

# RotoWorld®

MAGAZINE FOR THE ROTATIONAL MOLDING & PLASTICS DESIGN INDUSTRIES

VOLUME X, ISSUE 3 • 2014

## Rotational Molding Product Design



**Managing Rotational Molding  
Machine Energy Costs**

**The Changing Scene of the  
Rotomoulding Industry in India**

**PSI Brand**

Creating brilliant, permanent graphics  
for the rotational moulding industry

A COMPANY PROFILE

# ROTATIONAL MOLDING Product Design



BY MICHAEL PALOIAN, INTEGRATED DESIGN SYSTEMS, INC.



Photo 1



## “Rotational molding part design is often confused with product design, which is significantly more complex and broader in terms of design considerations versus part design or operation.”

Most rotational molders often think that a design, which is ideally engineered for the rotational molding process is equally ideal for the end user or market. This perception has encouraged many molders to include designers on staff as part of their overall services. In some instances the responsibilities of these designers are specifically restricted to optimizing incoming designs for the rotational molding process. This limited level of responsibility usually provides everyone with great added value, since the in-house designer contributes his expertise based on his knowledge of the process while the design has been developed by a designer familiar with the application. This separately managed integration of disciplines usually results in successful products if the parties work together cooperatively and productively. However, in other situations some molders believe an in-house staff designer is equally qualified to design an entire product, which is sometimes true but more often not. Product designers are very different from process-based part designers. Product designers define the entire product including its appearance, function, performance, cost, safety, and appeal based on the intended market. Instances where captive product designers have been successfully utilized by rotational molders is when molders have introduced proprietary products. In these situations in-house designers have an opportunity to gain an appreciation of the market, application, and requirements of the product. Examples include companies who mold pallets, kayaks, toys, etc. However, if a molder uses in-house designer to design an entire product for an OEM customer, the results may likely not be successful. This is especially true if the product is complex and the designer is inexperienced. The remainder of this article will provide highlights of the design development a rotationally molded portable car washer, shown in Photo 1, which was successfully completed after evaluating numerous critical design considerations.

The portable car washer product was originally conceived by Orhan Tucaltan, a businessman involved in the textile industry ([dumbo.com.tr](http://dumbo.com.tr)), who approached Celal Beysel, president of Floteks ([www.floteks.com.tr](http://www.floteks.com.tr)), located in Bursa, Turkey. Orhan got this idea after one of his trips to South America at which time he observed a man pushing a small cart with a water tank strapped to it, shown in Photo 2. The individual would push the tank up to cars on the street to wash cars with minimal amounts of water. The primary two advantages of a portable car wash cart moving to cars versus cars driving to a centralized station were limited free real estate and water within

a crowded city. Orhan’s concept was to introduce an environmentally friendly portable car washer to the Turkish market with similar conditions. The product was intended to minimize the use of water, utilize environmentally

friendly detergents, and run on a rechargeable battery. Orhan retained a local industrial designer who developed a concept of the new washer, shown in Photo 3. Although this concept described the overall shape of the car washer based on a few basic components, it represented only 15% of the work required to complete a manufacture a product. The concept was introduced to Integrated



Photo 2



Photo 3





Photo 6

5. The towel cleaning tank will include a removable drain plug accessed from the top.
6. The towel cleaning tank will be covered with a removable vacuum formed disk with drain hole.
7. The hinges will preferably be molded as an integral of the cover and main body if feasible.
8. All the components will be specified by Unknown.
9. A compartment for all cleaners will be included in the design.
10. The cart will include the following hardware (see photo 4):
  - a. Two fixed casters/wheels and one rotating wheel at the rear;
  - b. Water pump;
  - c. 12V battery;
  - d. Spray handle and 5 meters of 10 mm diameter hose; and
  - e. Aluminum control panel with graphic overlay – includes on/off switch/ 4 status LEDs and a 12 V receptacle for recharging the battery.

Integrated Design Systems (IDS) imported the rudimentary CAD files developed by the industrial design firm into SolidWorks and began remodeling the entire geometry in SolidWorks. The original CAD file was used as a template to generate the new completely parametric CAD files, which would be eventually finalized into the completed production design. It is always advisable to completely rebuild imported geometry in the native CAD program since imported geometry cannot be modified parametrically. This limitation restricts one from making critical design modifications, which are often required during some portion of the development process. In this particular product many critical design modifications to the base geometry were necessary, including the overall dimensions. After the overall geometry was remodeled parametrically, the design detailed based on countless design

considerations. A few of the most significant parameters will be described below:

### Internal Components and Storage Capacity

The exterior dimensions of the cart were modified to comply with optimized ergonomic requirements as well as maximum internal storage capacities and ease of access. Compartmentalizing these internal volumes required an understanding of the product's functional requirements as well as ergonomic considerations and processing parameters specific to the rotational molding process. The internal volume was segregated into three major compartments (see Photo 5) listed below based on the product's functional requirements:

- Front compartment for washing towels and retaining dirty water;
- Middle compartment for storing 65 liters of clean water; and
- Rear compartment for dry storage of detergents, dry towels, nozzle, hose, battery, and pump.

