Grey field

Search for an intermediate solution on the field of seating

Master Thesis 2013

András Kerékgyártó

Furniture Design Department
Aalto University, School of Arts, Design and Architecture

Black

Ergonomic / idealistic standpoint

Communication

Representative

 Passivity

Movement

Unnatural

Conventional

Specialized

White

„The way the world works"

Function

Functional

Activity / movement

Sitting

Natural

Alternative

General usability

Grey Field

Search for an intermediate solution on the field of seating

András Kerékgyártó

Furniture Design Department
Aalto University, School of Arts, Design and Architecture

Contents

The appearance of chairs, and the way we sit haven't really changed since centuries, despite developments in our lifestyle in the past one and a half century. Increasingly more people spend increasingly more time sitting unhealthily. The chair simply has not kept up with these developments and the new demands generated by them. There are still some very fundamental (ergonomic) problems with sitting, since it is not a natural position: it is indeed a paradox that the usage of conventional chairs still keeps increasing.

This phenomenon raises the question why still should we use these chairs if we have alternatives? The alternatives offer healthier position on the long run but only for a narrow group of people: in general we can say that we gain a more healthy position, but we lose the general usability. For example the kneeling chair puts unbearable stress on the knees for elderly people, or the saddle-chair is not usable with short skirt, the exercise ball is too unstable. There are situations where many different people have to be seated at the same time and these alternative solutions can not offer acceptable accommodation for all. This is why conventional chairs are so wide-spread, and this is what still forces people to use them: there are simply no better solutions when people with diverse needs have to be seated.

To sum it up, virtually we have two extremes, on the one hand the conventional chair, characterized by general usability, but at the same time by serious drawbacks as well: it is acceptable for the widest possible range of users, but not particularly good for anyone. The other extreme are the alternative solutions, which while very favorable for a particular group, exclude others. Currently there is no gradual transition between the two extremes, it is a black and white situation, a true schism.

This is where I see an unfilled gap even though the demand exists: there are several situations, spaces (e.g. waiting areas, auditoriums, restaurants, cafeteria) where users with diverse needs meet and have to stay seated for an extended periods of time, thus general usability and a more healthy position would be required.

With my degree project I am exploring what is between the two extremes: if one is black and the other white, what can be the gray? I am searching for the answer of the following question: can the comfort of the alternatives be mixed with the universality of the conventional sitting? For the above mentioned reasons I believe that there is a demand for filling this gap, to find the delicate balance and the right compromise between the two. It remains to be seen how radical this „grey" chair should be, can it be an independent seating solution on its own or an improved version of the conventional chairs.

Introduction

1. Klismos chair

If one would assess the progress of civilization in past three thousand years based on chairs, we might assume that not much happened: the appearance of chairs is surprisingly similar to those ancient ones, along with the way we sit and the posture we adopt when sitting. But in fact our way of life and habits have changed fundamentally: never before in history have mankind been so passive physically, it is safe to say that our lifestyle became sedentary. We sit increasingly more often and for more prolonged periods than ever, yet the ergonomics of sitting still follows the „old school".

On average people in the United States spend at least 30 percent of their day (8 hours or more) in sedentary activities,[1] or in other words 60 percent or more of their waking hours. We sit when commuting, when working with computer, and in our free time as well: when we eat, watch television or use game consoles. The fact that we actually spend most of our time sitting rather than standing (which is a more natural position) is a sufficient reason in itself to seriously reconsider our approach to seating. Our chairs, currently in use date back to an era when chair was a privilege of the ruling class, and the majority of the population was still physically active. Therefore these seating solutions can not comply with the challenges of the present, they are lagging behind the current demands.

These prolonged sedentary behaviors, so typical today can be directly linked to adverse health consequences, from which back pain is the most widespread and thus the most pressing problem to be addressed. In the United States[2] and United Kingdom[3] back pain is the second most common health-related complaint after stress, and the most common among bodily ones. The problem is not simple and isolated anymore; it reaches far beyond itself, and has several aspects, seriously affecting the economy for example. Backpain, (caused or made worse by prolonged sitting) by being the most common reason for sick-leave is responsible for most of the lost

---

[1] Matthews CE, et al. „Amount of time spent in sedentary behaviors in the United States, 2003-2004". In: *American Journal of Epidemiology* 2008, pp. 875-81. http://www.ncbi.nlm.nih.gov/pubmed/18303006 14. 10. 2012.
[2] "Summary Health Statistics for U.S. Adults: National Health Interview Survey, 2010". pp. 14., 48., Table 9. http://www.cdc.gov/nchs/data/series/sr_10/sr10_252.pdf 10. 12. 2012.
[3] "Musculoskeletal Disorders. Health and Safety Executive, 2011." http://www.hse.gov.uk/statistics/causdis/musculoskeletal/msd.pdf 10. 12. 2012.

working days and thus revenue. Consequently it is also the main reason for visiting a doctor, and the expenses of curing the results of inappropriate seating seriously charges the national healthcare-systems as well.[4] The rapid economic development and urbanization in the third-world countries further increases the scale and importance of the problem as the number of population involved is growing continuously.

This short introduction already makes clear that sitting is a really complicated issue, with many different aspects to be taken into account. A real paradigm shift and a multidisciplinary approach are needed, in order to address all these different sides of the problem. The hardware, the chair itself should be just a part of a bolder plan: a framework of actions is necessary, it should include public information campaigns - how to sit correctly should actually be incorporated into basic level education at schools -, promoting active transport modes, such as cycling, and nonsitting alternatives at community entertainment venues along with new regulations on workspaces that minimize the time of uninterrupted periods of sitting and the revision of certain industrial standards. The role of the designer is to identify valid problems, to oversee the whole system of interconnecting and intersecting forces and fit new, more appropriate solutions into this bigger picture, by using the existing information. Sufficient research- and ergonomical data are available since the 1970's to create better and more suitable seating solutions, yet chair design is still lagging behind current developments.

The main aim of this essay and my degree project is to overcome this lag and offer ideas which could point the way forward in seating design. The end result will be a chair built on and mergeing the experiences accumulated in the field of sitting, which necessitates a comprehensive analysis of the already existing solutions. I will go through the history of chairs and ergonomics, the ergonomic qualities and problems of general purpose chairs, and assess other chair-types and postures as well, in an attempt to uncover the major factors influencing chair design and find the right balance (the grey between the black and the white) between them so as not to compromize any of them. However this project points further than just a thesis topic, it holds much more potential. My goal is to create a framework of principles for myself which I can use as a guideline for my future work as the issues uncovered here are generally true and valid for a long time. They can form a solid basis for any future designs as comfort and usage should be an implicit starting point of any object. Therefore this essay should be open and permissive enough to leave a certain space for movement, or for future improvements to be incorporated into the framework.

---

[4] Reinecke, S. M. and Hazard, R. G.: Continous passive lumbar motion in seating. In: Lueder Rani, Noro Kageyu (eds.), *Hard Facts About Soft Machines: The Ergonomics Of Seating.* CRC Press, 1994, pp.157.

Chapter I. Historical background

Brief historical and cultural overwiev of sitting

Many of the problems and issues with chairs and way we use them are rooted deeply in their history, therefore it is crucial to examine how chairs and their usage evolved over time. Here I am attempting to collect only those most important aspects relevant for this current study. By chairs I mean seating furniture elevated from the ground and equipped with a backrest. The presence of a backrest differentiates a chair from a stool.

The history of sitting in the modern sense is parallel with upright human's, right from the beginning, when we stood on two legs for the first time. In fact most fo the problems with sitting also date back to the very same time: the uprighting of human. Since the uprighting it is very hard to call any posture natural: the change was very dramatic, and we can feel the consequences of it even today. During the history of mankind several postures evolved, but the closest we could ever get to our forever lost natural state is by moving, continous physical activity. In fact our body and muscles were designed for movement: moving is the process of transiting from one posture to the other, so it can not be called a posture. The closest maintained posture is perhaps the standing: while the back is "straight" during laying the distribution of masses and support are significantly different from standing. The other, non-natural postures serve the purpose of resting, such as kneeling, squatting and sitting. With the exception of sitting and laying these are highly temporary, they enable a fast transition to being active again, and thus were typical to tribes pursuing a non-settled hunter-gatherer lifestyle,where a contstant readiness and alertness was crucial. Sitting however is a fundamentally unnatural posture, which -if maintained over a prolonged period of time- cause a slouching back and adverse health consequences along with it.

It appears that chairs have emerged already during the Stone Age, but their more advanced development and widespread presence in daily life is linked to the ancient Egypt. Folding chairs and stools were used in Egypt since 4000 years ago "as portable thrones". Interestingly very similar designs were found from the Nordic bronze age, around 14th century BC, claimed to be used by the tribal or the spiritiual elite.[5] Remains of chairs with four legs and backrest were found from the times of the ancient Greece as well.

---

[5] Schulz, Matthias, „Bronze Age Espionage: Did Ancient Germans Steal the Pharaoh's Chair Design?"
http://www.spiegel.de/international/zeitgeist/how-did-egyptian-folding-chairs-end-up-in-northern-germany-a-830958.html 05. 04. 2013.

But even as settled lifestyle became more widespread in Europe chair usage was not predominant until the 19th century. The chair was a privilege of the rulers in the form of throne: "in the king's presence most people had to remain standing. Permission to use a stool —the only seat allowed in his presence—was a coveted honor".[6] This elevated position demonstrates dominance and authority, but also seriously restricts the scope for physical movement. This allows the ruler to focus his mental and spiritual abilities, and to connect with cosmic forces, for the benefit of the community. Indeed, the passive body, active mind a fundamental attribute of sitting all along it's long history, only the scale have changed dramaticaly since then. The usage of chair spread among the ruling class, aristocrats only later, around the reign of Louis XIV in France, because the aristocrats were living in wealth and relative passivity. One special case though was riding a horse: it meant sitting on horseback for long periods, but by its nature it can not be called passive: the rider constantly moves together with the horse, it is an early equivalent of dynamic sitting. The saddle lets thighs hang down, thus creating a posture where keeping the back upright is easier even without any backrest. In fact, the saddle was more suited for long-term use than the actual chairs. In strong contrast to aristocracy the lower classes of the feudalistic system exploited by the former were working very hard mainly in the agriculture and haven't spent much time sitting. These commoners used baskets, benches, stools, chests and such for the purpose.

2. Buddha statue

Up until the 9th century AD sitting on the floor was the common way of sitting throughout all major far-eastern cultures such as China, Korea and Japan. Other furnitures, such as desks and even buildings were accordingly low, since upright sitting was uncommon. The spreading of Buddhism in China around 200 AD however meant that sitting on raised platforms instead of simply mats gained more popularity as the figure of Buddha was always depicted in such posture. These elevated platforms were used as an honorific seat for special guests and dignitaries and by time evolved independently from Western world into similar types, such as chairs, benches, stools and sofas. Folding stools were similarly adapted and proliferated after they were brought in to China by the constantly attacking nomadic tribes.[7] The use of this diverse range of furniture became common throughout the whole society, but the more sophisticated designs were generally a privilege of official and/or elite class. With this early switch to higher, more elevated furniture structures China is the only major far-eastern culture with a long tradition of elevated sitting.

[6] de Dampierre, Florence: *Chairs: A History.* Harry N. Abrams, 2006.
[7] Wikipedia: „Chinese furniture". http://en.wikipedia.org/wiki/Chinese_furniture 16. 04. 2013.

In Korea and Japan sitting on the floor remained predominant, with their own specific postures. In Korea the cross-legged "turkish-style" sitting is prevalent, even the king and queen (before 1910) used to sit this way on a raised platform, without the limbs hanging down. In Japan seiza (meaning "proper sitting") is the traditional formal way of sitting. It is a kind of kneeling position, meals and tea ceremonies were held on tatami floor sitting around a low table. This manner of sitting was generally adopted in everyday life, chair was more of a symbol of authority and social status rather than a utility object before the Meiji era (1868-1912).

In Africa stools and chairs were also significant objects of leadership regalia to such an extent, that in some cases ("leadership stools") nobody was allowed to sit on them as it was a sign of their power, a royal insignia.[8] It is common through many African societies in every level that stools are very personal belongings, which expresses their owners status and believed to contain his spirit and power.[9]

It is apparent that sitting usually developed in communities which led a settled life, where a certain safety was already present without threats constantly endangering lives. It can be said that one mark of civilization is the seat that elevated the body from the cold and wet ground. It is also striking that during the long history of chairs so far discussed here aside from a few exceptions the elevated position meant elevated status as well. Even in today's English the expressions like "chairman" still reflect this representative era of chairs: the heads or directors of committees, boards and academic departments are addressed like this. Endowed professorships are still referred to as chairs. The chair raises it's occupant to an exceptional position, to a different level than all the others, who are excluded from this honour, thus representing a privileged status, authority. This exclusivity, that it differentiates its owner from others was in fact a key feature of chairs, more dominant than the functional one: chair was simply not meant to be used extensively for long periods.

