Proprioceptive Seating

Proprioception: [n] the ability to sense the position and location and orientation and movement of the body and its parts

See Also: equilibrium,
interoception,
kinaesthesia,
kinaesthesis,
kinanesthesia,
kinesthesia,
kinesthesis,
kinesthetics,
labyrinthine sense,
muscle sense,
sense of balance,
sense of equilibrium,
sense of movement,
somaesthesia,
somaesthesis,
somatatesthesis,
somatesthesia,
somatic sense,
somatic sensory system,
somatosensory system,
somesthesia,
somesthesis,
vestibular sense

Reconsidering office chair design

How awareness of proprioception and the body-use principles of the Alexander Technique provide a practical framework for improving office chair design, construction and use.

UPLIFTING SOLUTIONS

Proprioception – why does it matter?

Proprioception is the body's sense of itself. It involves the pull of gravity on receptors in our joints and tendons and assists us in knowing which way is up. Accurate proprioceptive awareness is essential to good posture and body use. For example, when an arm or a leg 'goes to sleep', proprioception is temporarily lost. Poor proprioception perpetuates back aches and repetitive strain injuries because we are unable to sense the extent to which we are damaging our bodies. Increasingly, the office chair is a prime culprit for undermining proprioception and natural posture.

It is commonly assumed that less gravity equals better posture. Wouldn't we all be more upright if gravity didn't weigh us down? The answer is no. Skylab experiments in the 1980's showed that the human body folded into a semi-crouched position in zero-gravity conditions. (Tengwall 1981). In fact, *our bodies lengthen naturally in response to gravity.*

Confusing stimuli can undermine our sense of gravity, and thus our ability to be upright. For example, standing on a soft sofa makes it difficult to balance easily – the feet have no reliable support with which to organize the whole body. A sense of stability can only be achieved by excessively tightening the body's muscles, which further reduces proprioceptive feedback.

"If proprioception is completely knocked out, the body becomes, so to speak, blind and deaf to itself and …ceases to 'own' itself, to feel itself as itself." (Sacks 1990)

Using a computer and a mouse requires fine motor skills. Imagine trying to paint a detailed picture while standing on an airbed. Your sense of gravity is undermined, and the muscles are extensively tensed to compensate. The airbed is a poor substitute for a level surface, and quickly tiring. Now consider working at your computer. Can you use your computer with minimum strain while sitting on a soft yielding seat? Or on a chair that requires you to tighten or pull towards the computer? Or on a chair that bounces or shifts with every breath you take?

Technological Progress and Postural Regress

Humans have evolved for constant movement, not to sit at work stations. We literally don't easily fit into our specialised technological environment, where certain tasks are performed over and over again. And while we are all obviously capable of sitting, human beings are not 'designed' to sit for most of the day. In many cultures, people do not - or did not - sit on chairs at all. Australian aborigines or American Indians depicted in 18th century illustrations, for example, do not slouch or stoop; they were evidently none the worse posture-wise for a lack of chairs.

Although we all now take chairs for granted, the invention of the chair is relatively recent event in the human time-line. Early chairs were often a symbol of status, such as a throne. (Of course, many contemporary chairs are also primarily designed for status. It's no coincidence that the *chairman* is the leader of most organisations.)

Other early chairs such as stools evolved as writing developed. Pages were leaned on raised surfaces. Paintings of medieval monks preparing illuminated manuscripts show them standing to work at large sloping desks. Other illustrations of renaissance scholars depict sloping desks above flat topped stools or benches. Dickensian law firms show clerks perching on high stools over sloping desks. Since the 16th century, pianists have perched on firm, height adjustable benches, providing essential stability for intricate hand movements. More support, less strain.

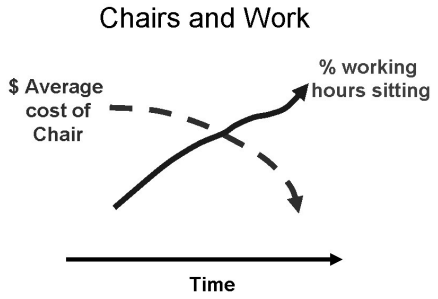
Enter the typewriter: a technical innovation requiring a flat, as opposed to a sloping, surface for use. Early typists sat on simple wooden chairs. The later swivel chairs of the early 20th century still featured flat seats with no or little padding.

More work is now being performed when sitting than at any other time in history

Our contemporary workforce comprises an ever increasing proportion of computerised 'knowledge workers', typically undertaking a large number of repetitive, screen based, data entry tasks. As such, more and more employees are becoming more and more sedentary. Obesity is a 'growing' problem, as are repetitive strain and back injuries, the latter now being the most frequent cause of time off work after the common cold.

