# Creating the Perfect Seat: Chair Design and Engineering

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**Keywords:** Chair, Design, Engineering, Spine, Neutral Position, Body, Back Pain

**Abstract**

The human body was never meant to live a sedentary lifestyle. Yet, many people today spend most of their time sitting in front of their desks and computers on poorly engineered chairs. In the long run, this can lead to grave problems such as lower back pain, poor blood circulation, low energy levels, stressed joints and misaligned spines. Aside from this, these chairs can also cause the negative permanent restructuring of the body – the body will become stuck in an "unnatural position." Therefore, it is vital that this serious problem be alleviated. And, although it is ultimately the responsibility of people to assume correct posture when sitting down, a well-engineered chair can certainly help out and promote the proper posture. As such, this article aims to explain and explore the engineering, technology, and feasibility behind the possibilities of creating a perfect chair and putting an end to problems associated with ill-engineered chairs.

# Creating the Perfect Chair

## Introduction

According to the British Chiropractic Association, the human body was never made for sitting down [1]. However, modern society dictates otherwise. With the majority of people spending most of their days sitting on poorly engineered chairs in offices and schools, a number of unfavorable conditions have arisen: chronic lower back pain, poor blood circulation, unnatural posture, low energy levels, and stressed joints.

This is a serious issue because the act of sitting for prolonged periods severely injures and wears down the human body over the long run. According to the British Chiropractic Association, the human body is not “designed to be so sedentary [1].” Instead, it was built for an active lifestyle, constantly hunting and gathering food [1]. Nonetheless, times have changed; people have to sit down and work to earn a living. Still, there has got to be a solution that will alleviate this problem.

Imagine a chair that allows your ankles to rest comfortably at the ideal angle, does not restrict blood flow whatsoever, and fully supports your upper and lower back. In fact, the reality of having such a chair is closer than people might believe; modern chairs have come a long way from their predecessors such as stone-made seats from the Roman Empire. Through advancements in engineering design and breakthrough technologies, the characteristics and features of chairs will continue to improve, and ultimately be perfected. Still, a chair’s functional and raw design should be based on the ergonomics of sitting.

**The Art of Sitting**

The ergonomics of sitting revolves around the physiology and structure of the human spine. The human spine is also known as the spinal or vertebral column, or in simple terms the "backbone" [2]. This aspect of the central nervous system is responsible for providing the human body with a flexible central support system [2]. It embodies 33 ring-like bones called the vertebrae which are wrapped with strong ligaments and muscles [2]. In essence, the spine holds the head and torso upright, yet enables the back and neck to bend and twist [2]. The way people sit and what they sit on strongly affects the health of their spines. Essentially, there are three types of sitting positions: anterior (forward leaning), middle (relaxed, unsupported), and posterior (backward leaning) – the first and the last being more ideal [4].

**Biomechanics of Sitting**

According to the Musculoskeletal Association of Chartered Physiotherapists (UK), various sitting postures have different effects on spinal load and trunk muscle activation. Some positions reduce the burden on the backbone [3]. Hence, a poor sitting posture which is mainly associated with the engineering design of the chair can cause spinal flexion, which negatively distresses spinal proprioception (the unconscious perception of movement and spatial orientation arising from stimuli within the body itself) and ultimately leads to lower back pain and restricted blood circulation. However, if the chair is already designed perfectly, it will be up to the people to correct their sitting positions – many experts recommended a slightly lordotic (curved inward) sitting posture which mimics the natural curve of the lumbar region of the

spine. As seen in **Fig. 1**, the Kyphosis sitting position (excessive outward curve of the spine/ hunching of the back) is not ideal for the human body as it puts stress, taxing load, and uneven pressure on the discs. If people observe and assume poor postures consistently and repeatedly over a long period of time, their bodies and spines will eventually adapt and restructure themselves, resulting in abnormality, misalignment, and chronic pain.

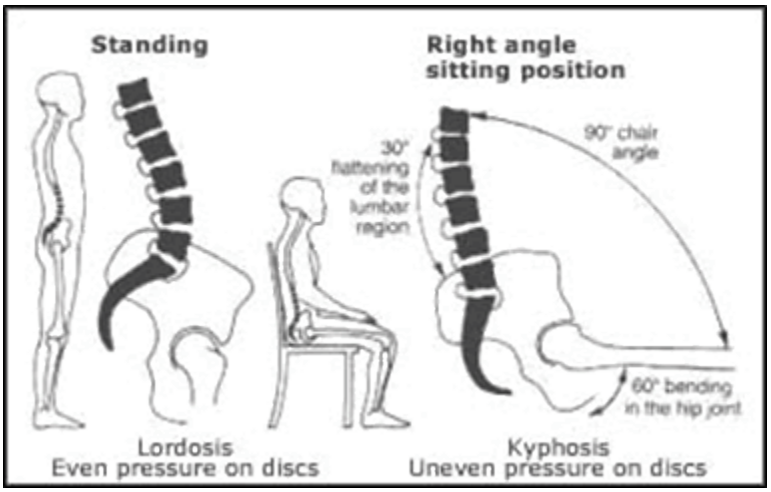


**Fig.1 : Kyphosis Sitting Position [7]**

It is important for people to assume their roles in practicing correct posture. Still, many of the ill-engineered chairs today make this a difficult task. This is because manufacturers prioritize profit margins over the expensive engineering and production that goes into making the ideal chair.

**Characteristics of the Ideal Chair**

Imagine no back aches, neck pain, or lack of energy. According to industrial and systems engineers, the human interface with the world of work strongly affects people's physiological health [6]. For instance, a dimly lit office with uncomfortable chairs and unreasonably hot

temperature would contribute to a high rate of absenteeism. Thus, human factors (specifically physiological characteristics such as the curvature of the spine and build of the nervous system) play a large role in shaping the characteristics of the perfect chair [6].