It was not before the Industrial revolutions at the end of the 18th century in Europe that along with many other consumer goods chairs became more available for the wider public: the Thonet. Indeed the processes started in this age brought the biggest change in the history of this object so far: a shift took place from the chair's craft origins to industrial production. Chairs have never been so widespread before. With the rapid industrialisation, desintegration of rural-feudal society, the bourgeoisie gaining strength, a new urban lifestyle emerged. The new inventions also enabled an acceleration of information-flow which meant that increasingly more information had to be processed: the bureucracy was flourishing, office white collar work became common.[10] Because sitting frees up the hands and the mind for other activities, it is a favourable position for information processing. Coupling the chair with a table transformed this

---

[8] „African Thrones - Stools – Chairs". http://www.ezakwantu.com/Gallery%20African%20Chairs%20-%20African%20Thrones%20-%20African%20Stools.htm 05. 05. 2013.
[9] „Asante stool". http://www.randafricanart.com/Asante_stool.html 05. 05. 2013.
[10] Jonathan Olivares: *A Taxonomy of Office Chairs.* Phaidon Press Limited. New York, 2011, pp. 17.

originally spiritual / luxury object into a powerful productive force: sitting has become a working position. The disciplined nature of sitting did not change however: it still demands ignoring the sensory world with willpower and devotion to abstract thoughts, though in a much less sublime way than in the earlier periods of the history of chairs. These developments also brought into existence a new genre, the office chair. The first such attempt - which already had one of the most important feature of modern office chairs: the promotion of movement as it could swivel and tilt in every direction - was Thomas E. Warren's Centripetal Spring Armchair in 1849.[11] It was a forerunner of the unfolding conflict between productivity oriented capitalism and human body, where office chair became a tool to make the most out of the employee. At the same time, the emergence of mass society made the education available for practically everyone, further widening the range of chair users. The advances in technology, the new and more affordable household devices free up considerable amount of time in the average people's life, meaning that chairs gained ground in the leisure time as well.

3. Centripetal Spring Armchair

But despite the enormous changes in the way and regularity/incidence the chairs were used, the postures which were inherited from the earlier, "representative" era were adapted. Chairs in an unchanged form were used in a way they were never meant to be: great masses of people started to spend long times in this unhealthy position. For a long time 'sitting straight" was thought to be the correct way, with the seat pan and the backrest usually in right angle. Indeed, when Thomas E. Warren's Centripetal Spring Armchair appeared it was deemed immoral, because it was too comfortable.[12] The idea of a chair assisting posture seemed unacceptable in an age when straight posture should be achieved unassisted, thus demonstrating willpower and morality: straight posture meant "straight will" as well. The Taylorist work methods widely adopted in the era divided the workflow into separate steps which meant, that the employees were also separated spatially and were sitting in different type of chairs reflecting their position within the company. Chair ranges usually offered 3-4 hierarchical distinctions by the different features and materials used from the most expensive executive chairs, to the basic ones intended for the administrative staff. This practice remained in use until the 1960's. The spreading of the computer work stations slowly started to dissolve the Taylorist, strictly separated work environment to replace it with a more open

---

[11] Jonathan Olivares: *A Taxonomy of Office Chairs*. Phaidon Press Limited. New York, 2011, pp. 17.
[12] Pynt, Jennifer, Higgs, J: "Nineteenth-Century Patent Seating: Too Comfortable to be Moral?" In: *Journal of Design History* 01/2008, pp. 277.

cooperation and communication oriented ambience. Time spent with sitting once again grew exponentially and consequently physical passivity also reached levels never seen before.

The extensive prevalence of the chair meant that as an object it has lost its exclusivity and representative nature but it was not yet counterbalanced by better comfort either. Chairs suffered a total loss of identity: they were neither representative, nor functional in the era. The great changes in everyday life simply rendered chairs obsolete with an immediate effect. The transition from an overly representative object to a more utilitarian commenced very slow: even the newborn office chair reflected their user's status (different materials, more robust construction) and it was not before the Aeron Chair of 1994 that the different versions of the range were about accommodating varying body sizes, rather than hierarchical distinction (only one colour, but three different sizes).[13] Designers of the twentieth century were preoccupied with experimentation with the new manufacturing processes, materials and how to combine them rather than the welfare of the body (see Marcel Breuer, Mies van der Rohe, etc.). The efforts didn't go deeper than the structural systems of the chairs, the wellbeing of the users was overwritten by the „sculptural fascination".[14] More attention was paid to how does the human interact better with his/her environment, and a bigger angle between the backrest and seat pan was slowly introduced mainly due to the emergence of ergonomics in the 1960's.

4. Aeron chair

[13] Jonathan Olivares: *A Taxonomy of Office Chairs*. Phaidon Press Limited. New York, 2011, pp. 19.
[14] See: Cranz, Galen, 2000: The Alexander Technique in the world of design: posture and the common chair. In: Harer, John B., Munden , Sharon (eds.), *The Alexander Technique Resource Book: A Reference Guide*. Scarecrow Press, 2008, pp. 90-98.

The science of ergonomics first appeared in the United States in the 1960's. Because of the many controversies around sitting the workplaces, offices came under scrutiny early on. It soon became clear that there was a significant mismatch between people and the furniture they were using, as the growing number of chronic backpain related complaints among office workers showed. In the form of sitting ergonomics encountered an enormous challenge: our newborn urban lifestyle condemns us to permanently adopt a posture, which is against our nature in every possible way. The burden of somehow softening the conflict between our body designed for physical activity and the passivity and muscular unloading so typical within the contemporary environments is heavier than ever before.

135°
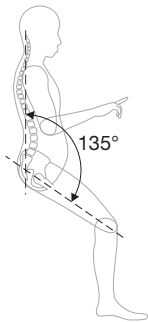
At the beginning sitting-related studies focused on finding "the right posture". Experiments of American orthopedic surgeon J.J. Keegan showed that a bigger openness than the usual 90 degrees angle of the legs and back is desirable and can lead to a healthier position. Based on these findings two schools came into being , both aiming at increasing the angle between the legs and back: Grandjean with a further inclination of the backrest, Mandal with forward-tilting seat pan, thus acchieving a horse-riding like position.[15] This latter idea was developed into the kneeling chair in 1979 by Hans Christian Mengshoel and the designers Oddvin Rykken, Svein Gusrud and Peter Opsvik.[16]

In the field of everyday life however only minor changes took place: Even though many experiments were carried out with different profiles and angles the widespread and generally accepted solution became the slightly inclined backrest, perhaps due to the fact that this solution differed the least from the traditional way of sitting and somewhat accommodated the new needs. The most commonly used angle between the seat pan and backrest became 105-107 degree instead of the 90. In some cases the planar straight backrest was replaced by a more articulated curved backrest with lumbar support, which can significantly improve comfort and posture.

The standards currently in force also support this kind of arrangement of chairs. According to the general guidelines paragraph in the relevant standard (EN 1335-1: 2001 Office furniture. Office work chair. Part 1: Dimensions. Determination of dimensions.) both the angle between the lower leg and thighs and the thighs and back should be near 90 degrees, the thighs close to horizontal and the upper body "straight". The dimensions given in this standard also promote this kind of posture:

---

[15] Mandal, A.C.:Influence of furniture height on posture and back pain. In: Lueder Rani, Noro Kageyu (eds.), *Hard Facts About Soft Machines: The Ergonomics Of Seating*. CRC Press, 1994, pp. 173.
[16] Massey, Anne: *Chair.*-(Objekt). Reaktion books. London, 2011, pp. 119.

Seat pan height: 400-510 mm

Maximum forward tilt of seat pan: 7 degrees

Seat depth: 380-420 mm

Lumbar support height over the seat pan: 170-200 mm

Backrest angle compared to vertical: 15 degrees

Conformity with these standards is not compulsory for launching new products on the market, but they serve as important guidelines and a Europewide accepted set of requirement and thus creates a more transparent situation, better oversight. As major producers choose to comply with these recommendations anyway and have their products tested according to them, the comparison and assessment is much easier. Currently however there are no standards or rules regulating the ergonomic arrangement of unconventional solutions, which makes the field of alternative seatings a grey, unregulated area. With no oversight or established requirements along which these products could be assessed it is very hard to judge the qualities of a certain product, nothing helps or protects the customer.

Fulfilling the general consumer protection regulations of each country however is mandatory. These requirements are about general safety, stability, ensuring that the product doesn't cause any harm for their users. This affects also those products, which are otherwise beyond the range of the standards regulating the ergonomic dimensions of seating furniture. I certainly see here a dire need for a generally accepted commitment and consensus about the possible and adequate alternative postures and the respective ergonomic measurements, whether in a form of extending the currently existing standards to cover this area as well, creating entirely new standards or any other forms of official recommendations.

In the recent past other, not necessarily posture-related issues with sitting came to light as well: the excessive passivity accompanying sitting may have severe cardiovascular and metabolical consequences and a high risk of obesity. During the 1990's the focus has shifted from "the right posture" towards ways of maintaining as much physical activity as possible even during sitting. It is based on the recognition that in fact no single posture can be maintained on the long run, as users would experience discomfort in a rather short time as it becomes constrained: more support actually means less freedom. This idea can be called "dynamic sitting". A dynamic chair typically would allow a wider range of movement on the part of the users by following or even triggering the user's movements. (Continuous Balance Motion chairs, see more at *Alternative solutions* chapter)

The developments in ergonomics are perhaps most widely implemented and most apparent in the field of office chairs. The adaptation of the principles of dynamic

sitting is much more complicated in the case of public/general usage chairs: the cultural expectation to stay still and straight during work are less stringent. The higher price/cost of these chairs is also generally more accepted which makes it possible to encorporate more complicated and costly mechanisms. In todays competitive environment a manufacturer can differentiate it's products by offering better comfort and ergonomics, a wide range of movement lately became an important selling point.

If we try to find the reason why sitting is so widespread, it is worth comparing it to other possible postures, especially to standing. In general sitting is less fatiguing than standing and reduces physiological loading. Sitting requires less muscular activity, heart rate, oxygen consumption and hydrostatic blood pressure in the feet and lower legs than does standing. Sitting also lowers the trunk's centre of gravity and increases the base of support and stability of the upper body. Such stability enhances one's capacity for precision tasks of fine movements. This made sitting the most favorable compromise known so far for activities requiring an active mind.

On the other hand, standing by its nature eliminates the slouching position and the low-back pain, some of the most notorious problems of sitting. Forces can be transferred more effectively while standing. A research also points out that brainwork can be more intensive, reaction times faster and in general alertness higher in a standing position: if we think why sitting was uncommon among non-settled communities this is hardly surprising.[17]

However static standing can be just as unhealthy as sitting: if maintained regularly for an extended period muscle pain, varicosity (a condition of abnormally dilated veins especially in the legs and lower trunk) and various orthopedical abnormalities, such as arthrosis (chronic degenerative disease of the joints resulting from the abrasive wear of the joints) or fallen arch/flatfoot (the arch of the feet collapses and the entire sole comes into a complete or near-complete contact with the ground as a result of the tendons of the feet not pulling together properly anymore) can be the result.[18]

It is clear that just exchanging sitting with a different posture is not sufficient in itself: a constant flow, regular changes between the two postures is needed. Recently a spreading of this more dynamic approach can be witnessed in office environments: variable height tables, high working chairs and stools enable work both in sitting and standing positions. Electronic adjustability of the desktop height can furter ease the regular change of posture. Several manufacturers are offering such furnitures already, for example Martela's Pinta EQ desk, also slightly loosening the strict grid system of standard measurements, which previously prevented the spreading of any higher-than-average chairs.

[17] Vercruyssen, Max, Simonton, Kevin: Effects of posture on mental performance: we think faster on our feet than on our seat. In: Lueder Rani, Noro Kageyu (eds.), *Hard Facts About Soft Machines: The Ergonomics Of Seating*. CRC Press, 1994, pp. 119.
[18] Vercruyssen, Max, Simonton, Kevin: Effects of posture on mental performance: we think faster on our feet than on our seat. In: Lueder Rani, Noro Kageyu (eds.), *Hard Facts About Soft Machines: The Ergonomics Of Seating*. CRC Press, 1994, pp. 119.

Chapter II. Problems with sitting

Adverse consequences of prolonged sitting and their reasons

As it was mentioned already sitting is not a natural posture, because of the passivity, lack of musclework, and the slouching posture one adopts after a certain period of time. If such unhealthy posture is maintained for prolonged periods regularly there is a high risk of severe health consequences. The slouching posture can cause muscosceletal disorders, (most typically lower back pain) while cardiovascular and metabolical ailments can be linked to the physical inactivity.

