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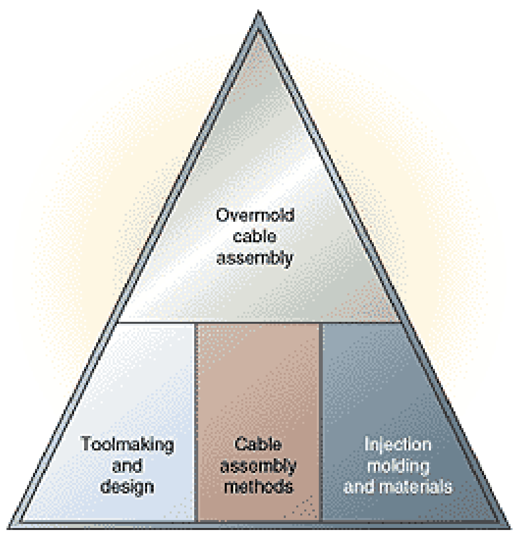
# Overmold Tooling Design

By Steve Burk

In overmold tooling design, it is important to integrate the cable assembly process, tooling design and injection molding process.




Overmold tooling is classified as insert molding. To help identify the difference in the two types of molding, think of injection molding as discrete components molded within a closed mold and insert molding as molding around an item inserted into the mold. During the insert molding process, the goal is to completely fill the mold cavity so that the cosmetic and functional requirements of the finished part are met, but at the same time not cause any uncontrolled molding material to exit the cavity and cause damage to the connector or cable inserted into the mold. It becomes a race to inject molding material into the cavity fast enough so it does not cool and cause restriction and then stop it before it flashes (escapes) at the connector or cable openings in the mold.

The key to overmold tooling is not just the mold tool that achieves the desired shape, but the integration of proper cable preparation and connector termination to provide a finished part that meets the quality and cost requirements. If the approach to the design is fragmented, in other words designed to satisfy the electrical requirements without regard for the mechanical requirements of the overmolding process, the finished part typically will be a problem.

Two basic types of injection molding machines are used in the overmolding industry — horizontal injection and vertical injection. Each machine type requires a different mold design and may affect the achieved output of the machine.

## Overmold Tooling System

What does the overmold tooling system look like and what are its components (see Figure 1)?

**1.** The mold base is the mounting unit attached to the molding machine plattens that holds the mold. There are many options in mold base designs. Universal multi-unit dye (MUD) bases provide off-the-shelf solutions to mold makers, including mold inserts for machining cavity and mold sections. Because these MUD bases typically add cost to the overall tooling system, many companies in the industry design their own custom configurations that allow for a wider range of mold sizes that can accommodate a range of molds at a lower cost.

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In vertical injection molding ma-chines, the sprue bushing is where the injection unit lines up against the mold and allows the molding material to flow from the injection unit into the cavity. The bushing should be made out of hardened tool steel and should be replaceable because it can be subjected to millions of cycles.


*Figure 1. An overmold tooling system.*

**2.** The "runner" is how the molding material is "funneled" through the molds to get to the different cavities. The runners connect the cavities together. Cold slugs or "runoffs" are essential to good cosmetics and reduced scrap rates as they allow material to flow without excess restriction caused by material cooling off within a runner and causing restriction which, in turn, causes material to be injected at higher pressures.

**3.** The loader bar is a section of the mold usually in one end of the cavity that is lifted up either by hand or the machine to allow the operator to insert a connector or terminated leads into it. Then, the bar is retracted back into place and a new part is ready to be molded.

**4.** The cavity is where the components are molded. Everything in a cavity is important because it affects the way a finished part will look: its shape, surface finish and size. Cavities can be aluminum or steel, and be polished, textured or plated.

**5.** A wire shut-off, or "pinch-off," is the section of the mold that pinches off on what is exiting the mold (typically wires) so that the molding material does not cause material to flash outside of the cavity. The fit and design of the shut-off are important. It must be tight enough to not allow the material to flow out of the cavity, but not so tight that it damages what it is shutting off. Shut-offs should be removable so that they can be interchanged with various sizes to accommodate varying cable diameters.

**6.** Knockouts are rods or pins that come up through the cavity or loader bar sections to eject or push out the finished parts after they have been molded. Knockouts usually leave residual impressions in plastic parts and are used only if required.

