HermanMiller

The Evolution of Anthropometrics and User Control

The science and research behind the Mirra™ chair

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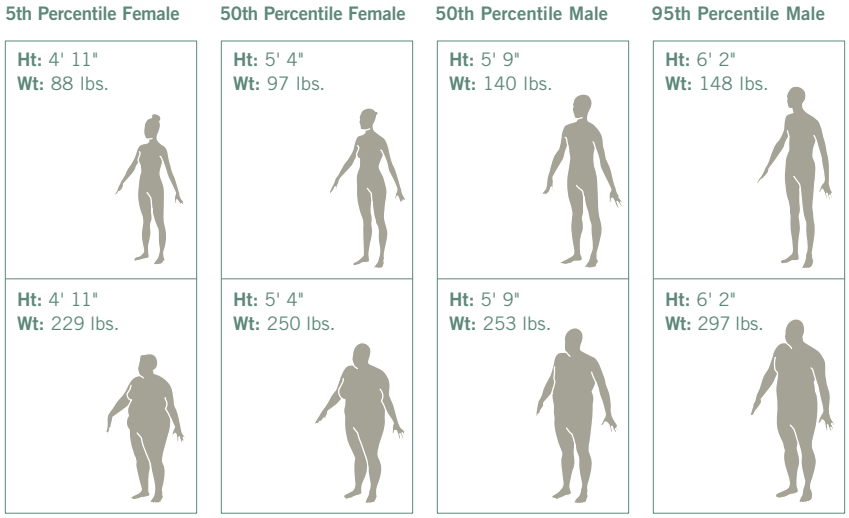
A work chair's geometry should reflect the full range of shapes and sizes of the population. *The work chair should not only fit this broad range of users but also be easily fine-tuned by the user to individual work postures and body sizes by the user.*

Figure 1

Mirra's flexible fit design meets 95 percent of the North American and European adult population. These selected subjects—among the lightest and heaviest for their given heights—illustrate how peoples' sizes vary. (CAESAR, 1998-2003)



What We Know: In the past, one of the authoritative sources for anthropometric data was the 1988 U.S. Army Anthropometric Survey (ANSUR) of United States armed forces personnel, which used conventional linear measurement techniques to record the anatomical dimensions of military personnel. While the test subjects were numerous, they were physically similar. Males were an average weight of 171 pounds and average height of 5 feet, 9 inches. A 95th percentile male was 6 feet, 1 inch and 216 pounds; a 5th percentile female was 5 feet and 110 pounds. The problem with using this data as a basis for seating research was that it did not accurately represent the diversity of physical sizes found in today's civilian office workplace.

NHANES III (The Third National Health and Nutrition Examination Survey), which supplements the military data, is a survey of civilians. It uses linear measurement techniques similar to ANSUR, though with a broader test group. In this database, a 95th percentile male is 6 feet, 2 inches and 246 pounds; a 5th percentile female is 4 feet, 11 inches and 113 pounds. What these numbers tell us is that there is indeed a significant anthropometric difference between military and civilian databases. To further illustrate: A 95th percentile female in the Army survey is 5 feet, 8 inches tall and 170 pounds, compared to a 95th percentile female civilian who is 5 feet, 8 inches tall and 229 pounds. Because increased weight equals increased shape, we are now able to address more accurate user profiles in our seating research.

Beginning in the late 1990s, improvements in three-dimensional scanning allowed for more complete human body measurements. Information now includes surface shape data that cannot be measured using conventional instruments. Herman Miller, along with other business partners from industries including transportation and clothing manufacturers, helped to sponsor the first large-scale 3-D survey of any population—military or otherwise. CAESAR, which stands for Civilian American and European Surface Anthropometry Resource, provides a comprehensive and realistic database of anthropometric information.

Our participation in the CAESAR study and subsequent research has helped us understand more accurately the behavior of the human spine and back when in seated positions. This knowledge gives Herman Miller the ability to design and produce products such as the Mirra chair that truly support the diverse sizes and scale of the human body.

Therefore: A good work chair can correctly and appropriately fit a broad range of users' sizes and proportions. A good work chair can be designed in such a way to accommodate the varying sizes of users.

Design Problem: People of all sizes and shapes adjust to the generalities of everyday objects. The height of countertops, the legroom in cars, the width of airplane seats, the depth of stairs or heights of rails—all too often are designed to the average size of the population. Yet when a product is designed to meet the "average," then average design is often the result.

