

The World is Nonlinear



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As engineers can attest, designing better products requires understanding of materials, loads and boundary conditions, environmental conditions, and component interaction in assemblies. Rise in the use of engineered materials like composites, elastomers and plastics, and special alloys, and more stringent market based or regulation based requirements necessitate deeper knowledge of product behavior well before being introduced into the market. This means that the inherent nonlinear response of the structural systems and the physical processes cannot be ignored during development phases.

Companies seeking to gain further insights into product behavior are going beyond virtual product testing by adopting simulation to understand and improve manufacturing processes. Since manufacturing processes are designed to introduce permanent deformation or change material characteristics, accurate simulations require robust handling of all the types of nonlinearities, namely: Geometric, Material, Boundary condition/contact, and Multiphysics.

The nonlinear simulation solution of Marc from MSC Software has been providing the advantage of accurate nonlinear modeling for four decades through its broad set of capabilities highlighted at the end of this document. With its powerful technology, Marc has also been addressing the manufacturing problems in various processes, like forming, welding, cutting, extrusion, curing, and more.

This supplemental issue highlights engineering ingenuity of some of our customers and the way they address their manufacturing challenges using nonlinear simulation. In the following customer stories, you see how the power of innovation effectively comes together with the right tools to solve complex design and manufacturing problems.

- **Hadley Industries**, whose core business is manufacturing cold roll formed products, used in building construction industry, developed and patented a unique cold forming process to significantly improve mechanical and structural properties of strip steel. By using Marc to simulate the manufacturing process, they expect to save on considerable tooling costs (which

could range from \$30,000 to \$150,000 for each design), and estimate to increase sales volume estimated to \$4 million over the next three years offering a superior product in the market.

- **Big Tyre**, a manufacturer of solid wheels primarily used in underground mining, is focused on improving safety by avoiding punctures and related damage and cost and improving performance. While the mining industry is moving towards solid tires, it comes with its challenges in the form of ground rutting, leading to further ride problems. Big Tyre has developed a non-pneumatic, non-solid segmented tire to overcome these problems by using composite leaf springs that are four times as flexible as steel. Since creating physical prototypes and testing multiple designs is a very expensive process, Big Tyre has been using Marc to test and perfect their design.
- **Litens Automotive Group** is a full service design and manufacturer of engineered power transmission systems and components. Its patented TorqFiltr crankshaft vibration control system incorporates a series of components that transmit power through frictional contacts rather than fixed connections. The product must be frequently customized to deliver optimal performance for a specific automotive engine. To avoid the high costs and time-consuming trial and error process, Litens has used Marc to accurately predict the design behavior, saving millions of dollars per year across their product line.
- **Pilsen Steel**, a leading producer of castings, ingots and forgings, located in Pilsen, Czech Republic, experienced difficulties with ingots cracking in a forging operation. COMTES FHT, contracted to investigate the problem, used Marc to analyze the process of heating the ingots in the furnace, which helped them to identify the root cause of failure. COMTES team also identified a solution to overcome this problem using Marc, which was then verified during the actual manufacturing process. This has helped reduce reject rate of the product and increased confidence in the process parameters.

I have truly enjoyed learning about some unique ways our customers have been using our products, and I'm sure you will too.

* If you are new to nonlinear analysis, a great introduction to it can be found in the white paper "When $f=Ku$, An Introductory Guide to Nonlinear Analysis," published by MSC Software, which is available at the following link: www.mscsoftware.com/f_not_equal_ku