HermanMiller

# Supporting the Spine When Seated

The science and research behind the Mirra™ chair

*By Studio 7.5: Burkhard Schmitz, Claudia Plikat, Roland Zwick, Carola Zwick, Nicolai Neubert; Bill Dowell; and Gretchen Gscheidle*

***The human spine is dynamic and requires dynamic support during seated periods.*** *The four regions of the spine have unique attributes and requirements; a good work chair should address those unique requirements. A work chair should also provide proper support for variations in spinal anatomy.*

**Figure 1**

The human spine and pelvis

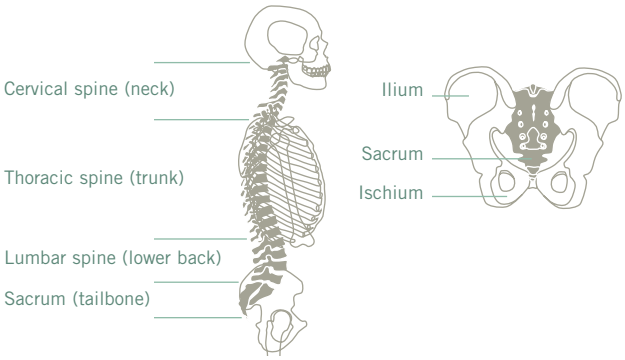
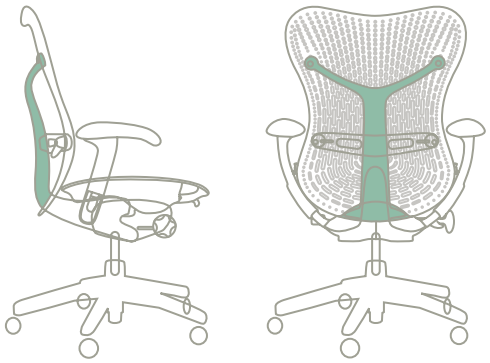



**Figure 2**

A Y-shaped spine connects to the MIrra chair in only two areas—at the base and at the top of the back—which allows for a great degree of flexibility. Without an integral structure or support, the Mirra chair's back can flex as the sitter flexes.



**What We Know:** Despite the fact that all human spines contain the same set of parts, the sizes and relationships among those parts vary. We've discovered much about the differences and nuances of human spines in recent years.

Herman Miller was one of 40 industry partners participating in the CAESAR (Civilian American and European Surface Anthropometry Resource) study, the first large-scale, three-dimensional anthropometric survey of civilians in the U.S., the Netherlands, and Italy. Prior to the CAESAR survey, anthropometric data was based on a fairly homogenous test group—military personnel—and provided linear measurements only, such as lengths and circumferences. Because of the measurement techniques and population of subjects, the results of the CAESAR study present a more comprehensive and realistic database of anthropometric information than previous surveys.

Through the CAESAR research, we have gained valuable knowledge about the diversity in shape and size of the civilian population. CAESAR has also provided us information about differences in body proportions, including the spine, and not just differences in weights and heights.

To understand how the Mirra chair addresses spinal variations, a brief anatomy lesson will be helpful (Figure 1).

The cervical region is in the neck area of the spine, from the skull to the shoulders. It is highly flexible and strong. The neck balances and supports the head, which weighs about eight pounds. The thoracic area is the upper and middle parts of the spine. Because it is connected to the rib cage, the thoracic region has very little mobility. The lumbar is the region of the lower back that contains the five lumbar vertebrae, the largest vertebrae in the spinal column. The lumbar area is capable of a great deal of movement. Below the lumbar area lies the sacral region, made up of five fused vertebrae, which is held between the pelvic bones on each side.

When properly aligned and balanced, the thoracic spine region has a kyphotic curve, which is slightly convex or outward. The cervical and lumbar spine regions have a lordotic curve, which is slightly concave or inward. These curves, which together give the spine its "S" shape, are essential to a healthy and strong back. They create the balance and the shock absorbers for the movements of the body.

These natural curves need to be supported and maintained to keep the back and spine relaxed and free of pain and pressure. They must also be supported as they change shape when the body moves. When a person moves from standing to sitting, the pelvis tends to rotate backward, and the lumbar curve flattens or even moves into a kyphotic curve. This increases pressure on the intervetrabral discs and increases muscle activity as the body attempts to restore balance lost when the lordotic curve changes.

Historically, it's been believed there was a relationship between a person's thoracic and lumbar regions based on height and gender. But this is not proven. The apex to the thoracic curve has a big variance. There is no relationship between the apex of the kyphotic curve of the upper back and the apex of the lumbar curve of the lower back. Result: We learned we couldn't be prescriptive; there was no perfect ratio to design to.

Through our ongoing research and participation in CAESAR, we now understand the human anatomy in general and the seated spine and back in particular. Our understanding gives us the ability to design and produce products such as the Mirra chair that truly support the unique requirements of the regions of the human spine.

**Therefore:** A good work chair will address those unique requirements of the four regions of the spine: cervical, thoracic, lumbar, and sacrum. A good work chair will support all the regions of the spine as a person shifts seated postures throughout the day.

A good work chair needs to be flexible in order to address the macro variables of human size and micro variables of back/spine scale.

**Design Problem:** The body needs to move. It's a natural response, even when sitting. A Herman Miller study on seating

**Figure 3**

Gradient perforations are calibrated and tuned to the spine's natural range of motion. The pattern allows for greater or lesser flex within the chair's back, similar to the differences in the flexibility range of the spine.