A typical bell curve tells us that a work chair that serves 95 percent of the population will work very well for those in the middle of that 95 percent and less effectively for those on the ends of that population.

Design Solution: The designers of the Mirra chair set out to create a single-sized chair that would meet the size requirements of 95 percent of the population, without compromising anyone in that range. Not a work chair designed to the average, but a work chair designed for every one within that 95 percent.

Mirra presents a single flexible fit design that meets 95 percent of the North American and European population without restricting comfort or fit, from a 4 foot, 11 inch, 113-pound woman (5th percentile) to a 6 foot, 2 inch, 246-pound male (95th percentile). It is actually engineered to a 300-pound load capacity (Figure 1).

This degree of adaptability is possible through the design of Mirra's self-contouring suspension material and polymer back, which provide the body with custom support and fit. They also eliminate pressure points for all sizes of users (Figure 2). The

Figure 2

In testing of both large, heavy users and small, light users, no pressure points are detected against the TriFlex back, even when users are in reclined positions.

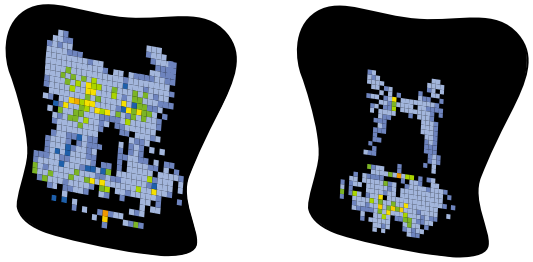
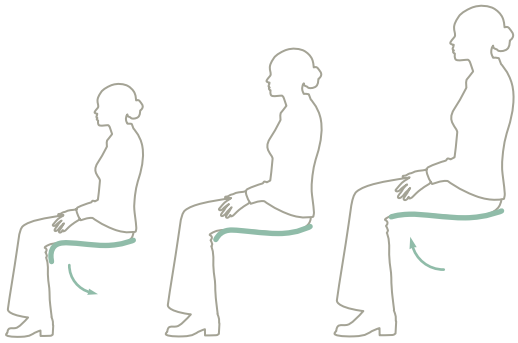


Figure 3

If the front edge of a chair seat hits the user's thighs at the wrong spot, it can constrict blood flow and invite muscle pain. A two-inch seat depth adjustment provides a variety of buttock-popliteal lengths with the ability to fit the depth to the body.



back of the Mirra chair is like a membrane. Every part of it has a level of flexibility. There is no spot where the sitter's back hits a rigid structural component, so a five-foot-tall sitter has the same support as the six-foot-tall sitter.

Like the Mirra seat's elastomeric AireWeave™ suspension, the polymer TriFlex™ back is also geographically neutral and responds to the sitter. The five-foot-tall sitter will find back support where it is needed because the back conforms to the shape of the sitter. The back is also generous in size and shape to fit all users, and it flexes freely because it is held in place by minimal but firm connection points on a carefully sized spine.

Beyond overall height and weight, differences in the size of individual body proportions are also accounted for. Since the length of the lower leg varies, the height of the seat must vary. In response, Mirra's seat height extends from 16 to 20 1/2 inches. (An optional seat height range of 15 to 19 1/2 inches is available.) A substantial height range also helps a sitter adjust more comfortably to nonadjustable office furniture.

The depth of the chair seat should allow the sitter to comfortably find the seat pocket, formed at the base of the chair's back, whether the sitter has a long or short upper leg length. Mirra achieves this through a revolutionary yet simple idea of curling the front of the seat to adjust the overall depth. While seated, the user can roll the FlexFront™ seat front inward or outward up to two inches, depending on where the front edge comfortably meets the thighs when the buttocks are settled into the rear of the seat (Figure 3).

What We Know: A chair that encourages adjustment, both actively from the sitter and passively through the design of the chair, will more likely be fine-tuned to the individual requirements of that person.

Experts agree that changing positions at work has important benefits for the sitter: Muscle movement aids blood circulation, spine movement nourishes the intervertebral discs, reclining while seated pumps nutrients to the discs, and continuous movement of joints is therapeutic for joints and ligaments. But when a chair requires the sitter to adjust it in order to shift into another position, it may discourage comfortable and supportive movement. Studies of people sitting at work indicate that they tend not to use manual adjustments on their chairs. In fact, according to a Herman Miller study, the majority of users adjust their chairs the first time they use them or not at all (Herman Miller Product Research, 1999).

Therefore: Work chairs need to be able to be fine-tuned to individual work postures and body sizes and, at the same time, to accommodate a range of users without compromising comfort and support.

