No-Hassle Kitchen Appliance

Finite element analysis helps redesign a countertop water filter that is easier to maintain, can be injection-molded in half the time and costs a third less to manufacture than previous models.

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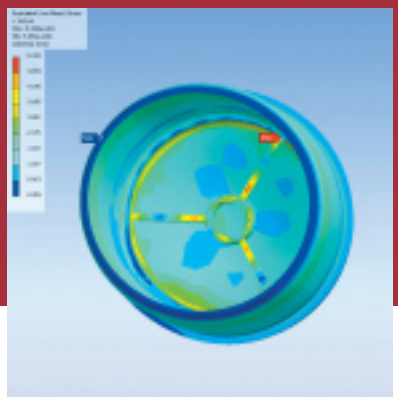
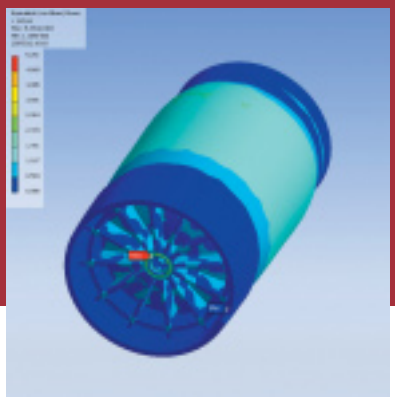
Even with degrees from top technical schools and considerable design experience, engineers find complex parts — especially ones with modern ergonomic curves — difficult to analyze with traditional handbook thermal and stress analysis. As a small one-man design shop, Stein Design completes several such projects each year that benefit from the application of finite element analysis (FEA).

The firm has used the technology to develop a wide range of plastic and cast parts, including water filtration systems, drinking fountains, medical bacteriological filters, emergency chemical drench systems and computer disk drives. Clients include Hewlett-Packard, Seagate, Plantronics and Duraflame — companies that value Stein Design for providing fast-turnaround designs that meet their unique engineering and business requirements. In the development of consumer products in particular, the firm recognizes that product aesthetics and visual impact often are critical elements in the commercial success of a product.

A countertop drinking water filter was redesigned to cut costs while making it easy for consumers to change the carbon filter cartridge and flow meter battery.

In one recent project, Water Safety Corporation of America in the United States commissioned Stein Design to complete a major redesign of their Essence™ countertop drinking water filter, an appliance intended to be attractive as well as effective in turning ordinary tap water into better-tasting, healthier water. The goal was to cut production time and cost while making it easier for consumers to change the carbon filter cartridge and flow meter battery annually. The previous housing had incorporated thick walls to accommodate the hydrostatic pressure of 150 psi required for certification by the National Sanitation Foundation (NSF), a mark recognized for its value in international trade and respected by regulatory agencies at the local, state and federal levels. These thick walls resulted in slow injection molding cycle times, excessive material usage and an undesirably expensive housing. However, arbitrarily reducing material





Left: In spite of the device's 0.27 inch-thick bottom wall and three internal ribs, stress-levels in the original design were excessive.This showed up as red areas on the ribs, as displayed in this color-coded stress plot.

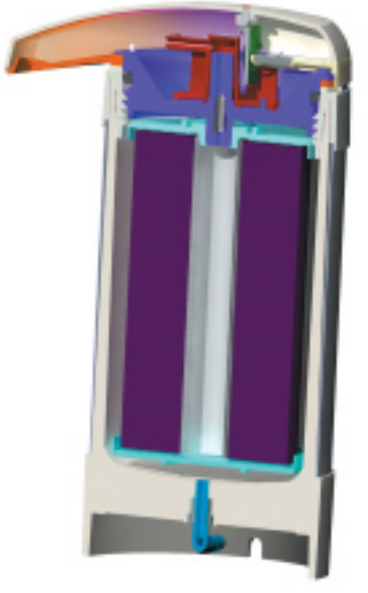
Right: After the iterative process of testing various combinations using ANSYS DesignSpace software, the final design included 12 radial ribs with a thickness of 0.125 inch.

from the overall design could potentially cause part failures leading to water damage of consumers' homes and high warranty costs. To account for these issues, Stein Design used FEA in developing a lightweight, reliable design for an appliance that would be easier for consumers to maintain.

The redesign was started by performing an FE analysis of Water Safety's existing product. When the housing was subjected to an internal hydrostatic pressure of 150 psi, analysis with software from ANSYS, Inc. showed that, in spite of its 0.27-inch-thick bottom wall and three internal ribs, stress levels of 5,360 psi were unacceptably close to the yield strength of the ABS thermoplastic material. In redesigning the housing, one of the primary concerns was reducing this maximum stress to half the material yield strength — thus providing a safety factor around 2.0 — while reducing wall thickness and injection molding cycle time for the parts.

To arrive at an optimal design satisfying these complex requirements, Stein Design performed an iterative process of evaluating different wall thickness and rib combinations. Three-dimensional models were designed in SolidWorks® software and then imported into ANSYS DesignSpace. Once the initial pressure loads and boundary conditions were set for the first model, the project geometry was updated with each new model iteration, making quick work of the analysis of "what if" scenarios. Since this was a highly cosmetic part, the maximum rib thickness was kept to a maximum of 70 percent of the wall thickness to ensure that the part would not display excessive marks where the ribs joined the outer cosmetic surface. Such indentations occur when the plastic cools and shrinks, and they are considered problematic on products that must be highly attractive in nature.

The iterative process of analyzing various rib and wall thickness combinations using FEA yielded a domed surface having a wall thickness of 0.175 inch and 12 radial ribs with a thickness of 0.125 inch minus 1/2 degree of rib draft. Rib height was 7/8 inch at the outside wall and sloped down to 1/2 inch at the inside of the rib hub. The maximum rib stress on the new design was reduced to 2,240 psi, giving a safety factor of 2.3 and exceeding the 2.0 target. At the same time, by reducing the nominal bottom housing wall thickness from 0.27 inch to 0.17 inch, injection molding cycle time was cut by a factor of two and part cost was lowered by more than a third.



Three-dimensional models of the water filter were designed in SolidWorks and then imported into ANSYS DesignSpace software for analysis of various ribbing configurations and wall thicknesses.

ANSYS DesignSpace software is an integral part of many Stein Design projects — and part of the reason the company has succeeded in the highly competitive engineering consulting business. Small consulting firms with no full-time analysts on staff can't afford to spend a lot of time and money on training to run a complicated FEA program. Engineers who use ANSYS DesignSpace need little training to be highly productive, and the tool interfaces seamlessly with SolidWorks mechanical design software. Stein Design finds it very easy to make quick changes to the part geometry and to regenerate the ANSYS DesignSpace FEA solutions to investigate "what-if" scenarios early in the design process, when design changes have little impact on project schedules and tooling. Even though several months may pass between FEA applications, the software is designed so users can get up to speed quickly in producing meaningful results. ■