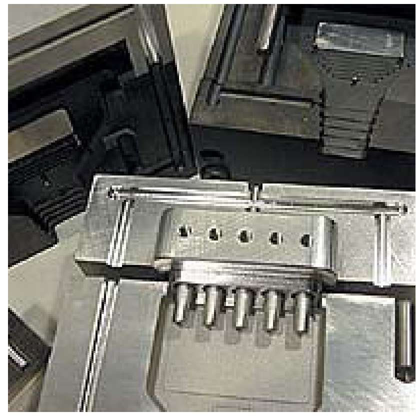
### Overmold Tooling Basics

Overmolding cable assemblies deals with a range of connector and cable types. Integral to good overmolding practice is the mechanical structure of the finished part. The elements of molding material requirements, such as durometer and flow characteristics, and the connector termination types play into whether an internal premold is required.

When determining overmold configuration, the variables begin with molding machine availability and the number of production shifts. The next consideration is the combination of how fast the part can be loaded into a mold, and what the approximate cycle time will be. Only then can the optimum number of cavities be determined. Often, mold makers want to maximize the number of cavities they can fit into a given mold base design without regard for loading time. If the machine is standing idle waiting for the operator to load the parts, optimum machine utilization is not achieved. In low-volume production runs, this is a cost-effective alternative to higher tooling costs. In high-volume situations, it causes a bottleneck in production.

Soft tooling is typically aluminum and, depending on the type of connector being overmolded, can last between 25,000 and 50,000 cycles if properly maintained. Hardened steel tooling costs approximately 30 to 40 percent more, and usually lasts 1,000,000 or more cycles. Advantages to aluminum tooling are shorter lead times and lower repair costs. Steel tooling, on the other hand, is less susceptible to damage but typically has longer fabrication lead times.

The premold is the inner mold shot, usually not seen in the finished part. The premold is mostly used for encapsulating the components to add mechanical strength to the finished part and provide shut-off points for the overmold. Often, companies that try to overmold parts with just a single overmold and no premold cause excessive cosmetic blemishes and high rejection rates. Typically, premolds can be molded with fan gates or bleed-off gates to minimize pressure and permit the overmolding of more sensitive parts without damage or flash. Generally, most of the structural integrity of an overmolded part comes though the design of the premold.



*Examples of typical overmolds.*

Overmolds are the final, outer mold and provide the final shape and shut-off around the connector and cable. The design complexities involved in the overmold are usually cosmetic and clean shut-off around the external components. A key element is even and consistent wall thickness of the overmold.

Materials used in overmolds are essential to the overall design. Overall wall thickness of the molded components combined with material type and shrinkage factors may affect finished part performance. Standard premolds consist of polypropylenes or polyvinyl chloride (PVC) materials while overmold materials may range from PVC to engineered plastics such as thermoplastic elastomers (TPE). Whenever possible, the design should incorporate material and component selection concurrently to provide the best possible combination.

### Overmold Tooling Design

The most common problems in overmolded cable assemblies center around overmolding approaches that limit the molding and assembly process parameters such that producing an acceptable range of parts is difficult. This is where the approach to overmold tooling design comes together. It is important to integrate the cable assembly process, tooling design and injection molding process. Too often, these functions are segregated and the end result is parts that do not work. The design of overmold tooling that facilitates interchangeable sections, and therefore modular molds, is often a great help in faster response to molding issues and lower tooling costs overall.

The familiar cry of "the molds don't work" often is the result of incomplete design of the overmold tooling relative to the cable assembly process, and utilizing a customer design that combines components, materials and processes that are inherently incompatible. Just as successful cable assemblies begin with good crimps, successful overmolded parts start with good mechanical stability between the components being molded. Once there is mechanical stability, the opportunity to focus on achieving optimum output from the design can be developed. Here, the combination of cavity design and part loading helps to determine the right configuration. Develop a multifaceted design team with a working knowledge of cable assembly and termination, overmold tooling design and injection molding processes. Approach the tooling equation from a less is better approach, and look at the total cost, including tooling, projected over the life of the part.

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### SPEC SHEET

**End Applications:**
Overmolded cable assemblies

**Related Products:**
Connectors, cables, cable assemblies

**Main Point:**
The familiar cry of "the molds don't work" often is the result of incomplete design of the overmold tooling relative to the cable assembly process, and utilizing a design that combines components, materials and processes that are inherently incompatible. Integral to good overmolding practice is the mechanical structure of the finished part.

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