Work chairs must allow people to sit comfortably and to easily make the adjustments that will support their movements and posture changes throughout the day. In other words, a work chair should adjust to its user, not the other way around.

Design Problem: If controls are difficult to use—difficult to find, to activate, or to recognize their effects—they won't be used. Users are not always properly trained on the how's and why's of chair adjustments and, left to their own learning, may avoid making adjustments altogether or make them improperly.

Work styles and workplace environments have changed. Laptop computers and wireless technology have made dedicated offices irrelevant for many; teams and collaborative work styles keep people moving through facilities and office spaces. Mobile workers have flexibility on one hand, but limited customization of office furniture, including seating, on the other.

Design Solution: A relationship between a chair and the user can be developed through experience and not instruction. The Mirra chair minimizes user effort without compromising the overall support.

We know that sitters seldom make the chair adjustments they should, yet work chairs continue to become more complex in the variety and number of adjustments offered. The ideal chair, of course, would adjust itself to the sitter. But short of a robotic

work chair, a work chair must help the user easily and intuitively make adjustments.

Passive adjustments are those that do not require adjustment from the user; in a sense, they are the chair's default setting. Mirra's seat and back provide such passive adjustments. The AireWeave suspension adjusts to the sitter's buttocks; the TriFlex polymer back with torsional flex moves and supports the sitter's back, from the thoracic to the pelvic areas. The back and seat continually adjust to the user yet require no action on the part of the sitter.

Active adjustments are those that the user makes to fine-tune the chair to his or her requirements. When researching and designing the adjustment controls, the Mirra design team considered user interface first and foremost. Mirra's adjustment controls are within the "easy reach" zone, which is within the normal drop range of the user's hands. Adjustments are also shaped to provide clues to the sitter. In particular, the tilt and angle adjustment lever is shaped like the seat and back of the Mirra chair—we call it the mini-Mirra. Intuitively, a user moves the mini-Mirra's "back" or "seat" to adjust the actual chair back and seat. The tactile quality of the adjustment control also lends clues to the user. The tilt tension knob, for example, on Mirra is large, soft, and within the drop area of the user's hand, making it easy to find, grasp, and turn.

The ability to make adjustments while seated was a mandate of the Mirra design team. The user interface is instrumental in helping the sitter understand the chair and continue to make adjustments. Knowing that adjustments are seldom made by the user, the designers of the Mirra chair set out to make the important tilt-tension adjustment easy to understand and adjust. With little effort—nine complete rotations of the tension knob completes the range of motion—the sitter will notice a difference in just one half of a turn. "Instant feedback" is how the designers describe this adjustment. Too instant, we initially discovered, when the maximum tilt range could be adjusted in just three complete knob rotations. We had to slow down the tension adjustment so that users, specifically those who are larger sized, could more sensitively balance the chair ride to their preference.

The intuitiveness of active adjustments and the simplicity of passive adjustments combine to support the user's natural body movements and postures throughout the day.

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Credits

Studio 7.5, located in Berlin, Germany, is composed of Nicolai Neubert, Claudia Plikat, Burkhard Schmitz, Carola Zwick, and Roland Zwick. With the exception of engineer Roland Zwick, the designers are cofounders and partners of the firm, which opened in 1992, and also teachers of industrial design and product design at universities in Germany. An interest in the tools that define how people work has led Studio 7.5 to design software interfaces, office seating, and medical equipment. Studio 7.5 has been collaborating with Herman Miller since the late 1990s.

Bill Dowell, C.P.E., leads a team of researchers at Herman Miller. His recent work includes published studies of seating behaviors, seated anthropometry, the effect of computing on seated posture, the components of subjective comfort, and methods for pressure mapping. Bill is a member of the Human Factors and Ergonomic Society, the CAESAR 3-D surface anthropometric survey, the work group that published the BIFMA Ergonomic Guideline for VDT Furniture, and the committee that revised the BSR/HFES 100 Standard for Human Factors Engineering of Computer Workstations. He is a board-certified ergonomist.

Gretchen Gscheidle is a product researcher at Herman Miller. Educated as an industrial designer, Gretchen now applies her creativity and problem-solving skills in her role as researcher on cross-functional product development teams. She has been the research link in the company's seating introductions beginning with the Aeron chair in 1994. Her research focuses on laboratory studies of pressure distribution, thermal comfort, kinematics, and usability, as well as field ethnography and user trials. Gretchen is a member of the Environmental Design Research Association.