During sitting in conventional chairs with 105-107 degrees angle between backrest and seat pan, the muscles give in and let the ribcage obey to gravity and fall slightly forward after a few minutes. At the same time because of the reclined position the sum of the upper trunk's mass travels slightly backward, behind the line of the sitting bones. This is critical because the sitting bones are the main supporting and contact points during sitting and the offset between them and the sum of the upper body's trunk acts as a lever rotating the pelvis backwards with the sitting bones as fulcrum point. The rotation of the pelvis further strengthens the slouching: the natural double "S" curve of the spine disappears. If the back and the spine is slouching it changes the vertebraes angle relative to each other and the vertebraes put a harmful pressure on the intervertebral discs.[19] Especially the spine's lower, so called lumbosacral region is endangered. J.J. Keegan's experiments showed that the most favorable angle between the legs and the back is somewhere around 135 degrees.[20] That's when the pressure in the intervertebral discs is the lowest. Riding on a horse or sitting in a kneeling chair uses this principle.

sum of the upper body's mass

torque

sitting bone   lever arm

---
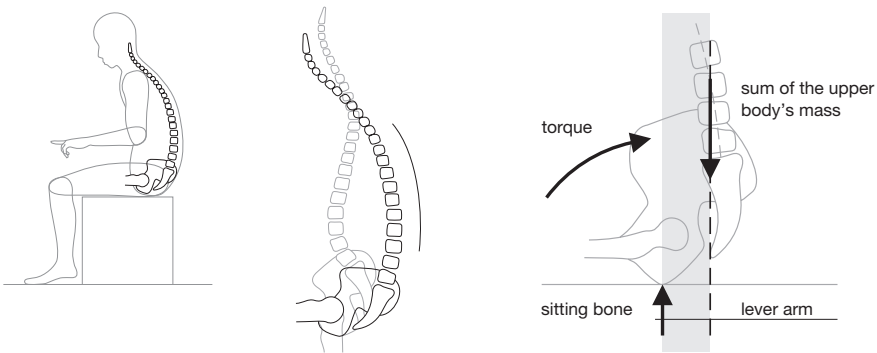
[19] Bendix, Tom: Low back pain and seating. In: Lueder Rani, Noro Kageyu (eds.), *Hard Facts About Soft Machines: The Ergonomics Of Seating*. CRC Press, 1994, pp. 152.
[20] Mandal, A.C.:Influence of furniture height on posture and back pain. In: Lueder Rani, Noro Kageyu (eds.), *Hard Facts About Soft Machines: The Ergonomics Of Seating*. CRC Press, 1994, pp. 173.

Muscosceletal consequences develop over time, the keywords are prolonged periods and constrained posture. There might be several other contributing factors as well, such as inherited ailments (e. g. weakness of vertebral discs or predisposition for herniated disc) or some kind of sudden physical shock, like a car crash or lifting heavy objects, or a period with high levels of stress and responsibility, and / or with unusually prolonged time of sedentary activities like studying before the year-end exams. Elementary and high school students are especially endangered, as they start sitting extensively at an age when their bones grow so rapidly that the development of their skeletal muscles simply can not keep up with it due to the physical passivity associated with sedentary activities so common in schools. This can lead to bad posture and scoliosis already at this young age.

Some researchers have pointed out that the reduced demands for physical activity associated with sitting is not just the absence of activity but rather an entirely unique physiology.[21] Physical inactivity can seriously compromize cardiovascular and metabolical health and can be directly linked to poor nutrition, obesity and insulin resistance, which can lead to diabetes. These health problems also increase the risk of coronary heart disease. Various other researches also show significant associations of TV time with excess body weight among high school students in regional mainland China and that leisure time Internet and computer use (which are mainly done in a sitting position) is related to overweight and obesity in Australian adults.[22] But even those adults who comply with the recomendations of 30 minutes of moderate-intensity daily physical activity can be in danger: in contemporary environments they still spend most of their waking hours sedentary anyway. It is possible for individuals to be physically active, yet highly sedentary (active couch-potato phenomenon).

The problem is further complicated by the timely distribution of sitting: in a recent study adults spent the same overall amount of time sedentary, but those having a higher number of interruptions in sitting than the others were beneficially associated with lower waist circumference, (6 cm difference in waist circumference on average) and body mass index.[23] These findings suggest that not only the reduction of total daily amount of time spent with sitting is beneficial, but also breaking up sitting time at regular intervals.

---

[21] Owen, N., G.N. Healy, C.E. Matthews, and D.W. Dunstan, „Too much sitting: the population health science of sedentary behavior". Exerc. *Sport Sci. Rev.*, Vol. 38, No. 3, pp. 106.
[22] Owen, N., G.N. Healy, C.E. Matthews, and D.W. Dunstan, „Too much sitting: the population health science of sedentary behavior". Exerc. *Sport Sci. Rev.*, Vol. 38, No. 3, pp. 111.
[23] Owen, N., G.N. Healy, C.E. Matthews, and D.W. Dunstan, „Too much sitting: the population health science of sedentary behavior". Exerc. *Sport Sci. Rev.*, Vol. 38, No. 3, pp. 109.

The issues introduced above are rooted deeply in our culture and became an insepa-rable part of our lifestyle. The inhabitants of the Western world, including the already westernized far-eastern countries are aborigines of this sedentary age: the acquirement of sedentary behaviors is one of the first steps of becoming a part of the society thus mainly the educational institutes are responsible for introducing children to the world of passive body, active mind. And indeed it is very hard if not impossible to lead a life without it.

Children start to sit extensively in schools and it remains like that throughout the different levels of education. Along with getting used to sitting in chairs children have to learn concentrating on abstract thought and logical operations by disciplining themselves and ignoring any sensory stimuli which could interfere with the learning process. This is also the first time when children encounter the need to commute be-tween their home and the educational institutes, which can further increase the time spent sitting. As it was already mentioned at the "Adverse consequences of prolonged sitting and their reasons" at this age the bones are growing very intensively which cou-pled with the general muscular unloading in schools, significantly increases the risk of developing bad posture and/or scoliosis.

It is clear that today's youth may already have back related ailments even before they would start to work. In today's occupational, transit, domestic environments however sitting posture is also predominant,[24] perhaps even more than in education: in the annual Occupational Employment Statistics of the United States from all occupations "Office and administrative support works" is the largest single group in the survey with 16%. Other mentioned jobs such as "Architecture and engineering" can also contain high levels of sitting.[25] The financial constraints of maintaining a livelihood makes it unavoidable for most people to integrate into this typical pattern. These work spaces are typically furnished in a way that everything (telephone, computer, printer etc.) is within the reach of the sitting occupant: office chairs even have wheels in case something is further away, confining the need to stand up to the absolute minimum, so that the worker spends as much time with "useful" - profit making - activities, as possible. Furthermore occupants usually can not choose their chair in which they will spend their daily eight hours; they have to use what is supplied by their employer.

Office chairs are rather ambivalent: while they were meant to help better adaption to the then newly emerged circumstances at workplaces and to somehow lessen the ef-fects of the productivity oriented capitalist society, they distort the perception of our body unnoticed by us, by hiding the dangers of - and even encouraging - something,

---

[24] S. M. Reinecke and R.G. Hazard: Continuous passive lumbar motion in seating. In: Lueder Rani, Noro Kageyu (eds.), *Hard Facts About Soft Machines: The Ergonomics Of Seating*. CRC Press, 1994, pp.157.
[25] U.S. Bureau of Labor and Statistics, "Occupational Employment Statistics". http://bls.gov/oes/2012/may/featured_data.htm#largest 08. 02. 2013.

which is harmful for our health, that is to stay seated continuously for extended periods. The comfort gives a false sense of security that the chair is doing everything instead of us, we are taken care of: it seems increasingly natural on every field of life to do as little physical effort as possible, when in fact we should grab every opportunity to move. Most people are not particularly conscious or knowledgeable about this matter and thus a bad habit can develop very easily, but breaking it later is very hard: while an inappropriate hardware can trigger it, a proper one in itself is not enough to solve it, only comprehensive measures can help. Discomfort - a natural reminder, a warning sign - is completely eliminated today, thus destroying our innate ability of sound judgment. One might even ask, wouldn't it be better to sit on uncomfortable chairs which remind us to change posture, stand up more often. This brings us so far away from our natural way of living that it became extremely hard to find the way back.

These above mentioned tendencies strongly influence design as well: many devices, such as computers, printers, scanners, phones, and many pieces of furniture are designed with this in mind, it became the standard: the grid system and height of storage units also adapts to the sitting person. (see Level 34 office storage project of Studio Aisslinger) Often the domestic environment is following this pattern and it can be observed how everything is arranged around the TV set.

5. Level 34 system

Naturally this interaction works in the other way around as well: our everyday tools and devices can also have an impact on our posture. A major milestone was the emergence of computer work stations, which dramatically changed how much and how we sit, with never before seen health consequences. With the fast-paced development in the electronics industry ever new gadgets appear that demand a fast adaptation on the user's part. Every new kind of equipment, such as cellular- and smart phones or tablets also bring new typical postures along with them: the smaller screens and buttons are much harder to see than computer screens, the user has to lean closer. Twenty years ago no one was sitting with bent neck and back stooping over an object which is not bigger than a pencil case, but now it is a very common behavior.

Today's mobile devices and communication technology also enable us to work or study practically everywhere, which already have to be taken into account when designing furniture for public venues: accommodating laptops, compatibility with the measurements of such devices, electric plugs, etc. This also means that the world of work/occupation can enter the domestic environment; working furniture can appear

in the homes and perhaps vice versa. Many major companies already support working from home for example 40% of IBM's workers work from home[26] which creates yet another scenario. Work and home are not separated so clearly anymore, there is a certain mixing. Interestingly furniture- and interior design haven't yet caught up with these tendencies due to the natural inertia of the industry, which can be a sign of insufficient flexibility on the industry's part, necessitating the introduction of new, faster reacting/more flexible manufacturing procedures.

Simultaneously the need of commuting between the home and workplace arises stronger than ever in one's life. This of course adds to the amount of daily total sedentary time, as our means of transport, cars or public transport vehicles are optimized for sitting. Even more alarming, that the current concept of relaxation also revolves around sitting: all the activities which belong to resting, such as TV viewing, using the Internet, playing with game consoles, etc. are all done while sitting.

The conveniences of modern life and the ever new innovations constantly embracing us are all pointing towards an even greater reduction of demand for our intervention and activity and there are no signs of this tendency to turn around. The basic values of our age, such as welfare, social safety, comfort are also reflecting this long strive of humans spectacularly. Even though the intention behind this effort is hard to question, this very endeavor meant to improve our living conditions is ultimately seriously restricting, and – as it seems unfortunately - harming us, for most of the time without us noticing. Apparently today's concept of comfort is strongly associated with muscular unloading, which is surprising if we consider that most of today's work is not really physically exhausting.

Life in Western and westernized countries is characterized by the fundamental duality of work and leisure time, but in fact behavior at occupational and domestic environments are highly similar, most likely we adopt the same posture (sitting) both when working and resting. After a long day's work in the office we go home and sit in front of the TV set or the internet. In an ideal world, or sometime in the future perhaps our understanding of relaxation should be turned round and if work is physically passive but mentally active the rest would be the opposite, mentally passive and physically active. But for this a whole lot of cultural factors would have to be changed, which is impossible without a very conscious and lengthy campaign, starting as early as basic level education or even from birth.

If we consider all these things it is apparent that perhaps it is more suitable to address the human race as homo sedens (~sitting human) than homo sapiens (intelligent or thinking human). This problem is so acute that it even surfaces in kid's movies: in Disney's recent animation, WALL-E the human race have fled to a space station from the polluted planet Earth and people live their entire life sitting.

---

[26] IBM, "Employee Well-being". http://www.ibm.com/ibm/responsibility/employees_well_being.shtml 15. 10 2013.

GENERAL PURPOSE CHAIRS

This essay, and the research phase of my project wouldn't be complete without an overview of chair types and what have been already done on this field. It is important to see what is currently available on the market, to assess and learn from these examples. Since my aim is to create a seating for public, general purpose use, I will concentrate my investigation to that topic. Due to the numerous overlaps with many other chair types, even this narrowed down inquiry has to be rather comprehensive: general purpose chairs are often used in such applications where more purpose-built, specialized alternatives would be also available. To get the bigger picture I will examine these borderlands, the interconnected categories, like office chairs, stools etc. as well. Sitting furniture intended only for resting, such as loungers, sofas, etc. therefore are outside of the scope of the current inquiry.

The category of general purpose chairs is rather hard to define, exactly due to its very general nature. So general in fact, that it could be called the archetype of chairs: it is the sort which can be seen the most. It is the most universal and widely used, yet basic chair type, which everybody knows and uses several times a day without noticing. It is so common, that its permanent presence in our life renders it almost invisible. It represents a reliable standard, but lacks any personal character and doesn't leave much individuality. One can mockingly even call them the cockroach of chairs, as they seem to appear even in such environments, where any other chair would be unimaginable.[27]

To better understand/tackle the nature of general purpose chairs we must take a look on how they are acquired. The great majority is typically sold as contract furniture: ordered directly from the manufacturer by architects, interior designers in big quantities for furnishing major projects: restaurants, cafes, educational institutes, governmental institutes, airports, railway- and bus stations, auditoriums, waiting areas, even offices. In order to meet all these demands, the chairs are often offered in a whole range of variations and combinations: different leg types, (column with casters, column with flat base, 4-legged, sledge, cross-bar bench/beam arrangement for public spaces and with different materials: solid wood or plywood, steel, different surface treatment: natural, colours, powder coating, chrome) optional armrest, with- or without upholstery, different upholstery materials (textile, leather, faux-leather) and colours. Most of them are available with a fitting table and even as a barstool version!