Ideally, a human-friendly chair would normalise spinal load and trunk muscle activation [3]. This would entail a comfortable and adjustable head rest allowing comfort and support for the neck – this would alleviate stiff necks. Additionally, it would include a slightly curved inward back support which will enable the spine to rest in its neutral position (i.e. spinal load and stress are minimized). Aside from this, the curved inward support unit will extend lung capacity, allowing deeper and more relaxed breathing as it forces the lungs and diaphragm to be at the upright position [8]. Further, it should feature an ergonomic recline system allowing the body to rest between the angles 100-110 degrees, which will lessen the stress on the lumbar (back) muscles – the user will be able to alter from the anterior and posterior positions with relative comfort and ease [4]. Moreover, it needs to have adjustable height; a high chair tends to increase pressure at the popliteal fold (underside of the knees), increasing pressure on the nerve and restricting blood circulation, while a low chair tends to increase weight on the ischial tuberosities (bony swelling found on lower part of the back), causing back pain [4]. Seat depth and cushioning should also be adjustable. Ideally, 14-18.5" for seat depth, as this allows the user to lie on the back rest, and 1.5-2" for cushioning as this enables the optimum comfort level [4]. To further promote proper posture, armrests should be installed as these provide extra postural, sitting, and standing support; however, these should not engage the bony parts of the elbow where the sensitive ulnar nerve is close to the surface [4]. Finally, the chair should also be equipped with an elevated leg rest to promote unrestricted blood circulation through the

organs and the body – this can help revitalize energy levels. Sadly, these types of chairs are inaccessible to the wide public.

In fact, Peter Opsvik, a Norwegian Industrial Engineer, became frustrated with the available chairs on the market that he decided to design one himself. As seen in **Fig. 2**, Opsvik's chair design includes most of the characteristics of an ideal chair. In **Fig. 3**, it can be observed that a person is resting in the neutral position. Still, many chair manufacturers have ignored these human factor associated solutions.

**Fig. 2: Peter Opsvik's Ideal Chair Design [9]**

**Fig. 3: Person Resting in the Neutral Position [9]**

**Creating the Ideal Chair: The Engineering behind it**

Creating the ideal chair has a lot to do with engineering: manufacturing processes and material selection.

Fundamentally, the chair's structure is determined by the characteristics of its material and the manufacturing processes used to build it. Some manufacturing processes that are able to produce chairs are plastic injection molding, metal casting, forming, stamping and shearing. These processes have their advantages and disadvantages [5].

The plastic injection molding process involves filling (injecting) molten plastic into a mold and then applying pressure to it to allow it to solidify to the desired shape. Usually, thermosetting plastic material is used for this process due to its nature of being consistent and irreversible after solidifying [5]. Aside from this, the plastic injection molding process allows extremely complex shapes to be built. Hence, plastic molded chairs can have the proper curvature, bends, height, and angles. Thus, the injection molding process can be extremely advantageous as it allows the chair to accommodate the raw human physique (i.e. the slight curvature of the spine) at relatively low cost. And due to its efficient, quick, and simple process, ideal chairs with high dimensional accuracy and stability can become accessible to the majority of people [5].

Likewise, the mentioned metal processes above can also build complexly engineered and spine-friendly chairs. In fact, the metal processes would likely offer a more solid and stiff build, hence forcing people to sit in the proper position, offering greater postural support. However, these metal processes would drive up the costs of production and hence the retail

price of these ideal chairs, denying some people the ability to own one. As seen in **Fig. 5**, the "Perfect Chair" by Human Touch features a leather finish with an underlying electronic metal chassis. Although this chair may be ideal since it solves the problems associated with poorly engineered chairs (such as lower back pain, neck pain, and limited blood circulation), it costs thousands of dollars; therefore, it is not accessible to a large market. However, a metal chair would still be more ideal than a plastic chair since it provides enhanced adjustability, durability, and reliability [5].


**Fig. 5: "The Perfect Chair" by Human Touch [8]**

**Feasibility**

Although the technology of creating an ideal chair is already available, the costs of production are extremely high (e.g. "The Perfect Chair" by Human Touch as seen in **Fig. 5**); hence, it is not accessible to majority of people because of the high retail price. Aside from this, there are few companies like Human Touch that diligently invest in producing a well-engineered chair possibly because of relatively high cost and low demand. Besides this, these chairs can

further be improved if each of them were custom built and tailored to each individual user (i.e. specific leg, arm, and back measurements will be used to build the chair), yet again, adding more costs. Without competition, which fuels innovation, specialized companies such as Human Touch will be able to continue to sell at a premium price. Still, it is feasible that perfectly engineered chairs will one day be ubiquitous in workplaces and schools universally – continuous ground breaking technology makes this possible.

For example, 3D printing allows computer models of realistic objects to be printed in a few hours [5]. People would then be able to use 3D scanners to create an extremely accurate image of their body proportions and hence, these photographs can be used to determine the dimensions of a custom-tailored chair, which can be printed out on the same day.

**The Future of Perfectly Engineered Chairs: The End of Lower Back Pain**

Through diligent research, constant innovation, and generous funding, the perfect chair will one day be accessible to the mass population. But more significantly, according to Dr. Waseem Bashir of the Department of Radiology and Diagnostic Imaging at the University of Alberta Hospital, “sitting in a sound anatomic position is essential, since the strain put on the spine and its associated ligaments over time can lead to pain, deformity and chronic illness [1].” In other terms, even though a perfect chair is developed, it is ultimately the responsibility of the user to practice proper posture; the chair merely supports and promotes this correct posture.

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