLE** – graphics are impossible to remove without destroying the plastic part and will remain vibrant for the life of the part. Options are available for enhanced durability in harsh environments and chemical resistance.

**COST EFFECTIVE** – eliminates post-molding labeling, handling and storage. It reduces WIP inventory, and the additional time required for post-production decoration, on-site or off-site.

**FLEXIBLE DESIGN** – available in a wide range of colors, effects, textures and graphic options and can replicate even the most challenging looks like stainless steel, wood grains and carbon fiber.
Limitations/Considerations

IMD requires proper mold design and construction for accurate placement and reliability, and often employs robotic automation as part of the process for increased speed and accuracy. This involves up-front investments that are typically repayed over the life of the product.

Traditional IML/IMD is best suited on flat surfaces with very low depth of draw. Limitations on 3-D applications include:

- Labels fold and crease
- Gate wash
- Distortion of image/windows
- Inks crack
- Very shallow depth of draw
- Must match film to resin
- Not compatible with appliance resins (poor adhesion)

While IML/IMD is a high quality, efficient, durable and cost effective form of labeling plastic, alternative methods are employed to compensate for the above mentioned limitations. Traditional decorative methods also create a quality product, but each comes with limitations and costs of their own. The following outlines traditional methods of decoration including their pros and cons.

Traditional Alternatives

**METAL FORMS** - thin, formed metal sheets placed as veneers over plastic, typically used to enhance the product aesthetically.

**Pros**
- Creates real stainless steel or other metal surface, look and feel
- Increased customer perceived value
- Increased retail price

**Cons**
- High cost
- Low durability

**PAINTING AND DIPPED COATINGS** - mainly used for coating of metals, such as household appliances, aluminum extrusions, drum hardware, and automobile and bicycle parts. Ideal for flat or cylindrical substrates.

**Pros**
- Very stable decorative and protective coating
- Competitive cost

**Cons**
- Requires complex process that is slow
- Durability can be a challenge

As printed items are stretched to fit the shape of 3 dimensional forms, the image is stretched, distorting the look of the original image. In many cases, the decorative element is also stretched to destroy the original look.
HYDROGRAPHIC DIPPING - the method of applying printed designs to three-dimensional surfaces on metal, plastic, glass, hard woods and other materials. In this process, a printed film is placed in water and a chemical activator is used to dissolve the film into a liquid and activate a bonding agent. The substrate is pre-treated with a base coat and then lowered into the water, through the floating ink layer, which wraps around and adheres to the substrate. A top coat is applied to enhance durability.

This process is used to decorate large products like entire all-terrain vehicles, car dashboards, small items like bike helmets or other automotive trim. Films can be applied to all types of substrates including plastic, fiberglass, wood, ceramics and metal.

Pros
- 360° coverage
- Image quality
- Substrate flexibility: plastic, fiberglass, wood, ceramics, metal
- Less expensive than powder coating

Cons
- High total cost with shipping and inventory
- Difficult to cover deep texture
- No variable imaging
- Not as durable as powder coating
- Low abrasion and chemical resistance

DECALS - a printed plastic, cloth, paper or ceramic substrate that is transferred to another surface upon contact, usually with the aid of heat or water. Decals are commonly used on plastics as a form of decoration and personalization. Government agencies often use decals on vehicles for identification.

Pros
- High quality graphics
- Large array of materials and looks

Cons
- Lack of durability
- Adhesive failure
**PAD PRINTING** - transfers a 2-D image onto a 3-D object. Through an indirect offset printing process, depressions are etched into a flat plate or printing block, and then filled with ink. The use of a silicone pad enables it to pick the image up from a flat plane and transfer it to a variety of surfaces, such as flat, cylindrical, spherical, compound angles, textures, concave or convex surfaces. Pad printing is used on difficult to print on products in many industries including medical, automotive, promotional, apparel, appliance, sports equipment and toys.

Pros
- Cost effective
- Flexible
- Reliable
- Good for irregular shapes

Cons
- Durability

**HEAT TRANSFER AND DIGITAL HEAT TRANSFER** - uses heat to transfer an image from wax to an object. Thermal-based printing methods work with pre-printed images on a single wax sheet or produce printed-on-the-fly images made by layering wax dye onto an object.