Even though this might seem like a lot of possibilities to customize the otherwise fairly basic chairs, but because of the large batches ordered, only on an architectural scale to make a distinction between different spaces or functions. The preferences or needs of the real end users in these public spaces can not be truly accommodated.

27 See photographer Michael Wolf's „Bastard chairs" project. http://photomichaelwolf.com/#bastard-chairs/1 23. 08. 2013.

Those involved have no other choice, but to use the chairs, which are given there, and in fact everybody is involved to a certain degree: most, if not all public venues, institutions, even work environments are furnished this way, areas where sometimes people spend considerable amount of time. For this reason durability, stackability, conformity with standards and regulations (fire safety regulations, emergency evacuation procedures, etc.) and of course affordable price is of prime importance. In contrast with this not too personalized usage these chairs can also appear in domestic environments via individual purchase. The requirements are much less stringent here, but the not so friendly (cheap, more industrial materials), characteristic look is definitely a disadvantage here, but that might be counterbalanced by the good price though.

6. Viola chair 7. Conventio chair 8. Tveir chair

Most general purpose chairs have fixed, separate seat pan and backrest, or often a one-piece shell. If they offer some kind of movement it is in almost every case done by the backrest, either due to the flexibility of the material (e.g. plywood or injection molded plastic, see especially Viola and Conventio chairs by Peter Opsvik) or with a very simple, mechanism-free solution, (see Tveir chair) thus offering a higher level of comfort in a cost-effective way. Using no expensive mechanisms is very important to keep the costs low, so that manufacturers can offer a good deal, even for large batches. Indeed, currently the primary factor determining the posture during sitting is the backrest inclination, the seat pans of various models, despite some exceptions (like Walter Papst's chair sold in Wilkhahn's 360 range, or J107 chair by Poul M. Volther: triangular seat pan for bigger of movements) doesn't differ much: they are horizontal or slightly (3-5 degrees) tilted backwards and that's about it. This offers some kind of comfort enhancing feature for the most widely adopted posture during sedentary activities, the reclined position, leaning against the backrest, but leaves the more problematic and possibly harmful upright („straight") and forward leaning positions untouched. It is much harder to give a valid solution to these postures, while it might very well be that it is more important to address this problem, because of its more harmful nature. It seems more likely that real improvement can only be achieved if the seat pan also takes part in the „action".

9. Walter Pabst's three-legged chair   10. J107 chair

Typical materials of these chairs are chrome plated or powder coated steel tube or rod, injection molded plastic (earlier glass fiber reinforced plastic), or molded plywood for sitting surfaces and armrests, usually no solid wood is used. Fixtures and connector pieces are kept to the minimum, all in all a very slim and efficient product that doesn't take up more than the absolutely necessary space. All this results in a slightly artificial, industrial look, very „product"-like, which some people might call impersonal or cold.

Currently only office chairs or the alternative solutions such as saddle chair or kneeling chairs are offering a different end user experience, by a greater range of tilting, or by unique geometry: it is apparent that ergonomic principles are much more widely applied. Due to their more specialized nature (and usually higher price) their use is much more restricted and less widespread.

Increased angle between the thighs and the back

Stool, barstool, saddle chair, kneeling chair

This group of sitting furniture enables somewhat different positions than basic chairs. Usually they are not equipped with backrest, but aim to open up the angle between the legs and the back, which makes it easier sit straight. This of course puts more stress on back muscles, which requires getting used to it.

The **stool**, without backrest being the simplest sitting furniture, perhaps has an even longer history than chairs. Once it has been more common as well, but by now significantly lost ground against chairs and forced into the background, as it doesn't support the back. No doubt, sitting on a stool is more exhausting than in a chair, the concentration, isolation from outside world can not be so complete. However it offers bigger freedom of movement, it is less restrictive (less support, less restrictions). Usually the seat of stools is smaller in size and slightly higher than a chair's, which creates a bigger, more open angle between the thighs and the back, making it easier to maintain a straight posture. Stools also show a bigger variation in seat shapes: triangular, rectangular and circular being the most common. Due to the rotational symmetry, stools have no orientation, which makes them rather universal.

Barstools are a special version of the ancient stool optimized for the height of the counter in bars: this makes them rather unstable compared to chairs as the center of gravity is higher up. They are often included as an additional version in general purpose chair ranges, to widen the manufacturer's offer (can be useful in a restaurant where they can buy fitting barstools along with chairs). Most barstools are four-legged or column-legged with gas-spring height adjustment. Sitting height is usually determined by a leg-supporting cross bar, which promotes a horse riding-like posture which is further encouraged by the shape/arrangement of the seat pan as it lets the thighs hang down.

Saddle chair is also a relative of the stool, but with a saddle-like seat pan, which lets the thighs drop even more, creating a horse riding position. It helps to reach an almost ideal position, when the pressure is the lowest in the intervertebral discs, (see "History of ergonomics part") but it only supports this sole posture. It is highly likely that sitting would become constrained in a relatively short time-span. For this reason it is

11. Saddle chair

only suitable for a limited number of tasks: primarily doctors, dentists, surgeons, hairdressers, cashiers use it, or wherever this half standing posture comes handy. On other tasks it can not replace the office- or general use chairs. Further limits the number of possible users that it is not quite suitable for women wearing short skirts, which is a quite common outfit in offices. Due to the legs of the user, a four-legged version is impossible, so all saddle chairs have one central column-leg.

Kneeling chair, which was already mentioned in the "History of ergonomics" chapter, is yet another attempt to approach the magic 135 degrees sitting angle. It prevents sliding forward by supporting the knees, instead of the bulge of the saddle chair. After the first model Peter Opsvik developed many variations of the original idea with a stress on facilitating more postures, such as the Variable Balans, Gravity Balans, Thatsit Balans, and Wing Balans and Duo Balans. All based on the same principle that the chair can roll into different positions depending on where exactly is the user's center of gravity at the given moment. These models however are rather clumsy and large, with a big range of movement which requires quite a bit of extra space around them. There are stabile variants of the kneeling chair as well, such as the Vital balans, Multi

12. Kneeling chair

balans, which can address this above issue, but then the problem already discussed about saddle chairs, namely that they only permit one posture, also emerges here. In addition to this, ingress/egress of the kneeling chair can be quite difficult, (especially for the elderly) therefore can't comply with regulations for quick evacuation in public venues. Excessive strain on the knees (the primary supporting point) can also be problematic for certain user groups, such as elderly people. For these reasons kneeling chair is not suitable for widespread use.

Gym ball, air filled cushion, other alternatives

These solutions are instable on purpose, so that muscle work is required on the part of the users to compensate it (dynamic sitting). Sitting on it requires getting used to it, as it can be a bit exhausting. Exactly due to this "continuous motion" these alternatives can not fulfill the cultural requirement of sitting still, thus mostly suitable for domestic-, or in some cases office use. What no other chair type can do so effectively though is promoting physical activity by breaking up motionless sitting.

Gym ball is big, air filled ball, big enough for the user to sit on it (bit higher than the standard sitting height). Its large size is its biggest disadvantage, making it uncomfortable to carry around or store.

13. Gym ball chair

Air filled disc/ cushion is an add-on for any regular chair, basically creating a gym ball from whatever it is placed on, due to the air inside. Its big advantage compared to the gym ball, that it is rather compact and thus mobile, the user can take it everywhere with him or herself, and place it on the currently used chair. The only minor problem is that it requires a height-adjustable chair, to counter the extra elevation of the cushion compared to desktop level.

14. Balance cushion

Office chairs represent the absolute extremity in terms of range of movement: swivel and tilt in every possible direction is almost a must in this category. Without doubt most effort and science is put into this category: it is in the forefront of the application of ergonomical principles. What makes this chair type special is that no other category is meant to be used for such long uninterrupted periods. This is of course a great challenge how to optimize a posture, which is fundamentally flawed. The generally higher prices of these chairs are more accepted, which means that cost-restrictions don't apply here so much, like in the case of general purpose chairs. Designers and manufacturers perhaps have greater freedom with technology and mechanisms: usual features are casters with wheels, swiveling mechanism, height adjustment with gas-spring tilting-sliding mechanisms of the seat pan and backrest, armrest. The materials used are also more advanced: breathable textiles, nets are used, but there are novelties even under the upholstery, such as the techno gel, or memory foams. The frame is made of die-cast aluminum, and/or different grades of plastics. However, the excessive number of mechanisms makes it hard to achieve spotless aesthetics, as the mechanisms are often not integral part of the chair's structure: many cases designers just try to hide them in various boxy plastic protrusions under the seat. This often results in a very machine-like, rather technical than welcoming appearance.

In a way office chairs could be called the ultimate chairs, not just because manufacturers put all their knowledge in it, but also due to the intensive use, which brings up all possible issues much more sharply and much earlier than any other chair type. Problems, even the slightest contradictions can be seen very vividly; therefore it is especially useful to study what are the trends and tendencies on the field of office chairs. To a certain degree all the dilemmas and challenges that office chairs facing today are valid for all the other chair types as well.

Not so long ago the main focus was on adjustability, in order to provide the most appropriate position for users with very diverse anthropometric dimensions. By time it became clear though that people didn't use these overly complicated adjustments, and users did not know how to properly fit them to their body anyway.[28] The focus shifted to chairs, which need just minimal adjustments on the user's part, but are moving together with the occupant, without restricting him or her. Today it is rather common, that the sliding and tilting of the seat pan and backrest are synchronized with each other. Some of the office chairs even move sideways, such as the On chair form Wilkhahn, in order to perfectly follow the users moves. This „three-dimensional" movement is claimed to be a breach with the cold, purely ergonomic approach and an attempt to shift office chair design in a more natural direction.

---

[28] Lueder, Rani: Adjustability in context. In: Lueder Rani, Noro Kageyu (eds.), *Hard Facts About Soft Machines: The Ergonomics Of Seating*. CRC Press, 1994, pp. 25-33.

15. ON chair

But despite the great efforts of designers and manufacturers a fundamental moral question regarding the objective of office chairs remains: It seems that doesn't matter how hard we try, sitting itself will never be any healthier: is it ethical to encourage users to stay seated for extended periods? Wouldn't it be better to make something which might be a bit more uncomfortable, but through this promotes standing up? (see also *Responsibility of culture* chapter) Despite the excessive complexity of office chairs and the amount of technology and science squeezed in them, we still couldn't find the "perfect solution" for such a basic need as sitting. Is it still worth trying to improve chairs and posture, aren't these all futile efforts?

16. Sitz 2

As an answer to these concerns many designers attempted to come up with some kind of replacement, alternative for office chairs, but so far, they all fell short of their goal. Originally Hans Roericht's Stitz 2 - a stool with CBM effect, that encourages the user to alternate between resting and standing – also started like this, but the manufacturer, (Wilkhahn) after realizing[29] that it is not really capable of replacing office chairs now offers it as a supplementary object for tasks which require frequent standing up and sitting down.

---

[29] „On by Wilkhahn". In: *Design report special.* Konradin Medien GmbH. Leinfelden-Echterdingen, 2009. pp. 10. http://www.wilkhahn.com/documents/Designreportspecial_ON_D_GB.pdf 10. 05. 2013.

Similarly activity oriented Konstantin Grcic's 360 project produced by Magis, which is something between a chair and stool without a real backrest or specific orientation: the user can sit on it in every direction. It is intentionally not ergonomic, but has the casters and height-adjustability of an office chair. It is intended for an active, dynamic use, moving around with only short periods of sitting.

17. 360 chair

Chapter III. Possible solutions

Possible solutions in a broader context

From the previous chapters it is already clear that the issues surrounding sitting are very widespread and complex. Trying to solve these issues solely by improving chairs is a serious underestimation of the problem. Sitting is so deeply-rooted in our every-day life that in fact the way we live and approach things should be changed. As with many other culture-related matters the change has to start in the head. Therefore, if we want to improve the current situation integrated, well-coordinated and compre-hensive actions are needed.

Most importantly in today's bipolar world, primarily consisting of the alternation of work and rest we have to rethink our relationship with recreation and comfort and thus give a new meaning to body culture as well. Our current, widely accepted notion of resting is that it equals with muscular unloading and comfort: since high levels of physical passivity is already predominant in occupational environments, it would be crucial to spend at least the remaining time (leisure time) actively. As perhaps labor conditions are harder to change than leisure time habits these are such steps which average people can already take by themselves. Further possibility to increase the daily time spent with moving can be active ways of commuting, such as cycling, walking or roller skating, where the infrastructure permits it.

