

Design and the Basics

Designing a product that is successful requires a comprehensive technical education, creativity, artistic talents and CAD skills, as well as a thorough understanding of product requirements. Before any product is designed, the manufacturer must identify its intended market and use. Although this statement may seem a bit elementary, there are many subtle implications associated with it that are often overlooked. It's too often that a company's management and engineering development team fail to recognize essential factors that will have a major impact on a product's successful introduction. Some of these include development time, environment of use, human factors, cost, shipping and overall appearance. Of these factors, the most difficult and costly to test are related to environmental conditions. These typically include long term effects of heat, stress, chemical resistance and UV degradation. Environmental considerations are especially critical in large parts such as water tanks, pallets and recreational products where safety is involved.

One of the challenges facing designers who are designing a rotationally molded product to withstand harsh environmental conditions is quantifying the parameters in the first place. Design parameters must be defined and quantified based on anticipated use. This can become a complex task, especially when the application is new and there are no predecessors. Sometimes these analyses require prototypes which are tested under anticipated conditions. Unfortunately, these activities must often take place within limited budgets and time constraints during which time shortcuts are taken or erroneous assumptions are made leading to a false sense of security.

Assessing the risk often requires a development team to carefully analyze the potential liability and potential failure modes when compared to costs of design modification or lawsuits. Testing costs and complexities increase significantly when failure modes are evaluated over a long period of time. A good example of this is a pallet. Depending upon the application, a pallet could be subjected to a variety of severe loading conditions, chemicals and temperature extremes. Loaded pallets are typically stacked on top of each other, in which case the bottom pallet experiences the total static load of all the pallets above it. In warehouses where temperatures can reach 120°F (approximately 50°C), materials such as polyethylene will experience creep or gradual permanent deformation under excessive loads. These factors must be taken into account in the design. Load distribution is another factor which must be considered. Concentrated loads versus uniformly distributed loads will induce different stresses in a

pallet requiring added reinforcement. Some chemical drum pallets are subjected to harsh chemicals that could cause stress crazing and premature failure. Pallets which are tipped sideways will introduce stress conditions that must be taken into consideration to avoid failure.

I recently received an email from a major company in the Middle East to assist them in the design of a rotationally molded underground compartment that would be surrounded by sand, gravel, water or rocks or any other type of hard material. I proposed that the design of such a product account for the following based on the fact that it would be buried at a depth of 2.5 meters:

- 1 Loads on the walls of the container must be calculated based on pressures exerted by compressed soil. Soil density, thermal gradient and moisture content would be required to accurately calculate transmitted loads into the walls of the compartment.
- 2 The specific resin must be defined along with its property profile. Physical properties such as tensile strength vs. temperature would be required for accurate analysis. If the information is not available, it must be tested by a certified lab.
- 3 An FEA analysis must be performed by a certified engineer based on various designs and the parameters previously determined.
- 4 After the design and theoretical calculations have been determined, a few pre-production parts would be molded and tested. These could be molded from a fabricated prototype tool or a production tool. The parts would be tested according to the conditions set in the FEA analysis. Measurements would be taken at critical points and compared to theoretic calculations. If required, wall thickness may be increased or ribs may be added depending upon correlation of data to calculations.

These are only a few examples of what factors must be considered in the design of a product. Good designs require a comprehensive knowledge of the application as well as materials and the manufacturing process. Development costs must be realistically appropriated to properly design and test a product. Good design is much more than simply creating 3D images in CAD which is simply drafting. The design case study featured in this month's *RotoWorld*® is an excellent example of how great design has been applied to a beautiful and innovative product.