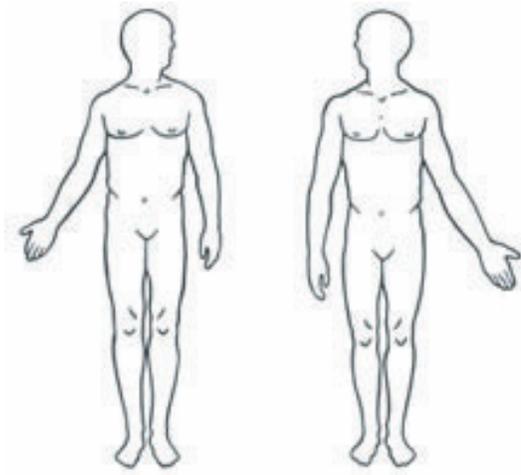




**If the Chair Fits.** The old adage, “People come in all shapes and sizes,” is a tired cliché to a lot of people. To those who design and manufacture office chairs, it’s a daily reminder of the difficult task they face: making chairs that fit a tremendously varied population. Walk through the offices of just about any company and you’ll see people of vastly different sizes and proportions.

You will notice diminutive workers whose feet barely touch the floor, as well as more lanky colleagues with knees awkwardly extended well beyond the front edge of their chairs. Some may weigh twice as much as others and may be more than a foot taller. Using the chair's adjustment features can make some people more comfortable, but others must endure the aggravation of chairs that don't fit correctly.

Correct fit is a chair that fits is one that allows the user to comfortably rest his or her feet on the floor, with the thighs fully supported and approximately parallel to the floor. The user's back should be comfortably supported, and the angle formed by the thighs and the torso should be between roughly 90 and 105 degrees. Tilting back should be easy, but not too easy. And the chair should permit frequent posture changes—an essential element of comfortable sitting.<sup>1</sup>



Smaller people sometimes feel pressure on the thighs and the backs of the knees because of chairs that are too high or too deep in the seat; discomfort and numbness in the legs and feet can follow. Chairs that adjust lower than most or have seats that can slide forward and backward to adjust seat depth can help. Otherwise, smaller people often move forward on the seat to relieve excessive pressure on their thighs and to let their feet comfortably reach the floor. But when they inch forward, they move away from the backrest and the much-needed support it provides, resulting in unhealthy slumped postures. Slumping in a chair flattens the lumbar area of the spine from its normal concave curvature—leading to back pain and, over time, an increased potential for muscular, ligament, or disc injury.<sup>2,3</sup>

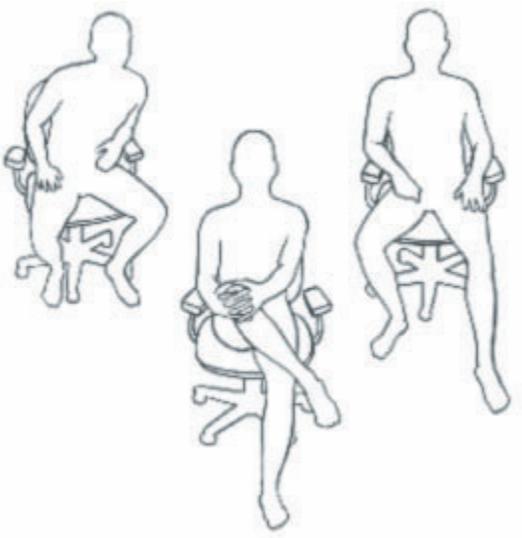
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To address the discomforts of sitting, chair designers turn to the science of anthropometry—the study of body measurement—to help determine dimensions of chairs. Books on anthropometrics are filled with tables and charts that divide the human population into percentiles. In North America, a 50th-percentile male—an average-sized man—is 5 feet, 9 inches tall, weighs 171 pounds, and has a popliteal height of 17 inches.<sup>4</sup> (Popliteal height, a critical measurement to chair designers, is the vertical distance between the floor and the crease just behind the knee.)<sup>5</sup> Very few people, though, are “average” for all, or even a few, different body measurements. Nearly everyone has at least one feature that is of a significantly different proportion than other areas of the body, such as long arms or short legs. A person may be in the 80th percentile for arm length, for example, but in the 10th percentile for leg length.