A more conscious, preventive approach to our body and wellbeing is also vital, to ac-knowledge that everybody is responsible for his or her own health, and should actively work on protecting it. In an age when we live longer and increasingly more unnatural, certain illnesses are already emerging in such a density that it threatens the sustainabili-ty of our health care systems: in fact, back problems can already be called a civilization illness (see first chapter). It is very important to realize that these ailments do not just happen, which then the doctors and medicines will cure, but that they are rather a consequence of something prior. Therefore we should think carefully how to prevent them, and to be able to do so, we need to have a basic knowledge of our nature.[30]

Many of these health problems can be traced back to the conflict between our body and the profit- and productivity oriented capitalism, which is especially obsessed with efficiency after the recent economic downturn and thus putting even more strain on their remaining employees. The consumer society also urges people to buy more and through this of course, to work more. One solution could be perhaps to slightly reduce the number of working hours (and passivity along with it) and free up more time for

---

[30] See: Cranz, Galen, 2000: The Alexander Technique in the world of design: posture and the common chair. In: Harer, John B., Munden , Sharon (eds.), *The Alexander Technique Resource Book: A Reference Guide.* Scarecrow Press, 2008, pp. 90-98.

moving and other activities.[31] There are already precedents of this trend in Western Europe, where the standard of living is generally higher and social security stronger, therefore maintaining a livelihood puts less strain on people. Believers of this idea also claim that shorter workweeks could offer a solution to the actual economic problems, because decreasing the efficiency, (with the current lower demand it doesn't matter that much anyway) more workers are needed for the same task and this way unemployment rates could be forced down as well. In Eastern-Europe, or other not so developed parts of the world however it is not really viable option yet.

Of course initiating such paradigm shifts can not be simply entrusted to people alone: without public awareness campaigns and incorporating these ideas into basic level education only very limited results could be expected. Schools should raise the awareness, by helping children to develop a healthy body culture, knowledge of how they should live healthily. If children are trained to be more conscious in these matters, it is quite likely that later on they will look and demand for better circumstances at work for example, and it will be harder to exploit them. Courses should be harmonized with each other so that each of them is enlightening a different side of the problem: biology can explain the theory, while physical education lessons can deal with the practical side (special exercises, emphasizing the importance of physical activity).

Even though this might seem like a lot of actions to take, school age is the best time to raise awareness, as elementary school is obligatory, thus the message can reach everybody. Later on, when children leave school their life starts to diversify and reaching them becomes much more difficult and costly. If we look closely it is also apparent that these measures don't necessarily require acquisition of any new equipment, or infrastructural investments: they are mostly of organizational nature, a new arrangement of the already existing systems and study plans have to be revised from time to time anyway. If we consider the effectiveness and the return (less strain on health-care in the future, etc.) of this investment one have to conclude that it is the best possible case to spend taxpayer money on. At least it is certainly cheaper than upgrading the health-care system to be able to accommodate a growing number of patients from Europe's already ageing population.

It is financially much more demanding though to make it actually possible to live actively. Such commitment has tremendous large scale implications on urban planning, design of the environment and on the infrastructure (see America's totally car-dependant lifestyle). Bicycle lanes, more parks and green areas have to be built and maintained, traffic culture have to be improved (at least in Eastern-Europe, altering the traffic rules accordingly, etc.) and so on. Moreover just by creating the opportunity it is still not granted that people will actually use it: they have to be informed about it, even persuaded perhaps. Breaking old, established habits - of going everywhere by car for example - can take considerable effort.

---

[31] Simms, Andrew: „The four-day week: less is more". http://www.theguardian.com/money/2013/feb/22/four-day-week-less-is-more 15. 10. 2013.

Last but not least working conditions, labor regulations and standards should be revised as well. A new concept of furnishing should be promoted, which forces the employee to break up sitting time: for example certain devices (e.g. printers) should not be within the reach of the seated occupant. Experiments should be carried out as to how people would react to such scenario and whether or not it would bring the desired result. Playfulness might be another keyword here as earlier precedents show (Piano Staircase project by The Fun Theory: an experiment how to persuade people to use the stairs instead of the escalator in an urban underpass)[32]. In this system new types of furniture can play their part as well: furniture, which promotes regular standing up, or even working in a standing position for shorter periods is in dire need. Fortunately desks, which can accommodate standing occupants or high chairs, are already gaining ground. Non-sitting alternatives in public venues are also worth looking at, leaning or semi-standing positions, etc.

Of course companies and employers will not take any steps or implement changes on their own accord: the conclusions of the above experiments have to be built in to the regulations. A compulsory general directive should be drawn up with the cooperation of all the involved scientific fields, (ergonomists, physiotherapists, orthopedists, psychologists, economists) other professionals (engineers, designers and architects) and governmental institutes (Ministry of Health, Ministry of Labor, Consumer protection, Development department etc.) which the respective agencies should harmonize their regulations with. These occupational health- and consumer protection regulations, laws and standards could take care of putting the ideas into practice.

This is obviously an enormous project, which necessitates a large-scale governmental/political engagement. Although the task is interdisciplinary, a centralized oversight and control is essential, to ensure as widespread, systematic application as possible. Organizing such a project requires a large decision-making capacity and apparatus, which is ideally above the local lobby-forces: for this reason perhaps the EU would be the most favorable body to initiate.

---

[32] see: http://www.thefuntheory.com/piano-staircase 14. 08. 2013.

While the development of new chairs is just one of the many important factors in the equation, but perhaps it is one of the easiest way to start with due to the more manageable scale of such a project. In order to achieve real improvement on the field of sitting, it is vital to see the bigger picture and to embed the new designs into this larger context, just designing "another chair" is not enough. When the shift happened from craft to serial production in the history of chairs innovation was led mainly by material-technological aspects as all kinds of new manufacturing methods had to be tried and tested. (see also: Brief historical and cultural overwiev of sitting chapter). Even though serial production is common for more than a century now, there is still a very strong material- and technology led orientation in design, designers are still trying hard to push the boundaries in terms of manufacturability instead function/usage based innovations. Many recent chairs, which look revolutionary because of the new materials

18. Pelt chair

actually don't offer anything new in terms of user experience (for example see Benjamin Hubert's Pelt chair) when compared to a 50 year old design (for example Eames chairs). Our ever changing life and demands however can offer endless opportunities for innovation. New situations and demands can just as well lead to new and unique solutions. In my opinion the experimentation with materials and technologies are justified only if the usage calls for them. Having a bigger picture, a general guideline definitely helps not to lose focus of the real matters. After all, a chair should be sitting furniture above all, aesthetics shouldn't overrule usability or the wellbeing of the user.

New designs should be based on the deep understanding of the most basic comfort needs, using and finding the knowledge accumulated on the field so far. The beneficial nature of lumbar support is well known for at least 30 years, but still every year many new chairs are coming out without it. It is beyond the author's comprehension if there are established means to contribute to the wellbeing of chair users why not taking advantage of it? Especially when incorporating these basic features (such as lumbar support or proper backrest-angle) doesn't even make manufacture more costly or difficult, nor makes it harder to achieve an aesthetically pleasing appearance: all in all it doesn't force neither party involved into any undesirable compromises. Designers supposed to know more about sitting than the consumers, and therefore have a responsibility towards them: it is not just about ergonomics, but ethics of the designer profession as well. Every chair should fulfill a certain set of „minimum requirements", the good ergonomical quality should be a standard, basic feature and all other aspect should come afterwards. Perhaps industrial standards for chairs should be supplemented with

these minimum requirements, maybe even lumbar support could be made mandatory, with attaching the suggested respective dimensions of it.

But this wouldn't more than just an idealist standpoint without taking into consideration „the way the world works". Of course chairs should look appealing, otherwise who would buy them? Appearance is extremely important today, because with most things we only encounter virtually through the internet, or brochures, which means that three-dimensional objects are presented in a dematerialized, two-dimensional and purely visual way. Of course to a certain degree this is a natural tendency, as sight is our primary sense organ,[33] but it is certainly further amplified by (the digital telecommunication, especially) the internet.

The pictures are often photographed in a studio, in front of a sterile white background, showing the furniture out of context: a supposedly utilitarian object such as a chair becomes a purely aesthetic matter, degraded to eye candy. This makes it impossible to truly and fully assess the capabilities of these objects and can distort our sound judgment: only one side of a complex matter will be dominant. This might result in „sexy" chairs designed just for the eye instead of the buttocks and back. Seems like that the transition from an exclusive object to a more "democratic" is still not concluded yet, as a new kind of representativeness is still overshadowing functionality.

While often the so-called design chairs look fascinating, and one would forgive even the most obvious shortcomings comfort-wise, the overly ergonomic chairs (such as office chairs) look more like machines sacrificing the appearance for the comfort. This results in a beautiful chair in which no one could sit too long, or a very comfortable one, in which no one wants to sit. In both cases the chair can not fulfill its purpose: it is easy to see why it is vital that function and appearance (representation) of chairs should be in harmony. A sexy looking, yet comfortable chair is needed!

It is indeed rather hard to find the balance between the two opposing forces, the representative, aesthetical and the functional qualities of chairs: these were the two forces battling with each other all along the history of chairs. But designers should take responsibility and design with the real needs and real-life usage in mind: it is somewhat unfair, perhaps even cynical in my opinion to simply label a chair "dining chair" if it is not suitable for any longer periods of use. It is false to assume a chair will always be used as planned by the designer: it is quite safe to say that a work chair will not only be used for working and so on.

---

[33] Zimmermann, Manfred, 1989. The nervous system in the context of information theory. In Schmidt, Robert F. & Thews, Gerhard (eds.), *Human Physiology*. Berlin, Springer-Verlag, pp. 166–173.

Chapter IV. Solutions for a better chair

Based on the lessons of the research phase, in this chapter I will outline the major objectives and propositions of my project in order to create a better general purpose chair. Most importantly perhaps, I will be aiming for a paradigm shift in user experience rather than in material usage or manufacturing techniques: in fact easily manufacturability with conventional methods can be beneficial, so that the chair could be available to a broader audience.

By focusing on the user experience I mean bringing the comfort level and experiences gained with office- and alternative seating to a more general, everyday level, to the field of general purpose chairs. I would like to apply a new kind of ergonomic approach so far mostly associated with office chairs: instead of differentiating between correct and incorrect positions, the stress should be on promotion of unrestricted movement, supporting and accommodating postural changes: chairs should be able to move with the occupant, which is unusual among general use chairs. The challenge is of course is how to incorporate this feature without the complicated, bulky and expensive mechanics.

Another question is how much can a new design break away from traditions and established methods: how radical can a chair be? Because sedentary behavior is so widespread and so deeply rooted in everyday life, even minor changes can have enormous implications. As it can be seen in the "Already existing solutions" chapter, too drastic, "revolutionary" changes (such as in the case of the kneeling chair) hold the danger of compromising compatibility with peoples habits, existing infrastructure and dimensional grid of current furniture and thus prove unpractical. Since one of the most typical uses of chairs is when they are coupled with tables, it is especially important how they fit together. A higher than normal chair – though ergonomically beneficial – leaves insufficient space for the legs under a conventional desk and forces the user to slouch, therefore straight away excluding one of the main applications of chairs. Revolutionary changes in an objects' use or appearance can be problematic from a psychological standpoint as well: while there is a strong demand for novelties on the customers' part, they have hardships in accepting something which fell too far from what is considered as the norm. This was already recognized by Raymond Loewy, who summarized this phenomenon in his MAYA (Most Advanced Yet Acceptable) principle.[34]

My aim with this project is to create furniture, which offers a valid, realistic solution to these problems, not just another concept. Based on my research I came to believe that in order to keep the general usability only very carefully measured alterations can

---

[34] http://www.raymondloewy.com/about/bio.html 05. 07. 2013.

be applied, without losing the sense of continuity with the long line of chairs since the ancient times. Perhaps the approach needed can be called more evolutionary than revolutionary. There are some recent shifts in lifestyle and thus chair usage as well: with the fading of the borderline between life and work, public use furniture can appear in domestic environments and perhaps general-use chairs will become even more widely used. Appearance in the domestic environment means that personality, friendly character is getting more important.

Target audience

Areas where high number of people with diverse needs encounter, where users can not choose their chair according to their preferences: public venues, waiting rooms, restaurants, cafés and auditoriums. This category of furniture is characterized by usage time ranging from minutes to a few hours. They can be used in domestic environments as well, therefore it is very hard to define exactly in which way and for how long periods will it be used. They should resist all the wear and tear which is possible in all the above mentioned scenarios.

The problems and challenges of public seating is a topic which interests me for a quite some time now: during my studies as a furniture designer (from 2009 onwards) it was constantly on the back of my head. Back in 2010 I was experimenting with different shapes which could work as a seat pan just as well as backrest. I was aiming to offer an alternative to current chairs and a better, more ergonomic posture. What I didn't realize at that time it was that enabling postural changes is more important than providing the perfect posture. Later, after testing and evaluating the chair, I realized that the concept behind it was lagging behind the current needs, mostly because it was optimized for only one position. By this work however I gained first hand personal experience on just how hard it is to find a valid, acceptable solution and obtained many lessons which can form a solid basis for my current work. These observations draw my attention to the importance of promoting postural changes, movements and activity and to find the right compromises. I came to the conclusion that an uncompromised chair simply can not exist, a chair without compromises is not a chair anymore (perhaps statue). Every chair is a sum of the many interplaying factor; in fact one might even say that chair is nothing but a set of compromises. Therefore, it is crucial to carefully measure all these factors and their relation to each other.

Based on the research, I determine and summarize here the major forces at play and requirements for a chair, which introduces new features on its field and a different user experience, without jeopardizing its usability.

