Paint Brush Handle

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March 12, 2003

Society of Plastics Engineers Blow Molding Division
2003 Student Design Competition
Recycled Paintbrush Handle

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I. Introduction

This detachable and reusable paintbrush handle is a great improvement over current designs. This product features a blow molded handed design which offers substantial material savings, detachable bristles for easy cleaning and extended product life, and the substitution of recycled materials where currently virgin materials are used.

Blow molding the handle will result in material savings and improved shape compared to currently produced handles. Current paintbrush handles tend to be made from virgin wood, chip wood (using adhesives) or solid plastic. By substituting these with a hollow handle made of blow molded high-density polyethylene, there will be at least a 50% reduction in the amount of material needed to manufacture the part. Blow molding also allows greater freedom to create an ergonomic shape that is aesthetically pleasing.

The paintbrush disassembles into two major parts, the handle, which is described here, and the detachable bristle assembly. The bristle assembly simply slips on to the handle with a snap-fit and is released by depressing the buttons on either side of the assembly. This allows for easy cleaning and replacement of the bristles when they are damaged or worn. It also means that the handle can be recycled easily at the end of its lengthened product life.

The paintbrush handle is made of high-density polyethylene. This material was chosen due to its physical properties, wide availability, ease of blow molding and price. HDPE is resistant to the solvents and other chemicals commonly found in paints and paint thinners.

The blow molded paintbrush handle is an improvement on current brush design. This design reduces material usage, cost, and environmental impact with a product that has improved performance and aesthetics.

II. Application of Blow Molding

Blow molding is the perfect method to manufacture this paintbrush handle. Because this is a simple product, there is no need to produce the part in two pieces, so this part can be manufactured using a closed mold. Since it is primarily a hollow part, injection molding would not be appropriate and rotational molding is too labor intensive and has too long of a cycle time for this inexpensive and large quantity part. Extrusion blow-molding is the most appropriate manufacturing method because it allows the hanging hole to be formed and there is no need for precise threads or other details that could be provided from injection blow-molding. Manufacturing the paintbrush handle using extrusion blow-molding the part means that there will be variation in wall thickness, but in this case the walls will be thickest at the narrowest part of the handle, reinforcing one of the possible weak spots. Blow molding also provides a good finish for our paintbrush handle. Our material choice, high-density polyethylene, is well suited for blow-molding. In 1990 HDPE comprised about 69% of all blow molded materials (Plastic Blow Molding Handbook, ed. Lee; 1990. Page 22.)
III. Design Details

A. Critical Design Parameters

The critical parameters of this design are ergonomic shape, resistance to paint and related solvents, recycled material content, and a snap-fit assembly mechanism that assembles with purchased paintbrush heads.

B. Material Specification

The optimum material for this product is 25%-50% recycled content HDPE Polyethylene. This material is tough, easy to process and has excellent solvent resistance due to its semi-crystalline molecular structure. It is also substantially cheaper than virgin resin, and offers significantly reduced environmental impact based on the fact that it is widely recycled/recyclable.

According to *Applied Engineering Tools for Recycling*, recycled HDPE is a natural fit for blow molding. “This recycled resin is often blow-molded...in non-food applications, at about an average weight content of 25%.” The report also says that “performance requirements may preclude higher recycled content.” However, since the performance requirements of a paintbrush handle are relatively low (at least in service), our hope is that the percentage of recycled content could be more than 25 percent. As a very rough guideline, maximum values for injection molding are listed at 50%.

C. Design for Manufacturability

i. Wall thickness

An average part thickness of .065” was selected based on guidelines published in the *Plastic Blow Molding Handbook*.

Parison thickness

The parison thickness was determined based on an equation published in the same source.

\[
\text{Average part thickness} = \left( \frac{\text{parison surface area}}{\text{part surface area}} \right) \times \left( \frac{\text{parison thickness}}{\text{parison thickness}} \right)
\]

Given an average part thickness of .065,” a part surface area of 17in², and a parison surface area of 8.639in², the resulting parison thickness is .1279 inches.

ii. Draft

No draft angle is necessary since the part has extremely generous radii on all sides.

iv. Shrinkage

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The mold should be created with a standard allowance of 1.5-3% shrinkage for HDPE (Lee, page 438). Of particular importance is the head end of the handle, where the upper tolerance dimensions for the outside of the snap fit assembly must be below the minimum tolerance dimensions for the inside of the purchased head assembly. (See design drawings for details).

v. Blow ratio
Based on an average mold diameter of 1.2 inches and an average parison diameter of .5 inches, the blow ratio was calculated at 1.2 in. / 0.5 in. = 2.4.

vi. Texture
The handle surface texture is intended to be as smooth as possible to facilitate easy mold release and paint removal when the part is in service, but the mold cavity will have to be slightly roughened because of the use of polyethylene.