Ergonomic considerations affected the location and types of drain plugs, compartment depths, and position of detergent bottles. Extensive knowledge of the rotational molding process and importance of uniform heat distribution during processing affected the spacing between walls, depth to width ratios, and draft angles.

### Stability and Center of Gravity

Critical examination of the original concept design revealed the spread between the pair of wheels toward the front of the cart might pose a stability problem. A computer simulation of the cart was studied to determine exactly how far the wheels should be separated for optimum stability when the cart was filled with 65 liters of water. After a series of simulations were completed based on different possible tip angles, the wheels were separated to the appropriate distance apart. This added separation significantly affected the appearance, as well as the moldability of the base, as shown in Photo 6. The wheel wells required by the added separation of the wheels were skillfully designed to visually complement the overall product appearance while also satisfying molding requirements. Tooling complications introduced by undercuts or intricate features were intentionally omitted, thus optimizing processing and cost of manufacturing.

### Human Factors

Since this product was so actively interacted by a user, human factors considerations were essential for overall success in the marketplace. Human factors affected virtually every feature in the product. A list of these details is highlighted below, and as shown in Photo 7. Detail A shows an undercut handle included as a feature within the removable middle water trough lid. Detail B shows the placement of a brake lock caster specifically located for ease of access by an operator's foot. Detail C illustrates the underside of a corrosion resistant coated steel handle securely mounted to the underside of the cart with four heavy duty bolts. Detail D illustrates the strategic location of the steel handle relative to the control panel for ease of operator interface. Detail E illustrates the inclusion of magnetic latches which securely retain the hinged lid in the closed position,

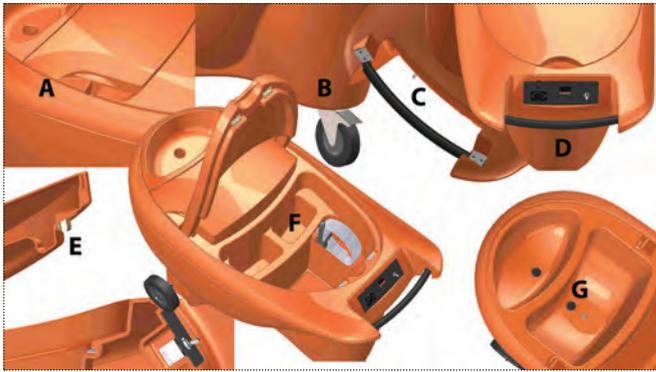


Photo 7

while allowing an operator to open the lid without releasing a latch. Detail F illustrates the location of two detergent bottle compartments for easy reach and a deep recessed cavity for storing many clean towels. The hose and nozzle have to be placed toward the side in a generously open cavity for easy storage and retrieval. Detail G shows two drain plugs which can easily be accessed from the top by an operator. The original design located these plugs in a deep recess under the cart, which would have been impossible to access without overturning it.

**Environmental Considerations**

Since these carts were intended for outdoor use, a UV stabilized grade of polyethylene was specified. Wheel diameters were specified to easily clear the underside of the cart during rolls over curbs and small rocks. The center of gravity was located within the boundaries of the cart wheels even when tilted 15 degrees about any axis. All external hoses running along the underside of the cart were recessed to prevent damage during transport along rough terrain.

**Ease of Assembly**

Numerous simulated assembly studies were performed throughout the development process to optimize the design for manufacturing. The exploded view in Photo 8 illustrates the majority of parts and components within this product. Every mounting point was verified for ease of accessibility with an appropriate tool by an assembler. Appropriate clearances were included in every part to assure proper fits during assembly. Some internal walls and partitions were designed as thermoformed plastic sheet as opposed to a molded-in feature to optimize the design. Provisions were made for wire routing and pathways for water carrying flexible tubes.

**Cost and Capital Investment**

Product cost and capital investment were well within the estimated budget because the number of parts required to build the product were minimized and secondary operations were virtually eliminated since all of the functional features were designed into the molded parts. Adequate clearances were included in all rotationally molded parts based on Floteks' processing capabilities and quality control standards. These clearances were less than half the conventional +/- .02"/in tolerance specified in ARM standards. This willingness to commit to tighter tolerance control provided the design team



Photo 8

the freedom to design parts with molded in features and fits, which resulted in an attractively functional product that was cost effective.