Even though “average” is an illusory concept in anthropometrics, office chairs are commonly designed with the intent of fitting everyone between the 5th percentile of women and the 95th percentile of men—theoretically covering 95 percent of the entire population. Unfortunately, this range is overly optimistic for three reasons. First, much of the data collected for anthropometric studies come from North American military populations, which include fewer very large and very small people compared to the population as a whole.<sup>6</sup> Second, it is not the same people who are excluded for each chair dimension. In other words, the five percent of women whose popliteal height is below the 5th percentile are not necessarily the same five

percent of women who fall below the 5th percentile for buttock-to-popliteal length (a seat-depth measurement).<sup>7</sup> This means that much more than five percent of the population may find that at least one chair dimension does not fit them well. Third, for some dimensions, office chairs simply don't cover the 5th- to 95th-percentile range. For chair height, for example, a typical range of height adjustment found in office chairs is from 16 to 20 1/2 inches. Even when allowing an additional inch for shoe heels, anthropometric tables for popliteal height show that 35 percent of all women would need their chairs lower than 16 inches.<sup>8</sup> One ergonomist who studied seat-height preferences among more than 200 Japanese women concluded that office chairs should, in fact, adjust down to a height of 14 1/2 inches.<sup>9</sup>

To accomplish the feat of fitting all of these differently sized people, many manufacturers offer chairs with various adjustments. Seat height and seat depth are generally the two most important dimensions of good fit; while some chairs may come with an array of adjustments, however, many of them don't adequately address these two critical issues. Whatever other adjustments they may have, the chairs may not adjust lower than 16 inches or allow users to change the depth of the seat—and therefore miss the fundamentals.



To assume that adjustable office chairs fit properly requires that people also have them adjusted correctly. A Herman Miller study of workers at a professional services company revealed the benefits of educating users on adjustments. Researchers compared a control group who received new chairs with an experimental group that received new chairs and ergonomic training. Both groups reported a decrease in “work-related discomfort,” 27 percent for those who received a new chair but 46 percent for those who received both a new chair and training on how to adjust it.<sup>10</sup> Manufacturers will need to continue their efforts to educate users on adjustment features in order to move toward the goal of proper fit for everyone.

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So while office chair manufacturers aim to fit 95 percent of the population, the proportion of people sitting in chairs that actually fit well and are properly adjusted is probably closer to 75 percent. And that number may be overly generous; estimates as low as 50 to 60 percent are not unreasonable, given the limitations of anthropometry and of people's ability to adjust their chairs. Given that about half of the 150 million laborers in the U.S. are white-collar workers, lots of people are sitting in office chairs every workday. If 25 percent are sitting in ill-fitting chairs, then millions of people aren't being properly fit. Some companies overcome the problem of size difference among their office workers by ordering chairs from different furniture manufacturers that make chairs with a smaller or larger scale than others.<sup>11</sup> A chair more closely scaled to the size of the user to begin with means less error in the adjustments, because the amount of adjustment needed is relatively small. It seems a logical progression for furniture manufacturers to offer chairs in different sizes, but this practice is quite rare because of the high cost of tooling for different sizes and the current popularity of adjustable chairs.

Chairs of different sizes have been used in educational seating for years. One of

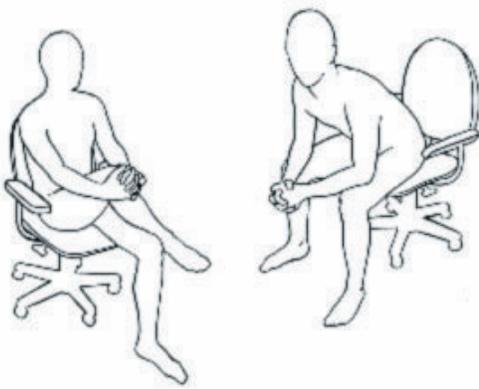
the earliest examples of this came from an anthropometric study of schoolchildren in Australia in the late 1940s, which found that, even among children in the same grade, variation in body size was great enough to warrant the design of six different-sized chairs for that country's elementary schools.<sup>12</sup> An argument can certainly be made that a similar level of anthropometric variation also exists in the adult population.

Providing good-fitting office chairs to different-sized workers will assume heightened importance as the workforce and the world economy continue to change.

