# Normal Distribution

A term used to describe a set of data, that when plotted, forms the shape of a symmetrical, bell-shaped curve.[1]

Normal distributions result when many independently measured values of a variable are plotted. The resulting bell-shaped curve is symmetrical, rising from a small number of cases at both extremes to a large number of cases in the middle. Normal distributions are found everywhere—annual temperature averages, stock market fluctuations, student test scores—and are thus commonly used to determine the parameters of a design.

In a normal distribution, the average of the variable measured is also the most common. As the variable deviates from this average, its frequency diminishes in accordance with the area under the curve. However, it is a mistake to conclude that the average is the preferred design parameter because it is the most common. Generally, a range across the normal distribution must be considered in defining design parameters, since variance between the average and the rest of the population translates to the variance the design must accommodate. For example, a shoe designed for the average of a population would fit only about 68 percent of the population.

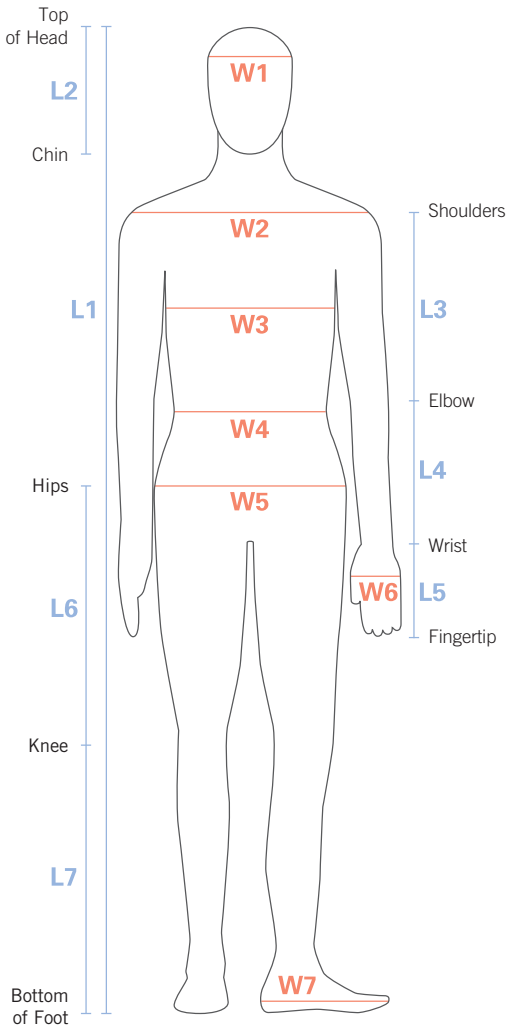
Additionally, it is important to avoid trying to create something that is average in all dimensions. A person average in one measure will not be average in other measures. The probability that a person will match the average of their population group in two measures is approximately 7 percent; this falls to less than 1 percent for eight measures. The common belief that average people exist and are the standard to which designers should design is called the "average person fallacy."[2]

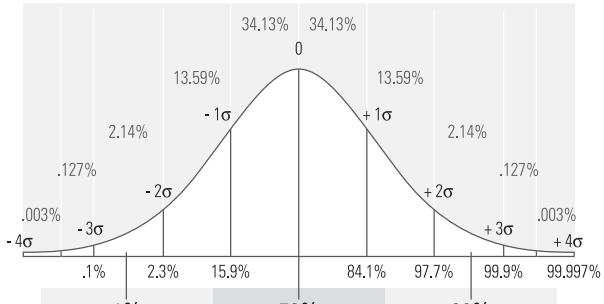
Where possible, create designs that will accommodate 98 percent of the population; namely, the first to the 99th percentile. While design considerations can be expanded to accommodate a larger portion of the population, generally, the larger the audience accommodated, the greater the costs. Consideration of the target population is key. When designing specifically for a narrow portion of the population (e.g., airline seats that will accommodate 98 percent of American males), it is crucial to obtain the appropriate measurement data for this very specific group.

See also Convergence, Most Advanced Yet Acceptable, and Most Average Facial Appearance Effect.

[1] Also known as *standard normal distribution*, *Gaussian distribution*, and *bell curve*.

[2] Anthropometric data drawn from *The Measure of Man and Woman* by Alvin R. Tilley and Henry Dreyfuss Associates, The Whitney Library of Design, 1993.




| | 1% | | 50% | | 99% | | |
|---|---|---|---|---|---|---|---|
| | male | female | male | female | male | female | |
| L1 | 62.6" | 58.1" | 69.1" | 64.0" | 75.6" | 69.8" | L1 |
| L2 | 6.3 | 7.6 | 8.7 | 8.6 | 9.9 | 9.7 | L2 |
| L3 | 12.5 | 12.5 | 14.4 | 13.2 | 16.2 | 14.8 | L3 |
| L4 | 10.4 | 9.3 | 11.4 | 10.2 | 12.4 | 11.2 | L4 |
| L5 | 6.6 | 6.0 | 7.5 | 6.9 | 8.4 | 7.8 | L5 |
| L6 | 15.2 | 13.8 | 16.7 | 15.4 | 18.4 | 16.9 | L6 |
| L7 | 14.7 | 13.3 | 16.6 | 15.1 | 18.0 | 16.4 | L7 |
| W1 | 5.6 | 5.2 | 6.1 | 5.7 | 6.7 | 6.3 | W1 |
| W2 | 15.8 | 13.5 | 18.3 | 16.1 | 20.6 | 18.0 | W2 |
| W3 | 10.3 | 8.8 | 12.2 | 10.4 | 14.1 | 12.1 | W3 |
| W4 | 9.2 | 7.4 | 11.4 | 9.0 | 13.6 | 10.7 | W4 |
| W5 | 11.4 | 11.2 | 14.2 | 14.6 | 16.9 | 16.8 | W5 |
| W6 | 3.7 | 3.2 | 4.1 | 3.6 | 4.6 | 4.1 | W6 |
| W7 | 9.2 | 8.3 | 10.4 | 9.5 | 11.7 | 11.7 | W7 |

The measures of men and women are normally distributed. The wide range of measures across the distribution illustrates the problem of simply designing for an average group. Note that no one man or woman is represented by these measures—i.e., there is no *average person* in reality.

The normal distribution is represented by a symmetric bell-shaped curve. The four standard deviations represented by  below and above the average reflect the normal percentages found in the variability around the average. Percentiles are indicated along the bottom of the curve. Note that in a normal distribution, approximately 68 percent of the population falls within one standard deviation of the average; approximately 95 percent of the population falls within two standard deviations of the average; and approximately 99 percent of the population falls within three standard deviations of the average.