Pros
- High-quality, colorful prints of photo-realistic images
- Durable

Cons
- Does not transfer on 3-D objects

**HOT STAMPING** - Hot stamping is a dry printing method of lithography in which predried ink or foils are transferred to a surface at high temperatures. In a hot stamping machine, a die is mounted and heated, with the product to be stamped beneath it. A metallized or painted roll-leaf carrier is inserted between the two, and the die presses down through it. The dry paint or foil used is impressed into the surface of the product.

Pros
- Offers a variety of bright films that give a metalized look

Cons
- More costly than traditional printing methods

**PRESSURE SENSITIVE LABELS** - are made of a face stock and a liner. Adhesive is applied on the back of the face stock and is married to a silicone treated liner. This allows the label to be removed from the liner and applied to the substrate. Pressure sensitive labels can form permanent or temporary bonds, allowing the label to be removed after months or years without residue. These labels are an excellent choice for almost any product, and can be applied to plastic, metal, wood and many other hard surfaces.

Pros
- Great versatility – can be applied to most substrates
- Low cost
- High visuals

Cons
- Durability
- Ideal application is on flat surfaces
A New Dimension for IML/IMD: 3-D

The recent introduction of 3-D IML/IMD has created new design possibilities by enabling the use of high quality visuals across surfaces, regardless of texture, shape or dimension. Advancements in film technology enhance the formability of these labels, increase the depth of draw, dramatically increase durability, and prevent image distortion across dimensional edges. This truly revolutionary product can change the way products appear more than any decoration technique introduced in the past 20 years.

Because 3-D parts have multiple angles and textures with varying depths and surface angles, it is critical that any new technology meet these application requirements. 3-D IML/IMD not only meets these requirements but outperforms existing technologies in most instances. Highly curved surfaces, textured surfaces, and deep cavities are easily achievable with 3-D IML. Thermoformed products can achieve depths of draw of several inches, and tight radius and sharp curves are achievable with the correct substrate selection. Nearly any shape or size can now be considered for this technology, opening doors for design and engineering to leverage IML/IMD for any product.

The advancement of films that has enabled 3-D applications of in-mold technology has also significantly increased the durability and longevity of these labels. With a life span increase of more than tenfold over traditional IML, these labels are now even more suited for communicating brand and safety messages on durable goods with long life spans in harsh outdoor applications and even chemically abrasive environments.

Image distortion, especially on curved surfaces and around corners has long perplexed IML manufacturers. However, advancements in image design and printing technology have solved this problem. Skilled digital design combined with the latest in proprietary printing inks and equipment have finally overcome this long standing obstacle to create crisp, clear visuals that don’t distort around curves. Furthermore, the look of brushed metals, chromes, wood grains, paints and coatings, carbon fiber and nearly any natural or synthetic finish can now be achieved in any shape with 3-D IMD. These proprietary inks and decorative laminates create stunning visuals with hundreds of new options for designers.

These new capabilities eliminate the previous limitations of IML/IMD and enable manufacturers to explore the cost and operational benefits of IML/IMD on their products.
Decoration Option Comparison

Below is a comparison of the previous page’s discussed decoration methods and how they rank on cost, cycle time, durability, image quality, formability and variable printing.

<table>
<thead>
<tr>
<th>Decoration Option</th>
<th>Total Cost</th>
<th>Decorating Time</th>
<th>Durability</th>
<th>Image Quality</th>
<th>3D Shapes</th>
<th>Variable Printing</th>
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Summary

IML/IMD provide greater decorating options than most other labeling and decorating methods. Until recently, 3-D products were unable to benefit from the enhanced durability, lower manufacturing costs and elimination of post-process decorating. Innovations in film and ink technology have opened IML/IMD to these products and manufacturing methods. With increased depths of draw, increased formability and no image distortion, manufacturers should reevaluate using IML/IMD on injection molded components.

3-D IML adding decoration to complex shapes.
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