EASE OF INGRESS/EGRESS

Due to fire protection reasons the likelihood of emergency evacuations in public venues /institutions have to be considered and ease of egress of chairs is absolutely vital from this standpoint (this is where most alternative solutions fail). Besides, the very diverse user group of these chairs can also include people, (e.g. elderly) who can find it hard to sit down in a too low or unstable chair.

CONNECTABILITY

Connectability is also linked to the fire protection regulations. It is stated in the respective standard (EN 14703: 2007 Furniture. Links for non-domestic seating linked together in a row. Strength requirements and test methods.) that chairs have to stay connected and must not be thrown around in case of an emergency evacuation.

EASE OF STORAGE

In public venues/institutions such as restaurants, mess halls, auditoriums where a very high number of chairs are used stackability, space-saving storage is a major expectation. Chairs can only be stacked effectively if they are rather slim themselves with minimal cross sections. This also means that there is simply no space to accommodate complicated mechanics.

AFFORDABILITY

Due to the fact that these chairs are acquired in large batches, manufacturers have to offer them at a reasonable price, thus manufacturing costs have to be kept low. For this reason in this application simple construction is preferred, which allows no complicated mechanisms and adjustability. The absence of adjustability doesn't yet hurt too much in applications shorter than 4 hours (after that adjustable office chairs should be used).

EASE OF CREATING VARIATIONS

Manufacturers strive to offer many different versions of the basic model in order to cover as many possible applications as possible and thus receive more orders. These

versions should require minimal investment by leaving the pieces, which require an expensive mold untouched for example, to be able to maintain a good selling price.

BELONGINGS

At public spaces not only the users themselves have to be accommodated, but a lot of additional belongings as well, such as bags, coats, etc.

INCLUSIVITY/ACCOMMODATING USERS WITH DIVERSE NEEDS

In order keep the general usability everyday real life situations and users with diverse needs have to be taken into consideration. More complex shaped seat pan surfaces can interfere with the users clothing, women with skirts for example have problems with the upward bulge of saddle chairs, while elderly people can have difficulties with the egress and ingress.

COMPATIBILITY

Too revolutionary solutions hold the danger of losing the compatibility with the already existing furniture/ architectural grid systems, thus seriously restricting the possible applications. Even the ergonomically most advanced chair is doomed if it can not be used together with current tables, as only a smaller number of people could enjoy its benefits. A chair with perhaps a bit more cautious, moderate innovations, but with a broader range of applications on the other hand can reach much more people and can bring a real change in their life.

WIDE RANGE OF POSTURES

The seat-pan shape should allow for a wide range of postures (not just one "perfect") e.g. crossed legs, stretching out, etc. Changes between postures can break up the passivity, and lengthens the period until sitting is considered comfortable. Opening up the angle between the thighs and the back so as to reduce the rotation of the pelvis and achieve a lordotic position of the spine is also beneficial.

BREAKING UP SEDENTARY TIME

The chair not only should allow different postures, but even promote breaking up sedentary time with encouraging frequent stand ups and/or posture changes. Offering some movement, so that the chair follows its user can make a real difference, but in this category of chairs only something very cost-effective and compact solution is imaginable, for example based on the natural flexibility of materials, something which is integral part of the chair, without increasing its volume. If there is movement, it should remain within safe limits, and the layout and appearance of the chair

should ensure the user that it is stable and safe.

ACCEPTABILITY

When talking about innovations on the field of sitting, a special attention should be paid to the semantics and acceptability. Due to the great inertia of habits a too big step forward can result in rejection by the public. The chair should remain easily recognizable and understandable. Of course people have the ability to adapt, but the shorter period of use typical to general usage also means that there is no time for getting accustomed to unusual solutions: the sitting experience shouldn't be too different from the norm.

At the beginning of the design process I was seeking for seat shell shapes which can *accommodate* multiple postures without movement, purely by geometry, assuming that it is sufficient in itself to *promote* postural changes. However the encouragements of Esa-Pekka Takala from the Finnish Institute of Occupational Health convinced me that incorporating movement into general purpose chairs would be beneficial and there is a need for it. I started to seek mechanism-free ways of movement, as it was also clear (see *General requirements for general use chairs*) that mechanisms hardly fit into this application. Moving sitting surfaces is still a rarity apart from office chairs, but there are some other examples nevertheless which can serve as an analogue/inspiration for my project.

Talking about chairs and movement, it is inescapable to mention Peter Opsvik's works. It is interesting to follow his progress through the years from the first kneeling chairs to the promotion of movement. With his often weird looking furniture he constantly tried to overcome stereotypical sitting habits questioned the importance of body support over freedom of movement.[35] He designed many unconventional pieces of sitting furniture, but their usability in a public environment is questionable, therefore from our point of view one of his more conventional and less well-known work is perhaps more interesting. The Viola chair is intended for general use, but Opsvik tried to exploit his accumulated experience with movement. The seat shell is made from

plywood, but the slots cut into the material give extra flexibility on the upper part of the backrest and the front part of the seat pan, enabling a wider range of movements, despite the conventional height of the chair. It is significant that motion is provided with the absence of material, the perforation that is, rather than the presence of some mechanism. The movement is a built-in, integral feature of the chair, not something added to it.

19. Detail of Viola chair

In the 1980's there was intensive experimentation in Finland as well. On the Visio 200 lounge chair designed by Yrjö Wiherheimo and Simo Hekkilä the separate sitting surfaces are connected with coil springs to each other and to the thin tubular metal frame. In the later, simplified models of the Visio range, leaf springs were used.

The Jobb chair by Wiherheimo & Pekka Kojo is an office chair, but provides a range of movement with an ingenious solution: the seat pan is connected to the base with solid rubber cylinders. This represents a transition between the springs and the move

---

[35] http://www.opsvik.no/ 10. 09. 2013.

ment as integral part of structure-idea (Opsvik's Viola chair). All in all, a simple and-universal solution which can be applied with ease even in general purpose chairs.

Having no moving parts at all, but actually tilting the whole chair is also a possibility, as it is widely known since the first rocking chairs: the Vitra Tip Ton chair uses this prin ciple, but instead of rocking all along a curved arch it has two positions for inclined

20. Visio 200 lounge chair

21. Visio range chair

22. Jobb chair

23. Tip Ton chair

Two chairs are the result of my research, which serve as a test of the ideas presented in this paper. This way it becomes possible to assess, whether it is possible to achieve real change with a more multidisciplinary approach. Strictly speaking it took more than a year to develop the chairs through trial and error and many restarts, but as it can be seen in the "History of project" chapter the thought process started roughly four years ago, and by far still not over.

After rewieving all the collected information, I decided to go ahead with incorporating movement into my project. Most chairs which provide some movement have a moving backrest but a fixed seat pan (see for example the Tveir chair). But in fact, a tilting seat pan can bring a bigger difference, and backrest inclination is not so vital, therefore I chose to focus on achieving movement with the seat pan. The seat primarily should tilt forward, reaching "negative" angles, (sloping forwards) making it easier to lean for

ward. By controlling the position of the pelvis of the sitting person through seat pan tilt and lumbar supports, it is easier for the user to maintain a more optimal (lordotic) upper trunk position.

The most ideal solution seemed to be utilizing flexibility of plywood, so that the new feature would not increase the volume of the chair at all. This proved to be problematic, since the flexing of plywood can lead to material fatigue and eventually the breaking of the material. Due to the significant difference between the industrial methods and the workshop conditions at the University, it would be almost impossible to find that material thickness and composition which is flexible and strong enough at the same time. For this reason I turned my attention towards other simple ways of providing movement, such as steel springs or rubber mounts.

Rubber mounts seemed to be an ideal solution, because they are not moving parts per se, the movement is provided by the flexing of the rubber. Even better that they are sold in versions with thread molded into the rubber, making the application much easier: for the proper alignment just a screw hole is needed on any surface on which the mount should be fixed. For providing the seat pan tilt, a mount with a great resistance is needed because its movement should not be too abrupt in order not to throw the occupant out of the chair. To further lessen this risk a stopper should be also incorporated into the chair to limit the range of the tilt. The resistance of the mount depends

24. Rubber mount

on its diameter, height and hardness of the rubber, in the final version of the chair a 50mm diameter, 19mm high version was chosen with 60 shore hardness and thread on one side. The forward tilting seat pan necessitates something which prevents sliding down: besides ordinary upholstery I started to look for some kind of material (like rubber, silicone, faux-leather, etc.) which can be glued in a thin layer directly to the seat surface, in order to offer a cheaper alternative. The padding can also distribute the weight evenly, therefore minimizing the pressure on the supporting points of the body and increasing comfort.
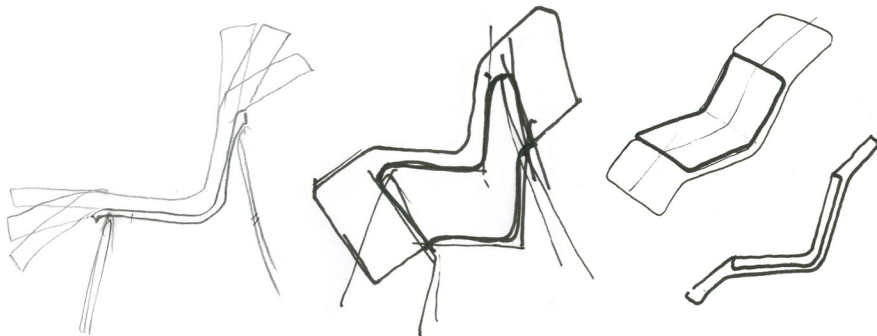
Initial ideas with a central solid core and flexible surfaces around it.
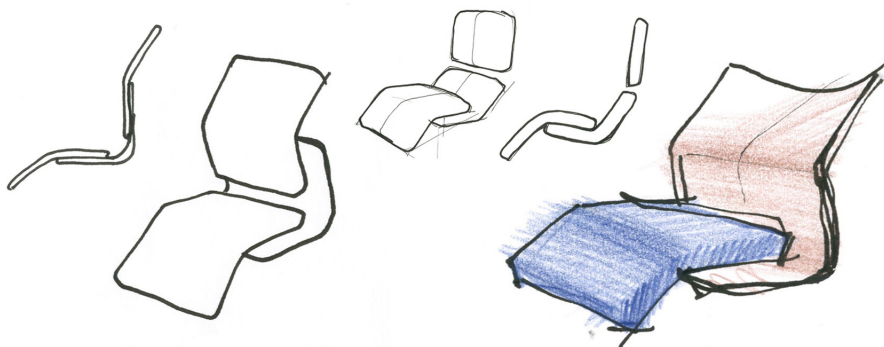
The idea of solid center core was kept, but with two separate tilting sitting surfaces. This would provide a stabile base to build upon.
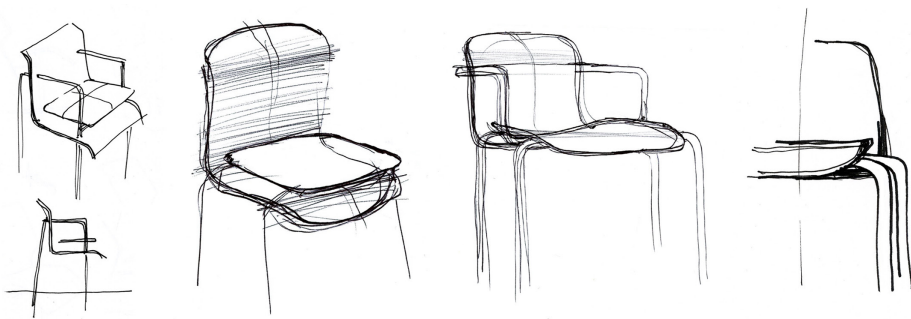
Searching for the shape of the outer shell. At the beginning I was aiming for an organized, more angular look, which makes it easier to integrate the tilting seat pan.

To take full advantage of the above measures the backrest should be equipped with lumbar support. Basically two directions seemed viable: a fixed backrest which can also function as the base of the tilting seat, or a separate backrest, which can move slightly with a similar solution like the seat. The version where only the seat is tilting can perhaps be more affordable and thus introduce a new kind of sitting experience to a broader public, but I wanted to see what happens if the idea is brought to its maximum potential. The more tilting-moving surfaces there are, the more critical it is however, to ensure the user of its safety. For this reason I decided to go with a double shell design, which means separate tilting seat and backrest surfaces, with movement range of 5 degrees each and one static, outer shell, providing stability, and acting as stopper for the moving parts preventing too great angles. The movement is restricted to one way only: the seat pan can only tilt forward, the pivoting point is forward to the sitter's center of gravity, so it only moves when the user leans forward, or stretches out.

