CAE Takes a **Front Seat**

Engineers use ANSYS software to meet complex and potentially conflicting requirements to design a chair for a wide range of body types and postures.

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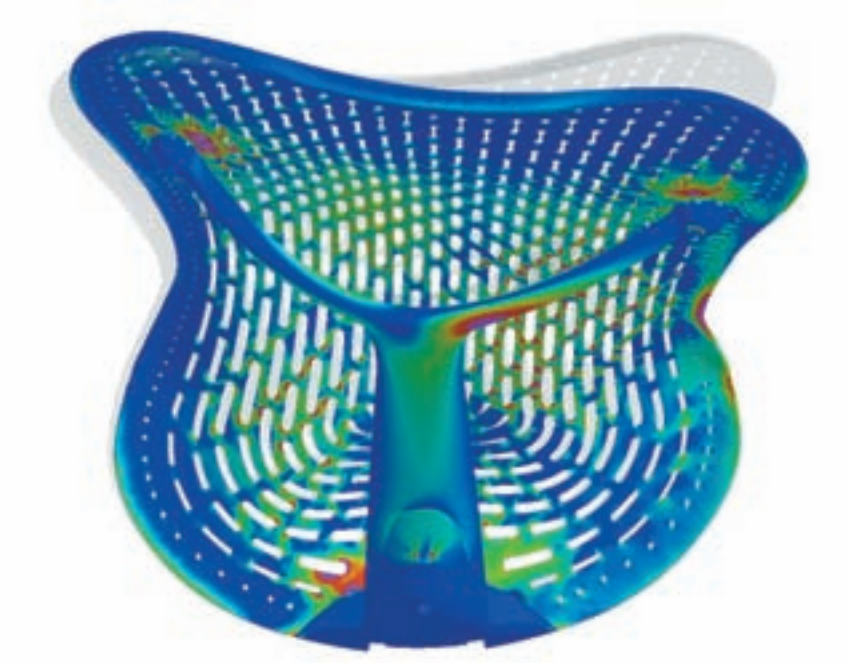


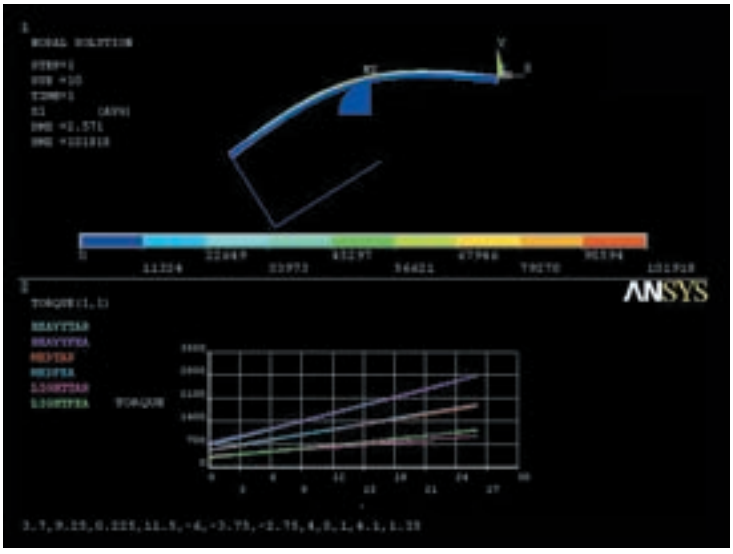
The TriFlex back that automatically adjusts to each user was developed as a single composite plastic structure using analysis to determine the coupled response of the back and its supporting spine.

Herman Miller Inc. transformed the residential furniture industry as America's first proponent of modern design, beginning in the early 1930s through collaborations with iconic figures like Gilbert Rohde, George Nelson, Charles and Ray Eames, Isamu Noguchi and Alexander Girard. Later the company transformed the modern office with the world's first open-plan office systems in the 1960s and the concept of ergonomic office seating in 1976 with the introduction of the Ergon® chair, followed by the Equa® chair in 1984. In 1994, the company launched the groundbreaking Aeron® chair. Founded in 1923, the company is one of the oldest and most respected names in American design. It has been recognized as a design leader, receiving the Smithsonian's "National Design Award." Dozens of its designs are in the permanent collections at major museums worldwide, including the New York Museum of Modern Art, the Whitney Museum, the Henry Ford and the Smithsonian Institution.