A greater proportion of Asian workers (who tend to be of smaller stature)<sup>13</sup> in the U.S. work force could raise the demand for smaller chairs.<sup>14</sup> And as free trade among different countries grows, so will the need for U.S. office furniture manufacturers to provide suitable-fitting chairs for Asian markets. Pulling at the other end of the anthropometric bell curve, long-term trends indicate that generations from Europe and North America have been growing steadily taller—and wider—over the last several decades.<sup>15</sup>

Chair manufacturers will also need to focus on the seating requirements of women as women continue to become a greater percentage of the workforce in the years ahead.<sup>16</sup> The two genders, in addition to the obvious anthropometric differences, have some subtle but distinctly different characteristics important to chair designers. For example, men tilt back in their chairs more than women because, with additional upper body weight, men need to recline to relieve the extra pressure being placed on their ischial tuberosities.<sup>17</sup> Cultural issues must be considered as well; simply designing smaller-sized chairs for women (particularly women executives) disregards the common nonverbal messages that chair sizes connote about job status. Industry experts have criticized chair design as being biased toward male users. Designing chairs that demonstrate a thorough understanding of how gender differences affect the fit of office chairs is already overdue, and it will become increasingly important as the face of the workforce continues to change.

Even as the working population grows more diverse, there are realities that make the idea of a single-sized chair attractive for some. The sophisticated manipulation of computers and software has become the norm for knowledge workers. Fit for them may be less of an issue than the need to provide proper support through the wide range of postures they assume. Then, too, some organizations opt for one chair to fit as many different-sized people as possible to ease the managing of standards programs and inventories across global locations. In William Shakespeare's play *All's Well That Ends Well*, a clown attempts to convince a countess that he can respond to her seemingly impossible challenge: an answer to fit all questions. The clown foolishly pleads with the countess that he will be able to provide such an answer, and he likens such high-mindedness to "a barber's chair that fits all buttocks; the pin-buttock, the quatch-buttock, the brawn-buttock, or any buttock."<sup>18</sup> Such a chair certainly would be astonishingly comprehensive and all-inclusive, for human beings are of shapes and sizes as varied and individualistic



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as fingerprints. A single chair that fits all people is as challenging to design as it is to find one answer to fit all questions. As long as chairs continue to reflect the human beings who use them, variety will be a consideration.

## Notes

- <sup>1</sup> Carson, R., "Ergonomically Designed Chairs Adjust to Individual Demands," *Occupational Health & Safety* (June 1993), p.73.
- <sup>2</sup> Dagostino, M., "Lumbar Support Most Critical Feature to Consider During Chair Selection," *Occupational Health & Safety* (March 1994), p.63.
- <sup>3</sup> Zacharkow, D., *Posture: Sitting, Standing, Chair Design and Exercise* (Charles C. Thomas, Springfield, IL, 1988), p.106.
- <sup>4</sup> Gordon, C.C., et al., 1988 Anthropometric Survey of U.S. Army Personnel: Summary Statistics Interim Report (United States Army Natick Research, Development, and Engineering Center, Natick, Massachusetts, 1989), pp.38, 132, 145.
- <sup>5</sup> Pheasant, S.T., "Anthropometry and the Design of Workspaces," Eds. J.R. Wilson and E.N. Corlett, *Evaluation of Human Work: A Practical Ergonomics Methodology* (Taylor & Francis, London, 1990), p.463.
- <sup>6</sup> Herman Miller, Inc., p.26.
- <sup>7</sup> Gordon, pp.73, 132.
- <sup>8</sup> *Ibid.*, p.132.
- <sup>9</sup> Takeoka H., S. Yamada, and K. Nora, "Participatory Ergonomics for Seating—Need for User-Oriented Approach," Proceedings of the Human Factors Society 35th Annual Meeting, 2 (1991), pp.939-943.
- <sup>10</sup> Herman Miller Workplace Performance Study (September 2003).
- <sup>11</sup> Herman Miller, Inc., "Body Support in the Office: Sitting, Seating, and Low Back Pain," p.29.
- <sup>12</sup> Oxford, H.W., "Anthropometric Data for Educational Chairs," *Ergonomics*, 12:12 (1969), pp.140-161.
- <sup>13</sup> Pheasant, p.459.
- <sup>14</sup> U.S. Department of Labor, Bureau of Labor Statistics, *Occupational Outlook Quarterly* (Fall 1991), p.12.
- <sup>15</sup> Pheasant, p.458.
- <sup>16</sup> Centon, M.J., et al., "Into the 21st Century," *The Futurist* (July- August 1988), p.35.
- <sup>17</sup> Lohr, p.D6.
- <sup>18</sup> Shakespeare, W., *All's Well That Ends Well* (Yale University Press, New Haven, 1965), p.31.