The second, (or actually third) outer shell apart from having the message of stability has one more psychological function: it also makes the chair look more cozy and welcoming, which is addressing the issue of general purpose chairs being rather cold and impersonal. The material is molded plywood, with several different finishing possibilities, which can have the warmth of natural materials combined with the covered or upholstered sitting surfaces. Without this outer shell, just the metal frame would be left, which would result in more industrial, cold look. My aim was to find a shape which is simple to produce with conventional methods (no 3D veneer needed, etc.), yet has a three-dimensional look.
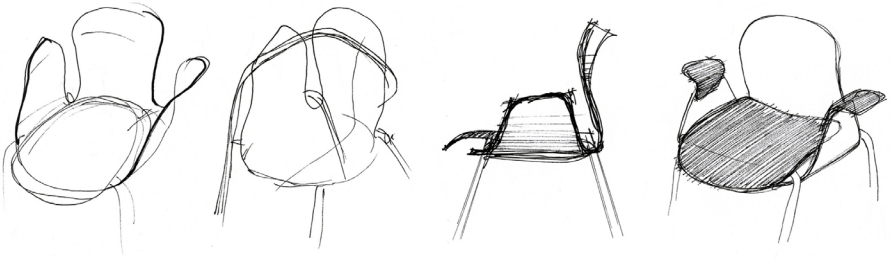
Shifting from the angular look to a more organic, perhaps more warm and welcoming look. There could be many possibilities for customisation with many additional elements, such as armrests or backrest.


Intermediate stage, without separate tilting backrest and upward curving part on the side (armrest) which can be seen on the earlier sketches are now cut short. The curvature of the outer shell doesn't follow the cutout of the seat pan at the front.


25. Since I was unsatisfied with how the sitting surfaces and the outer shell fit together. I wanted something like how the sections of the tennis ball are intersecting each other. Therefore I started experimenting with different geometries, the shapes of the final variant are all result of geometrical intersections of the seat surfaces and the outer shell.

The final version embraces the sitting surfaces like a palm and forms a "belly" to accommodate and hide the rubber mounts as well, giving an organic, sleek, streamlined appearance. The edges of the surfaces run parallel with each other. It doesn't contain any compound bending meaning that it bends only in one plane at any given point, making for an easier manufacturability and thus a more affordable product at the end. The outer shell is the biggest plywood part of the chair, but even this is smaller than an ordinary chair's shell (not to mention the tilting surfaces) which results in smaller moulds, and once again more simple production. All in all, my chair might consist of slightly more parts, but they are considerably smaller (on average by 10-15cms) than that of other chairs (see at the *Final main measurements of the chair*).

Since there is some movement involved, a slight gap is present between the tilting surfaces and the outer shell. Due to the tilting, the size of the gap can not be constant, which holds the danger of injuring the users finger. To prevent this I decided to add padding not only on top of the seat and backrest, but also to the bottom on the upholstered versions. This would close the gap, not leaving any chance for somebody putting a finger there and cushioning the movement of the tilting surfaces.
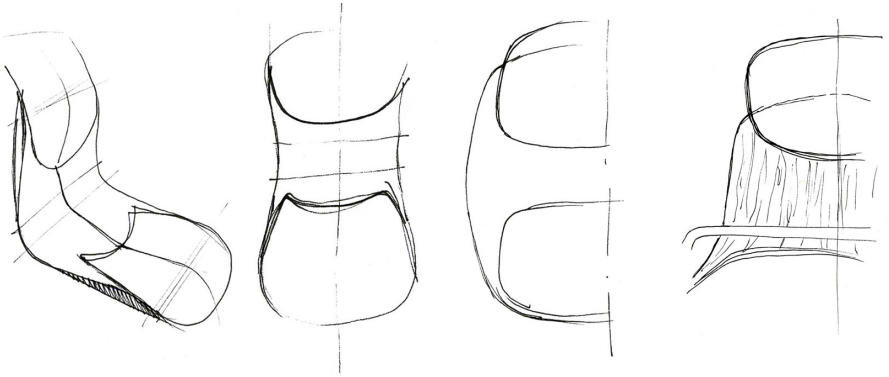
Studying the relationship between outlines. I wanted to make this intersecting geometry somehow visible, so I opted for the piece slightly overhanging and shifted on each other.

Backrest
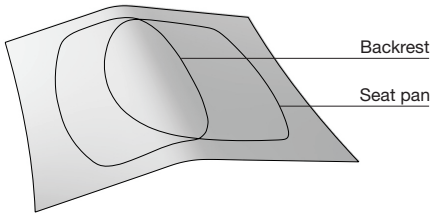
Seat pan

The tilting surfaces are not exactly the same shape, but coming off from the same mold, contributing to the economical manufacturability and thus the affordability of the product as well.
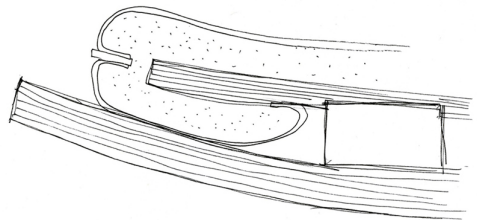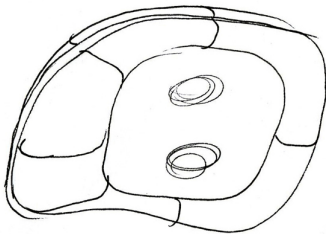
First sketches of the padded underside of the seat pan.

54   I wanted to keep the legs very thin and offer the possibility of stacking, for which metal can provide the necessary stiffness the best. With connecting the legs on the floor level the closed loop gives enough strength to go down with the diameter to 12 mm. Solid rod material was chosen due to the easier bendability: the tube is sensitive to tooling as the walls are prone to collapse at the inner radius of the bending. For this reason almost no manufacturing companies in the industry are working with 12mm tube material due to the combination of low demand and high tooling costs. All in all the availability of the technology is very poor, whereas the widest possible range of users and availability is one of the key aspects of my project, the solid material's added weight is something we have to live with. The diameter of the rod also determines the size of the screws: with M5 thread there is enough material left even if the screw goes all the way through.

To further reduce the cross section of the chair – and increase the number of chairs which can be stacked on each other in one column – I decided to integrate the frame into the "belly" hiding the rubber mounts, so as to some degree take back what was initially lost with the decision to use rubber mounts. If the legs were fixed to the outer shell conventionally, from beneath the loss would be double ("belly" plus legs) but this way it is somewhat countered. The front leg goes into a slot cut into the outer shell, while the back leg loops over the outer shell, so the shell is actually suspended. This way even the underside of the chair is covered and flush, further adding to the "aerodynamic" appearance.

The sitting exprience

Along with providing tilting-movement it can be also beneficial to slightly raise the height of the seat pan from the usual 430-450mm. This brings sitting closer to standing, making sitting down and standing up easier, thus encourages activity and breaking up sedentary time. The ease of ingress/egress is especially beneficial for certain user groups. The height of conventional tables however seriously limits the possibility of raising the seat, as sufficient space has to remain for the user's thighs. For this reason I believe that if one would like to keep the compatibility with current tables, the maximum is somewhere around 470 mm.

While the sitting height will be increased, the depth could be decreased, so that it would be closer to that of stools. This, coupled with the tilting lets the legs hang in a greater angle compared to the trunk than on conventional chairs, contributing to a less harmful sitting experience. The rounded, orientation-wise less restrictive shapes of stools is also worth taking over, as they together with the reduced depth allow more freedom for the legs, more postures, even sitting sideways. This admittedly trades support for more freedom: it provides more opportunities to move, more postures are possible, which is nowadays more actual perhaps. Shorter seats result in more compact general dimensions, which means more effective storage (more chairs can be stored on the same area) and in auditoriums while the distance of the chairs should remain the same, the aisles between the rows can be wider, making it easier to move around.
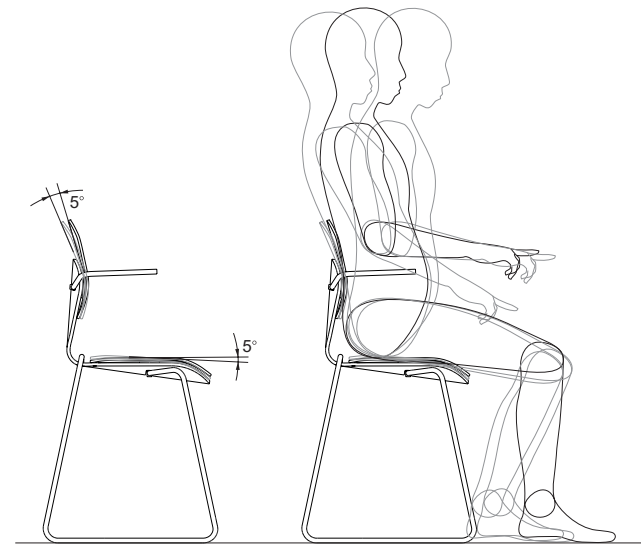

Movement range of the tilting seat surfaces: they are acting towards a graeter angle of sitting. With a 5 degree range each, the total achievable sitting angle is around 115 degrees, compared to the usual 105 degrees.

58 The frame structure

The frame is basically sandwiched between the tilting seat surfaces and the outer shell. This way they support each other: the outer shell makes the otherwise quite flexible metal frame rigid enough to carry the tilting seat pan. The back leg is screwed to the outer shell, while the front leg is supporting it from beneath with its angled part hanging out from the slot. There is also a bent sheet which is welded to the front leg and conforms to the curvature of the shell. The role of this "tongue" is to press the outer shell from the top against the front leg, generating tension in the structure and thus more rigidity. The tongue has to be rotated in with the front leg through the slot. The slightly curved tongue and rod of the front leg intersects along a three-dimensional line, making it even stiffer. The tongue can be connected to the shell by screws and expanding sockets from the inside (that means a dismountable connection) or with ep-
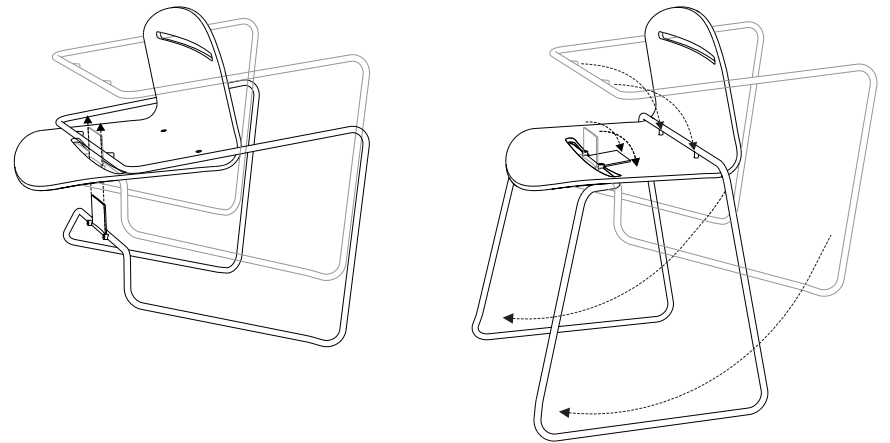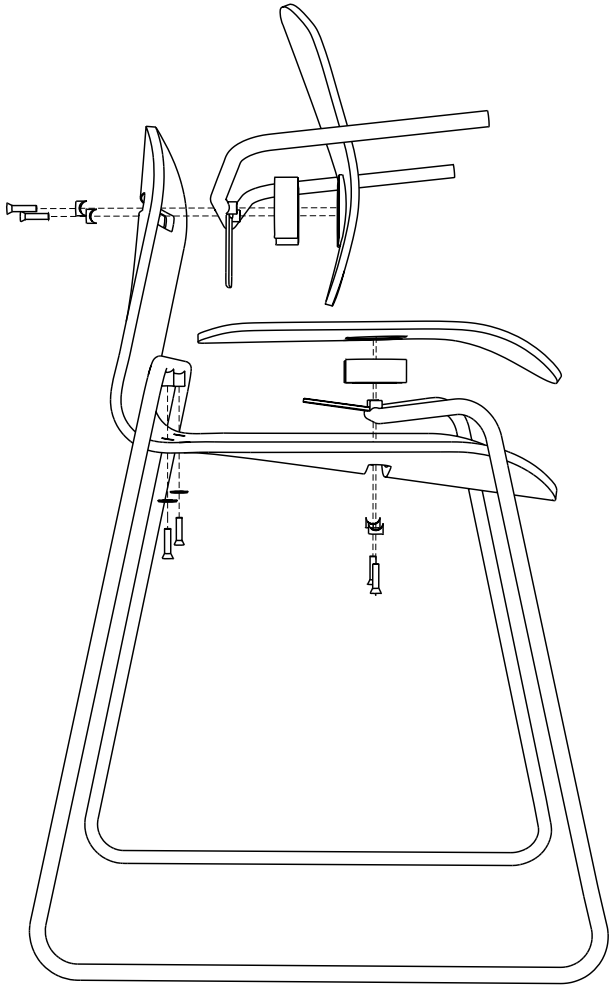
The optional armrest is fixed directly to the outer shell, similarly to the front leg, with a "tongue". Putting weight on the armrest actually presses the tongue against the outer shell, not weakening it. For this reason large forces are put on the welding between the armrest and the tongue, this is where the three-dimensional intersection comes handy. The outer shell takes a good portion of the load as well, relieving the forces on the armrest by flexing quite a bit. Again similarly to the front leg the tongue is either screwed or glued to the shell from the inside and the rubber piece of the tilting backrest is connected to the armrest with screws. The construction of the no-armrest version is simpler: a block of solid wood glued to the shell provides the right positioning and angle for the rubber pieces (in this case there is a direct connection between the tilting backrest and outer shell). The only visible screws are the ones holding the rubber parts, but they are painted with the same colour as the frame. This way the visible screw heads, structural elements are kept to the minimum, in order to make the chair look more organic, less machine-like, to break away from the mechanical nature of "ergonomic chairs".
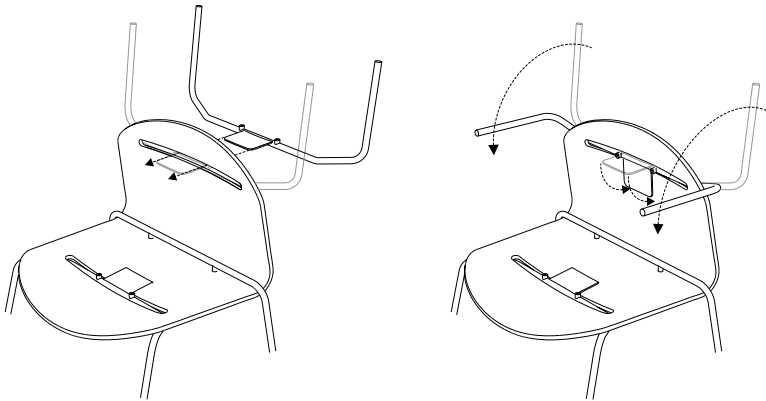
Material choice of the final versions

Materials, fabrics, textures and colours were chosen in such a way, that they are contrasting each other and give a warm impression.