The irony is that while vast quantities of global information is literally at our fingertips, our capacity to interpret and act upon personal tactile information has diminished. Flat desks, flat keyboards (requiring workers to rotate in a more forward direction) are opposed by soft padded seats, which often tilt the worker away from the work surface. Add to this uneasy struggle the need to lift arms forward from the torso towards the keyboard and mouse for most of the working day, and another physical dynamic is introduced that can easily throw the worker off balance.

Meanwhile, back at the factory, new cheaper methods of chair construction have been developed. The emergence of mass production techniques and new materials, such as injection moulding, has driven down costs. The situation is summarised by the graph below - larger numbers of people working from chairs, the relative cost of which has declined markedly.



More of us are working in cheaper chairs than ever before, and sitting in them for more hours each day.

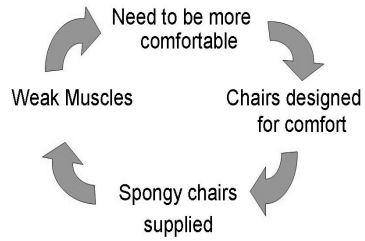
We have evolved into a table and chair working culture (Clark 2002) where many, if not most, activities take place at a right angled 90% sitting position. And that's not necessarily good for us.

Questionable Ergonomics

It hasn't taken long for people to experience the problems created by our new way of working. Confusion has developed between what *feels* good, what *is* good, and how much a chair should cost. This has triggered the development of various ergonomic solutions for chair design, based on many questionable ideas.
Familiar examples include,
More padding = more comfort.
More reclining = more comfort.
Bigger chair = more comfort.
Lumbar support = better posture.
More movement or "bounce" while sitting = better posture.

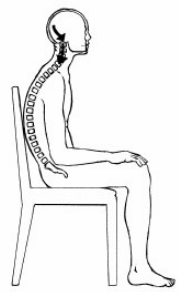
There have been multiple studies into seating ergonomics and the posture that we should assume when working at school or at the office, at our desks. Many of the studies proceed from certain cultural assumptions: we somehow should "sit up straight!" as our primary school teachers instructed us. A growing body of research, beginning with FM Alexander's insights over 100 years ago through to Mandal (1987) and Cranz (1998) show that many ergonomic assumptions have been just plain wrong. Ergonomics continues to be a confused science, with many contradictions.

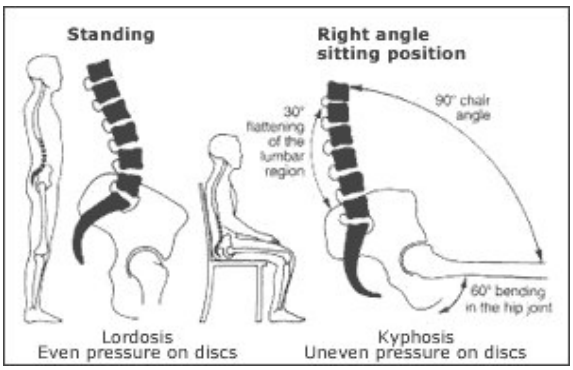
In many cases an unspoken cultural bias (Cranz 1998) is built into seat posture. Where chairs have been designed specifically for work, it was often on the principle that people should sit upright, with hip, knees and ankles all at right angles. There is no scientific basis for assuming that a right angled posture, for working at a right angled desk, is a desirable posture (Mandal 1987). Indeed, the right angle seat posture is intrinsically stressful to the spine. The position of the thigh muscles affects the lumbar (mid-lower) portion of the spine, pulling it backwards and sending it in the direction of a 'C' shaped slump, which is exacerbated by the natural tendency to keep the eyes at a horizontal level. Therefore the spine tends to change shape but the position of the head does not.



The Cycle of Perpetual Discomfort.

It is obviously difficult to experience accurate proprioception in these circumstances. A much preferable posture is achieved when the upper leg is allowed to slope downward towards the floor, allowing the work of sitting upright to be distributed more evenly along the spine. As Mandal (1987) notes, a sitting posture that approaches the natural resting position, is a more suitable position and allows the spine to carry the body weight in a more comfortable way. Mandal terms this "Balanced Seating".





Illustrations courtesy Dr AC Mandal, Copenhagen.

A posture requiring a 90 degree angle at the hip joint is not healthy for the spine. Several studies have indicated a more open posture, of up to 135 degrees at the hip joint, is preferable.

Tilting the seat pan forward alters the sitter's centre of gravity from behind the sitting bones (ischial tuberosity) to directly above them. The lumbar curve (lordosis) is restored, reducing pressure on the discs. As a result, muscles do not have to be contracted or tensed to maintain an upright posture.

