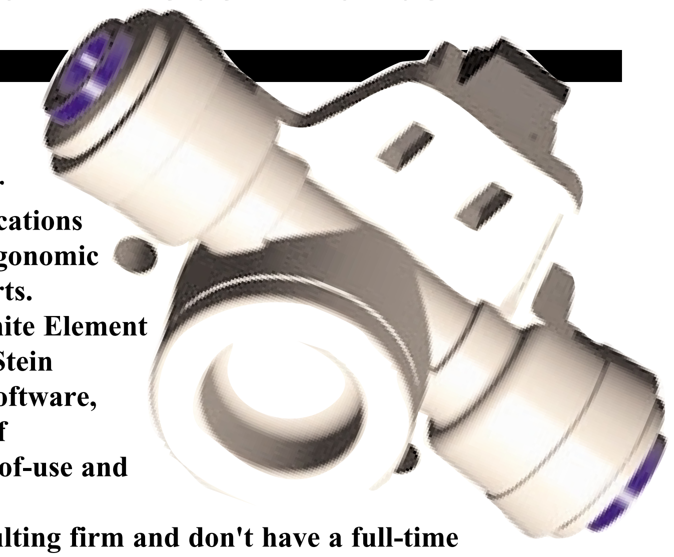
CASE STUDY:

Stein Design Trusts DesignSpace® for Analyzing Complex Flow Meter Parts



For a small design shop in Truckee, Calif., designing a plastic flow meter housing for use in liquid dispensing applications involves modeling modern ergonomic curves and other complex parts.

After evaluating several Finite Element Analysis packages, the firm, Stein Design, chose DesignSpace® software, distributed by ANSYS, Inc. of Canonsburg, PA, for its ease-of-use and accuracy.

"Since we are a small consulting firm and don't have a full-time analyst on staff, we can't afford to spend a lot of time and money on training to run a complicated FEA program," said Matthew Stein, owner and principal engineer. "DesignSpace meshes seamlessly with our SolidWorks mechanical design software and takes little training to use."

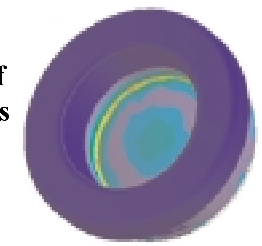
Developed for flow meter distributor Renau Electronic Laboratories of Chatsworth, Calif., the plastic modular flow meters are installed in commercial coffee makers, vending machines and water filtration devices and must be designed to withstand long-term pressures at near-boiling temperatures. A housing failure could easily cause a flood in an office, restaurant or other commercial building where these meters are used.

The project involved complex plastic-injection-molded parts, including intersecting slots and bosses, or raised circular projections. Using handbook calculations would have been difficult, requiring a large safety factor to account for calculation inaccuracies of unknown proportions.

To achieve acceptable high-temperature performance at a reasonable price, Stein chose a 20 percent glass-filled polypropylene from RTP. Approved by the National Sanitation Foundation, the material has a tensile strength of 7,200-psi and a 264-psi heat deflection temperature of 285 degrees.

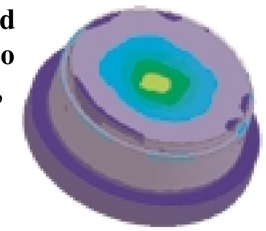
Stein used a Tristar 233 MHz Pentium II with 256 MB RAM and SCSI drives to run the analyses along with SolidWorks software to model and assemble the parts. To allow loading of only wet surfaces with a pressure of 200-psi Stein used split lines to cut the interior surfaces.

Target stress is 1,800-psi maximum (25 percent of tensile strength) when loaded at 200-psi. During the first analysis, the flow module housing had a maximum equivalent stress of 3,074-psi X) around the boss at the housing's bottom center. Burst tests on an earlier version of the flow module resulted in failures at the sharp inside corner of an identical boss. The cap had a maximum equivalent stress of 1,945-psi X) located at the inside corner of the cap.

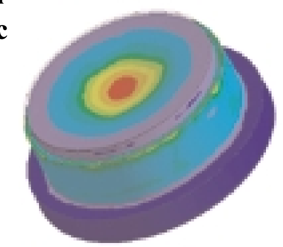


To strengthen the parts without adding the increased cost of thicker walls, Stein added ribs around the bottom central boss in the housing and increased the inside cap radius from .015-inch to .093-inch. On the next FEA run, the flow module housing's maximum equivalent stress decreased to 1,428-psi X), and the cap maximum equivalent stress decreased to only 945-psi X).

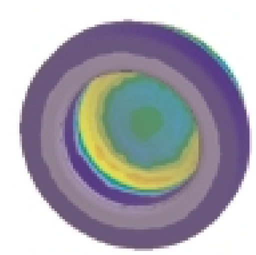
Additionally, Stein used DesignSpace to check the snap fit design. For the first run, the snap had a flex beam measuring .210-inch long, .040-inch thick with a .040-inch snap hook and a .005-inch radius at the bottom of the snap beam. In order to simulate the snap deflection that occurs during the assembly, Stein selected an edge of the snap hook and gave it a .040-inch horizontal deflection.



To accurately model actual snap behavior, Stein also chose to make one of the vertical base surfaces frictionless, rather than fixing the base's bottom horizontal surface. This support condition allowed the base to slide vertically as the snap arm flexes; otherwise, a fixed base surface would have doubly constrained the snap head during flexure, resulting in unrealistic bending stresses at the snap head. The first snap FEA run gave a maximum equivalent stress of 34,036-psi with significant zones at around 24,000-psi, which is unacceptably high x).



For the second snap run, Stein modified the three-dimensional model. He thinned the flex beam to .030-inch, reduced the snap hook/deflection to .025-inch and increased the base fillet to .030-inch. This reduced the maximum equivalent stress to small surface zones of 11,559-psi, with more significant zones of 7,000-psi and under x). Although the plastic has a tensile strength of only 7,200-psi, these high levels of surface stress are acceptable since the snaps are only flexed once during assembly. According to Stein, a little surface yielding is acceptable as long as the snaps are subjected to only a few cycles.



Using DesignSpace, Stein improved the flow meter housing's strength by 220 percent, maintaining the same wall thickness and achieving the targeted safety factor without significant cost increases.

"We are very pleased with the performance and ease-of-use of DesignSpace," Stein said. "The addition of DesignSpace has enabled us to release new products with a greater level of confidence and has sped the introduction of these products by reducing the number of design iterations and tests."

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