CHAIR NO. 1.

Upholstered version with armrest.

Sitting surfaces:
Birch plywood, upholstered. Designers Guild Allia fabric with 30 000 cycle Martindale.
Outer shell:
Molded oak plywood.
Leg-structure and armrest:
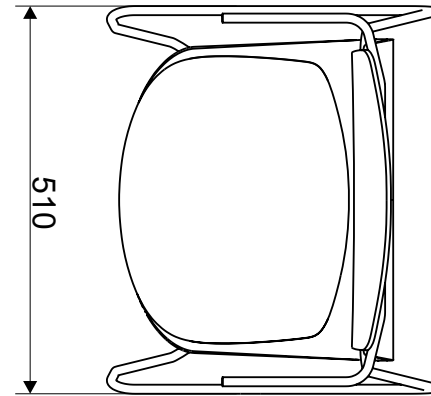12 mm solid steel rod, powder coated in RAL 6034 (Pastel turquoise) colour.

CHAIR NO. 2.

Basic version without armrest.

Sitting surfaces:
Birch plywood, with faux leather glued right on the plywood surface for friction. Faux leather fabric with 50 000 cycle Martindale.
Outer shell:
Molded ash plywood.
Leg-structure:
12 mm solid steel rod, powder coated in RAL 1019 (Grey beige) colour.

510

M1:10

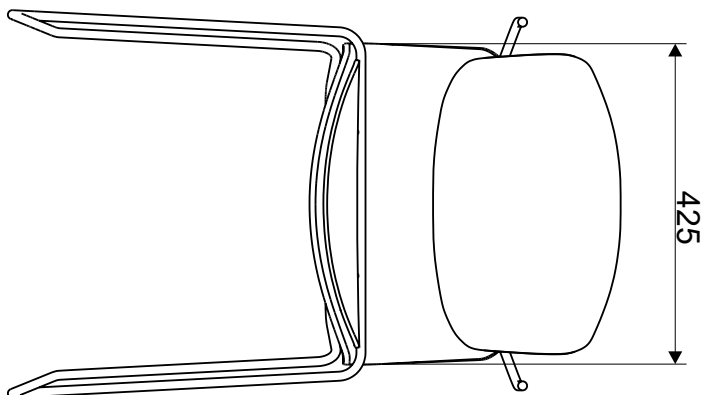**References**
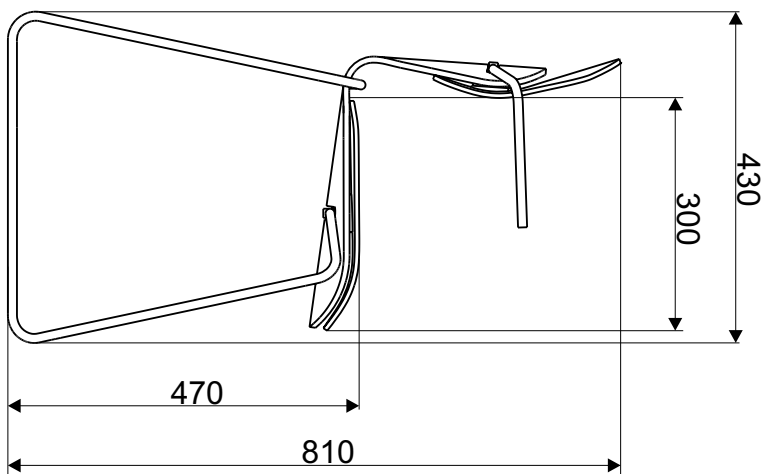
Sources from the internet

„African Thrones - Stools – Chairs".
http://www.ezakwantu.com/Gallery%20African%20Chairs%20-%20African%20
Thrones%20-%20African%20Stools.htm 05. 05. 2013.

„Asante stool". http://www.randafricanart.com/Asante_stool.html 05. 05. 2013.

http://www.opsvik.no/ 10. 09. 2013.

http://www.raymondloewy.com/about/bio.html 05. 07. 2013.

http://www.thefuntheory.com/piano-staircase 14. 08. 2013.

IBM, "Employee Well-being".
http://www.ibm.com/ibm/responsibility/employees_well_being.shtml 15. 10 2013.

Matthews CE, et al. „Amount of time spent in sedentary behaviors in the United
States, 2003-2004". In: American Journal of Epidemiology 2008, pp. 875-81.
http://www.ncbi.nlm.nih.gov/pubmed/18303006 14. 10. 2012.

Michael Wolf's „Bastard chairs" project.
http://photomichaelwolf.com/#bastard-chairs/1 23. 08. 2013.

"Musculoskeletal Disorders. Health and Safety Executive, 2011."
http://www.hse.gov.uk/statistics/causdis/musculoskeletal/msd.pdf 10. 12. 2012.

Schulz, Matthias, „Bronze Age Espionage: Did Ancient Germans Steal the Pharaoh's
Chair Design?" http://www.spiegel.de/international/zeitgeist/how-did-egyptian-
folding-chairs-end-up-in-northern-germany-a-830958.html 05. 04. 2013.

Simms, Andrew: „The four-day week: less is more". http://www.theguardian.com/
money/2013/feb/22/four-day-week-less-is-more 15. 10. 2013.

"Summary Health Statistics for U.S. Adults: National Health Interview Survey,
2010". http://www.cdc.gov/nchs/data/series/sr_10/sr10_252.pdf 10. 12. 2012.

U.S. Bureau of Labor and Statistics, "Occupational Employment Statistics".
http://bls.gov/oes/2012/may/featured_data.htm#largest 08. 02. 2013.

Wikipedia: „Chinese furniture".
http://en.wikipedia.org/wiki/Chinese_furniture 16. 04. 2013

Printed sources

Cranz, Galen, 2000: The Alexander Technique in the world of design: posture and the common chair. In: Harer, John B., Munden , Sharon (eds.), T*he Alexander Technique Resource Book: A Reference Guide.* Scarecrow Press, 2008, pp. 90-98.

de Dampierre, Florence: *Chairs: A History.* Harry N. Abrams, 2006.
Jonathan Olivares: A Taxonomy of Office Chairs. Phaidon Press Limited. New York, 2011.

Lueder Rani, Noro Kageyu (eds.), *Hard Facts About Soft Machines: The Ergonomics Of Seating.* CRC Press, 1994.

Massey, Anne: *Chair.*-(Objekt). Reaktion books. London, 2011.

 „On by Wilkhahn". In: *Design report special.* Konradin Medien GmbH. Leinfelden-Echterdingen, 2009.

Owen, N., G.N. Healy, C.E. Matthews, and D.W. Dunstan, „Too much sitting: the population health science of sedentary behavior". Exerc. *Sport Sci. Rev.*, Vol. 38, No. 3.

Pynt, Jennifer, Higgs, J: "Nineteenth-Century Patent Seating: Too Comfortable to be Moral?" In: *Journal of Design History* 01/2008, pp. 277.

Zimmermann, Manfred, 1989. The nervous system in the context of information theory. In Schmidt, Robert F. & Thews, Gerhard (eds.), *Human Physiology.* Berlin, Springer-Verlag, pp. 166–173.

Picture credits

The unmarked pictures are made by, or belong to the author.

1.   Reconstruction of an ancient Greek Klismos chair, based on vase paintings.
     http://prettyinspirational.blogspot.fi/2012/02/icons-madonna-and-klismos-
     chair.html 16. 10. 2013.
2.   Buddha statue from the Gupta period (320 AD–600s AD). Archaeological
     Museum, Sarnath, India.
     http://en.wikipedia.org/wiki/File:Buddha_in_Sarnath_Museum_%28Dham-
     majak_Mutra%29.jpg 16. 10. 2013.
3.   Centripetal Spring Armchair by Thomas E. Warren.
     http://www.design-museum.de/en/collection/100-masterpieces/detailseiten/
     centripetal-spring-armchair-warren.html 16. 10. 2013.
4.   Aeron chair by Don Chadwick and Bill Stumpf for Herman Miller.
     http://www.brooklynmuseum.org/opencollection/objects/169418/Aeron_
     Chair# 16. 10. 2013.
5.   Level 34 office storage system by Werner Aisslinger for Vitra
     http://www.vitra.com/en-us/product/level-34?subfam.id=103362 17. 10. 2013.
6.   Viola chiar by Peter Opsvik.
     http://www.yankodesign.com/2007/03/05/viola-the-tilting-chair-by-peter-ops-
     vik/ 16. 10. 2013.
7.   Convenio Wing chair by Peter Opsvik, produced by HÅG
     http://objects.designapplause.com/2011/hag-conventio-wing-peter-ops-
     vik/9603/ 16. 10. 2013.
8.   Tveir chair designed by Erla Sólveig Oskarsdóttir for Ames.
      http://www.amesdesign.de/design-concept/ames-tveir 16.10. 2013.
9.   Three legged chair by Walter Pabst sold in Wilkhahn's 360 range.
     http://www.edition20.com/en/products/Dreibeiner-by-Wilkhahn-by-Walter-
     Pabst 16. 10. 2013.
10. J107 chair by Poul M. Volther produced by HAY
     http://hayshop.dk/products/22-dining-chairs/319-j107-chair/ 16. 10. 2013.
11. Salli Sway saddle chair.
     http://www.salli.com/china/default.asp?siteid=ch-en&id=Chairs_Salli_Sway
     17. 10. 2013.
12. Variable balans kneeling chair by Peter Opsvik for Varier.
     http://www.varierfurniture.com/Products/Prevent/Variable-balans-R 17. 10.
     2013.
13. Gym ball, also known as exercise ball or swiss ball.
     http://img2.wfrcdn.com/lf/49/hash/18189/6240421/1/Isokinetics-Fit-
     ness-Ball-Chair.jpg 17. 10. 2013.

14. Sissel SITFIT balance cushion. http://www.sisseluk.com/model/uk/en/c-rehabilitation/s-balance/6752_sisse-la_sitfita_plus_black.php 17. 10. 2013.
15. On chair by Wiege for Wilkhahn. http://www.wilkhahn.com/ 18. 10. 2013.
   Stitz 2 by Hans Roericht for Wilkhahn. http://www.wilkhahn.com/ 18. 10. 2013.
16. 360 chair by Konstantin Grcic for Magis. http://www.domusweb.it/en/design/2010/11/12/block-notes-3-magis.html 18. 10. 2013.
17. Pelt chair by Benjamin Hubert for De La Espada. http://www.contemporist.com/2012/10/04/pelt-chair-by-benjamin-hubert-for-de-la-espada/pe_041012_06/ 18. 10. 2013.
18. Viola chair by Peter Opsvik. Detail of the cutout in the plywood enabling more flexibility. http://www.opsvik.no/ 19. 10. 2013.
19. Visio 200 lounge chair designed by Yrjö Wiherheimo and Simo Hekkilä for Vivero Oy. http://www.19west.de/en/products/sold-visio-200-simo-heikkil%C3%A4-and-yrj%C3%B6-wiherheimo-vivero-oy 19. 10. 2013.
20. Visio range chairs designed by Yrjö Wiherheimo and Simo Hekkilä for Vivero Oy. http://www.vivero.fi/in/index.php?main_page=product_info&cPath=1_10&products_id=146&language=en 19. 10. 2013.
21. Jobb chair by Yrjö Wiherheimo & Pekka Kojo for Vivero Oy. http://www.archiexpo.com/prod/vivero/office-chairs-casters-9602-83042.html#product-item_505417 19. 10. 2013.
22. Tip Ton chair by Barber Osgerby for Vitra. http://www.vitra.com/en-us/product/tip-ton 19. 10. 2013.
23. Threaded rubber mount. http://www.wunderlichamerica.com/motorcycle/8500127-SB2.html 19. 10. 2013.