D. Cost Analysis
The paintbrush assembly consists of two parts, a handle and a head (which contains the bristles). Our proposal is that the handle would be the only part of the design manufactured from scratch. The bristle assembly would be the same as standard 1.5” paintbrush heads, which should be available for purchase from any number of suppliers.

Manufacturing cost for the handle
According to Recycled Plastics Market (http://www.caplasticsmarkets.com), the price of recycled HDPE in February 2003 was just under 14 cents per pound. This is significantly cheaper than virgin HDPE resins, which run closer to 40 cents per pound.
Assuming a material composition of 75% virgin resin and 25% recycled HDPE in our paintbrush handle, this would put our combined material cost at roughly 34 cents per pound. The flash trim from our produced parts can be reclaimed.

Using product dimensions of 5 1/2” X 1” X .5”, the surface area of the handle is approximately 17 in². Multiplied by an average wall thickness of .065” the volume of material required to produce the handle is 1.105 in³. Given a density for HDPE of .954 g/cm³ (see material data sheet for BASF Lupolen 5261 Z, blow molding grade in appendix section D) this would translate into roughly (1.105in³) (.0345 lb/in3) = 0.038 pounds of material per part. Multiplied by our average price of 34 cents per pound, this puts the total material cost per part at ($ .34/lb) (.038 lb/part) = 0.01292 dollars per part.
Secondary operations will include trimming any flash from the perimeter of the part, trimming the nipple at the nozzle end, and cutting 3 slots for the snap-fit assembly. Two of these slots are through cuts and could be done with a band saw or similar tool. The other is a standard slot and would have to be milled. Costs associated with these secondary operations would be machine time and labor. Ballpark values for each part would be 1-2 minutes of machine time and less than 3-5 minutes of labor cost. A final step would be assembling the handle with the paintbrush head. Please see head section below for more details.

Mold costs would be at the low end for this product. It is small in size and simple in geometry, with no moving parts required in the mold. The only areas of complexity are the hole in the handle and the opening at the nozzle end of the mold. The hole could be easily accomplished with pins, and the head end has been simplified for molding purposes by adding a nipple where the nozzle comes in. Final part geometry for the snap fit is accomplished totally with secondary operations.

ii. Purchasing the head
The intention of this design is for the paintbrush handle to be assembled with stock paintbrush heads that are purchased as opposed to manufactured. Standard paintbrush heads that we examined have a hollow metal band which holds the bristles in place. Our intent would be to purchase these parts with no handle attached, and then to mill a simple female slot in either side of the hollow section as a mating part for the snap fit button. (Please see design drawings for clarification.)

Cost of purchasing the paintbrush heads is unknown. With such a widely available commodity it is assumed that bristles with pre-assembled metal banding would be readily available from multiple suppliers at extremely competitive pricing.

IV. Mold Tooling Details
Since this is a relatively small and simple product, the mold tooling requires few special features. The part is symmetrical and the only areas of complexity are the hole in the handle, which is easily accomplished by a pinchoff, and the nozzle end of the mold. The nozzle opening has been designed to be incorporated into the part and should be trimmed off, not pinched. The tail will be automatically trimmed with a tail pinchoff insert. The parting line will fall on the major axis of symmetry and the tail pinchoff will be at one of the places that has high wall thickness, so the seam will be adequately reinforced.
The mold will be smooth enough to provide the appropriate finish for the final part and to make it easier to release the part from the mold. Simple ejector pins will be included to facilitate this process.

There is a possible technical difficulty with the shoulder of the product. Since it is a severe angle to the nozzle opening and will be the thinnest area of the part, there is concern over the structural integrity, but the upper edge of the shoulder is neither cosmetic nor structural. Final part geometry for the snap fit is accomplished totally with secondary operations.

V. Manufacturing Details

The design includes several details that make it idea for extrusion blow molding. Essentially it is a container which has one closed end and one open end. The hole in the handle is also ideally accomplished with extrusion blow molding.

Since paintbrushes come in a wide variety of sizes, there will have to be a number of different molds for this product. The process will be the same for all of the possible handles, except for increasing the diameter of the parison for much larger parts. Due to the shape of the product, it would be more appropriate to have different molds for the different sized paintbrush handles rather than having volume-changing inserts.

VI. Design Drawings

A. Paint Brush Handle

B. Dimensioned Drawings

C. Assembly

D. Mold Tooling