The Design Conundrum: towards Better Office Chair Design

Thonet chair c.1890

Cesca chair, Breuer, 1924

Barcelona chair,
Van Der Rohe 1925

Tulip chair
Saarinen 1955

The above chair design milestones have significantly influenced office chair development

While chairs are obviously an important medium for good body use, particularly in an office environment, most chairs have a very weak physiological basis for their design. In fact, many chair designers pay little regard to physiological or ergonomic issues, specifically where the principal reason for designing a chair is to make a design statement, to provide a work of art or sculpture. As Rybcynski (1987) notes in relation to interior design generally, designers are often faced with the conflict between what *looks* good and what *feels* good. Even though certain schools of design such as the Bauhaus dictum of 'form follows function' advocate the primacy of functionally, most often the *style* of a design wins out, leaving users with the least comfortable option.

Many of the most famous chair designs of the 20th century are at best ergonomically suspect. They look great but their utility is often quite poor. This problem is further compounded in the area of office chair design because even when a chair appears to be wholly functional, manufactured with little regard to fashion, it still may not be a good design ergonomically. The most comfortable office chair is not necessarily the best ergonomic chair. Just as a bean bag or a very soft mattress both might initially feel comfortable, over time they are likely to cause chronic back pain.

Series 7, Jacobsen 1955

Beanbag anon c1965

Balans chair Opsvik 1975

Active Balance chair Stenning 1998

Post war chair designs have had a greater focus on ergonomics, not always successfully, as the Beanbag illustrates

Confused about Comfort

As shoes shape feet, so chairs shape bodies. Sitting in chairs is not a natural activity – many cultures rarely use them. Humans are immensely adaptable. Throw us off balance by putting us into a curved seat for long enough, and our bodies will reshape to suit. This starts to affect how we organize our body parts relative to each other, even when not working at a desk. The body's accommodation to suit the chair undermines the basis of easy postural support. Eventually we feel we need a curved chair in which to collapse our deformed bodies. The chair becomes a cradle for our confusion.

Then add the idea that we should use these same chairs in which to "sit up straight" and the lumbar support merely pokes forward the sagging curve of our collapsing bodies. The way we use our body affects its ability to function well. Use affects function. Chairs have a direct impact on the way we use our bodies.

A good chair encourages healthy balance by providing firm support and easy orientation to the working task. Bad chairs progressively reorganize our bodies for the worse, leading to back and strain injuries. After this has happened, a better chair can often feel wrong at first, as our perception has been remodeled by years of sitting in poor chairs. Despite this, a better chair can provide the conditions for subsequent postural improvement and strain reduction.

An Effective Design Methodology

The Alexander Technique (AT) is a unique discipline dedicated to improved body use through restoring the accuracy of the proprioceptive sense. Based on the writings of the Australian FM Alexander, the technique has been established for over 100 years and largely pre-dates modern ergonomic analysis. It offers an invaluable framework for human-sensitive furniture design.

Central to the technique is the concept that the relationship of the head, neck and back has a direct effect on the co-ordination and well being of the whole person. Ideally the head needs to be balanced in such a way that the length of the spine is not curved or compressed. Lightness and ease are possible when an equal amount of work is performed by complementary muscle groups. Long term comfort requires some muscle use.

Padding and Proprioception. Too much cushioning can cause the body to sink into a chair constraining movement. A soft chair may be comfortable at first, but as the body sinks blood circulation lowers, skin temperature rises in affected areas, and compression under thighs increases. The pelvic bowl needs to open out against a firm surface. Overly upholstered seats allow the bones to sink and pelvic wings to turn in on themselves.

Head / neck relationship. A chair should not disturb the capacity of the person to organise and maintain the proper dynamic between the head and neck. The head / neck relationship is not fixed. The neck should not be forced into a swan like configuration with the spine inclining backward and the head inclining forward. Backrests should have the ability to 'follow' the sitter through a dedicated range of adjustment to the angle of the back rest, *without* simultaneously adjusting the seat pan angle, as the user moves forward in the chair.

Maintain natural spine curvature. The spine itself should not be deformed: the two forward curves at the neck and lumbar should be maintained. The sitter should be able to pivot comfortably from the pelvis, with adequate lumbar support.

Weight distribution through the feet. Feet should be comfortably on the floor with 60% of the weight through the sit bones and 40% of the weight through the heels (i.e. the whole weight of the legs should be supported by the feet).

Multiple chair sizes. While exact anthropometric statistics are not available for all countries (eg contemporary data on current average Australian body sizes is unavailable), it is self evident that people come in many shapes and sizes, with different movement habits. Reject 'one size fits all'. Office chairs must be available in different sizes.

Multiple adjustment points. Height of backrest, tilt of seat pan, height of seat pan, and tilt of backrest are all desirable adjustments within certain parameters to accommodate a range of movements, and to compensate for differing energy levels throughout the day.

The Stenning Active Balance office chair was designed with the above principles in mind.

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