As one of the leaders in high-performance office furniture, Herman Miller set its sights in 2000 on the long-neglected and potentially lucrative mid-priced segment of the market, representing half of all office chairs sold worldwide. The goal was to develop the Mirra™ chair as an entirely new reference point for mid-priced office seating offering ergonomic comfort for a wide range of body types and postures and easy adjustability for fit and feel. The cost also needed to be kept as low as possible through reduced part counts and effective use of structural materials, developed completely under Design for the Environment (DFE) protocols.

Given these many complex and potentially conflicting requirements, developing the chair through cycles of trial-and-error physical testing was considered impractical because the approach is expensive, time-consuming, and limits the number of design alternatives to be evaluated. Engineers needed a way to optimize

Herman Miller's new award-winning Mirra office chair was developed through virtual prototyping using ANSYS software.



ANSYS Structural software played a key role in the development of the cantilever leaf spring and moving fulcrum tilt mechanism.

the design early in the development by investigating a wide range of possibilities at that stage. These challenges were met through the use of virtual prototyping, in which "what-if" scenarios can be readily studied in the computer and hardware testing is more of a verification of the design at the end of the cycle.

One of the key virtual prototyping technologies selected was ANSYS structural analysis software, used as the primary tool for determining stress and deflection on every part of the chair. Engineers routinely used ANSYS DesignSpace to develop major components such as the base, arms, and pedestal. For more complex analysis, ANSYS DesignSpace models were used by an analyst as the basis for detailed simulation with ANSYS Structural software.

ANSYS Structural played an important role in the development of one of the chair's key assemblies: a cantilever leaf spring and moving fulcrum tilt mechanism that provide resistive force so that a person can lean back comfortably. Torque curves were generated to represent the force required to support various body types in three seat positions: upright, fully tilted and midway. The analyst wrote a text script file to simulate a range of spring and fulcrum combinations to operate within this torque-curve design envelope. Output from ANSYS software included spring deflection and stress distributions, giving engineers insight into each design so that they could select and refine the configuration that worked best. The result was an optimal mechanism that provided the range of torque required with only a few simple adjustments. Guided by the simulation, the design met the company's objectives of comfort and adjustability. Moreover, the text script file will be used as a basis for developing similar mechanisms in other chair models.

Another major feature of the chair is a "passively adjustable" polypropylene back. In contrast to conventional rigid-back chairs, the pliable TriFlex™ back design provides the proper deflection according to the user's posture and movements. This concept evenly distributes seating forces, thus reducing load concentrations and fatigue. Engineers used ANSYS Structural software to determine the coupled response of the back and its supporting spine based on the material characteristics of each part together with the size and geometric pattern of the perforated back. Analysis was used extensively to engineer a single composite plastic structure that delivered the required coupled deflection response, reduced the parts count for the assembly and conformed to the DFE environmental criteria.

With the aid of simulation, Herman Miller developed an optimal chair design that delivered the required functionality while maintaining the company's high quality standards of wear and reliability. Prototype testing time was minimized, with a physical mock-up used to verify the functional performance established through analysis. Simulation also enabled engineers to consolidate parts into integral modules, thus minimizing part counts and lowering manufacturing costs significantly. Due to these and other cost efficiencies, product margins for the Mirra have met target objectives. In terms of market acceptance, the chair has consistently exceeded the company's targets for orders and shipments.

Introduced in 2003, the Mirra chair received the Gold Award in the Best of NeoCon industry competition. It was named by *FORTUNE* magazine as one of the "Best Products of the Year" and received the Chicago Athenaeum Museum of Architecture and Design's Good Design Award. The goal of the Mirra chair was to set a new reference point for the mid-price seating market in terms of ergonomics and adjustability. Simulation with ANSYS software certainly allowed Herman Miller to meet these objectives with advanced technology that could be integrated easily into its product development process. Rather than merely fix problems toward the end of the development cycle, simulation was used to guide the design. As a result, the Mirra is probably one of Herman Miller's most successful and highly engineered products. ■