**Mold Design**

An in-depth understanding of mold design provided the design team a critical advantage in integrating functional, aesthetic, and processing parameters into the overall product design. Defining parting lines along the external complex surface without introducing undercuts was essential to maintaining the general appearance without compromising tooling complexity. Although numerous molded complicated part geometry, tooling complexity was minimized because undercuts were eliminated unless absolutely necessary. Draft was included in all wall surfaces oriented in the direction of mold separation. Areas that required possible minor dimensional adjustments after first article inspection were designed metal safe or with extra clearance to allow mold material to be removed to attain the desired dimensions without welding.

**Processing and Ease of Molding**

The complex internal compartments within the base were designed based on considerations of heat distribution and material flow. Concerns of possible surface porosity, partial fills, or thin walls were considered before the final compartment sizes and wall separations were finalized. A comprehensive knowledge of the rotational

molding process and close collaboration with Floteks' experience molding similar complex parts enabled the design team at Integrated Design to finalize the critical design details. Providing uniform heat over the entire surface of a mold is always a challenge for rotationally molded parts. In addition to uniform heat distribution, parting lines are always a challenge. A small bead was added around the parting line between the top half and lower half of the main body mold to address this concern. This design feature was included as a compromise to the original design intent to disguise the parting line that would be extenuated if it were omitted.

### Structural Integrity and Overall Strength

Critical areas requiring extra structural support were engineered to provide exceptional performance. These areas included the lower section of the main body which supported the wheel axle, the handle attachment area, and the area of the hinged lids. Molded-in hinges were much more reliable, attractive, and cost effective than the original metal hinges. The molded-in hinges were designed to withstand abuse as well as wind gusts, which would rip off conventional fastened metal hinges. Added structural support was included along the wheel axle, which was constantly subjected to impact loads induced during transport and constant stresses resulting from the overall weight of the loaded washer. The added curved tubular steel handle was specifically designed to be easily manufactured yet structurally secured to the main body. Internal

components were also designed to mount on structurally secure surfaces.

### Tolerances

The many advantages of rotational molding are often offset by the poor tolerance control of this manufacturing process. This limitation often presents challenges to designers who must design parts to fit and function within reasonable expectations. Some of the challenges pertaining to tolerances and design requirements for this product were in the following areas:

- Water tight seal between the top covers and main tank body
- Water tight seal between the drain plugs and main tank body
- Attachment between the hinged lid and main tank body
- Hole locations between components and main tank body

These challenges were met with creative solutions. The water tight seals between the main tank body and the cover were achieved with a simple die cut gasket, shown in Photo 9. This elegantly simple design provided a seal that was highly compliant, cost effective, and efficiently retained the lid to the main tank body. Drain plugs were specified in a low durometer rubber to provide a reliable drain seal yet be easily removed. The hinged lid was designed as an integral part of the main tank body by simply drilling two holes on either side, which accepted two pins during assembly to form an extremely robust hinge. Hole locations in the main tank were



**Niland Company**

Rotationally Molded Plastics  
Your Source for Any Plastic Hollow Product Shape Up  
to (95" diameter) and No Matter How Intricate.

**1-800-648-9013**

**Toll Free Fax 1-888-779-3065**

320 N. Clark, Dept. JT, El Paso, Texas 79905

International Calls: Tel 915-779-1405 Fax: 915-779-3618

**www.nilandco.com tom@nilandco.com**





Photo 9

designed to mate to CNC machined plastic panels, which could easily be modified if dimensional deviations in the molded parts were experienced.

**Performance and Reliability**

The overall performance and reliability of the washer exceeded expectations due to the creative integration of design with a thorough understanding of processing and tool design related to the product application. Relatively complex products such as this car washer cannot be developed as individual parts solely based on processing or mold design. All products require an integrated design approach which optimizes the desired product specifications with the selected manufacturing processes. The word processes was used versus process because most products require more than one manufacturing process. The car washer will be launched in the

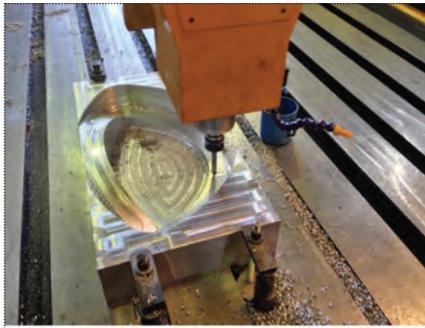


Photo 10



Photo 11

Turkish market in the upcoming weeks.

**Conclusion**

Good product design results in successful products if properly leveraged in marketing strategies as well as the overall business plan. This case study hopefully provided you the reader with a glimpse at a few of the many decisions and considerations that are required to design a successful product. Good product design requires a balance of maintaining an attractive appearance for product branding, optimum product performance, highest quality, lowest cost, and safety.

For future product design consider contacting a reputable design firm for expert professional results. For more information contact Michael Paloian, Integrated Design Systems, Inc. ([www.idsys.com](http://www.idsys.com)). 