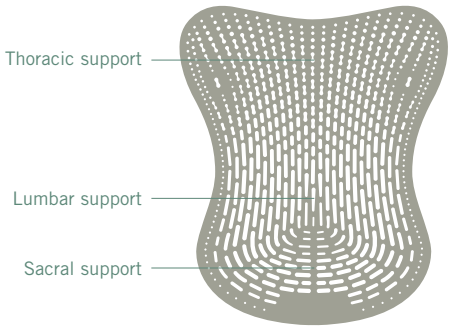
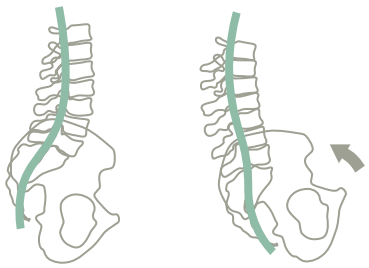



**Figure 4**

The position of the pelvis determines the shape of the lumbar spine.




behavior finds that seated people move their torso an average of 53 times an hour. Nearly 28 percent of those moves involve leaning or turning (Dowell *et al.* 2001).

Most work chairs, however, are too rigid to allow the sitter's torso to move the way it prefers. To compensate, sitters tend to move away from the backrest, thereby losing the support for the back.

Nor do most work chairs equitably support the entire spine, from the thoracic region to the sacrum, and the unique requirements of each of those spinal areas. While they may provide support to the lower back, the upper back is often overlooked.

With most traditional foam-and-fabric chairs, or those with integral frame structures, the contour of the backrest may mimic the general contour of the human spine, but it does not respond to the individual's shape and scale or allow much flexibility in movement.

**Design Solution:** Provide a work chair that supports the entire spine and addresses the differences in the spinal anatomy within that support. The construction of the Mirra chair allows it to mirror naturally the leaning and turning motions of the sitter.

The original logic beyond Mirra's back design was this: What if the chair's back could be enlarged and held in place at points, instead of by a surrounding structure? The back, however, would need to be more structural, like a semi-rigid or rubbery mat.

The back design of the Mirra chair is supported by a Y-shaped spine, external to the chair's back. It connects to the chair in only two areas—at the base and top of the chair back—which allows for a great degree of torsional flex. This design provides the sitter with the freedom to move, lean, and bend, while the back of the Mirra chair moves and bends in the same way. Without an integral structure or support, the Mirra chair's back can flex as the sitter flexes (Figure 2 and 5).

The material and design of the chair's back is calibrated and tuned to the spine's natural range of motion. Mirra's gradient patterned back rose from much engineering experimentation focused on being intentional about the degree and direction of ergonomically appropriate flex. The pattern allows for greater or lesser flex within the chair's back, similar to the differences in the flexibility range of the spine. We refer to these areas within the chair's back as flex zones (Figure 3).

The thoracic region has little flexibility, so the perforations in the chair's upper back area are tighter and smaller, supporting the nuanced thoracic movement. The lumbar region, on the other hand, has a great deal of flexibility, so the perforations in that area open up to give greater supported mobility to this part of the spine. As flexibility increases or decreases naturally through the spine, so does the back of the Mirra chair.

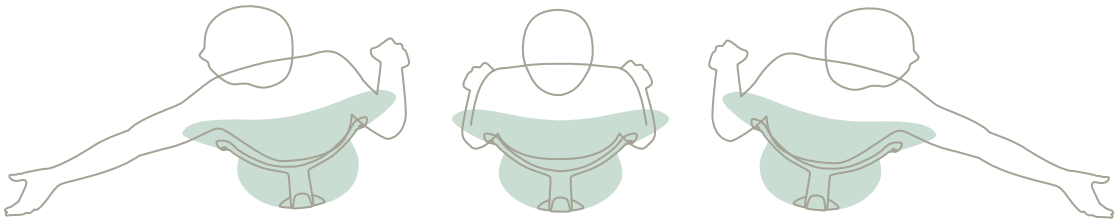
CAESAR research provided us with new information about the differences in proportions and the relationship between the lordotic (inward) and kyphotic (outward) spinal curves. Women, for example, are more lordotic and have a deeper lumbar curve than men. On average, women's lumbar curves are 12 percent deeper than men's. Yet the height of the lumbar region is about the same for both men and women (Dowell, 1995). An independent lumbar support, then, provides the sitter with the ability to adjust to his or her own lumbar curve. The Mirra chair's adjustable lumbar design offers a simple yet effective way to match the level and location of lumbar support to the sitter's body and preference.

The pelvis dictates the curve of the spine. If the pelvis rotates out of its natural forward curve into a rearward position, the entire spine works to restore balance, and the result is muscle fatigue and discomfort through the entire back. However, when the pelvis maintains a controlled forward rotation, the spinal curve of the back remains aligned both naturally and comfortably (Figure 4).

With the postural support that Mirra's passive PostureFit™ provides, the pelvic region is supported constantly. A camber shape at the base of the back creates an arched area that gives support. The design helps to control the position of the pelvis

**Figure 5**

The Y-shaped spine design provides torsional flex, giving the user the freedom to move, lean, and bend, while the back of the chair moves and bends in the same way.



and, therefore, the spine. While it is important for a sitter to dynamically fit a chair's back to his or her lumbar curve, pelvic support should be stable—always there, always supporting, always "reminding" the pelvis to remain forward.

The entire torso of the person sitting in a Mirra chair is considered, from flexibility in the upper back for reach and movement to flexibility in the lumbar area for fit and, finally, to stability in the pelvic region to promote more healthful postures.

## References

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Dowell, Green, and Yuan (2001), "Office Seating Behaviors: An Investigation of Posture, Task, and Job Type," *Proceedings of the Human Factors and Ergonomics Society 45th Annual Meeting.*

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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.