

## SEAT DESIGN - WHAT INFLUENCES WHAT?

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**Bengt Engström Seating**

A seating system influences its user and the most important question to ask when setting up a chair or wheelchair is – "How can both comfortable and functional solutions be reached to decrease the risk of long-term injuries?" This short lecture informs about direct and indirect influence. The method is through body-awareness and is a physically interactive workshop, so bring your body and use your senses!

The objective is to learn more about how humans normally react in sitting and discover what dictates what. Natural compensations used in sitting are mainly caused by the design of the chair. My hope is that you the participant will have a deeper understanding for what can and should be done to with a chair's or wheelchair's seat and backrest design to improve overall sitting tolerance.

### **The Chair Influences Many Senses**

Our body is very sensitive to positions. There are many kinds of sense organs registering changes in the body. All of them are of course important, but in sitting focus is on the ones that register the position of the body and the influence from the surfaces contacting the body. We cannot "shut off" our sense organs, they go on registering continuously. If no external (side) support is used, the body of a person who is standing is continuously in motion, a balancing motion, known as postural sway. We really do not "see" the movements of the body, but they are present all the time. Feet are designed for standing, walking and running. The sole, the foot joints and foot muscles as well as the legs' joints and muscles register pressure and pressure-directions when the foot is in contact with a surface of support. The pressure on the sole influences the joints differently, depending on the magnitude and direction of the pressure. To maintain balance, pressure variations lead directly to muscular reactions throughout the body. When the muscles balance and stabilize the body, or its parts, we are very seldom conscious that it is happening. The muscles are automatically activated by the senses on a subconscious level. The reactions and corrections are very precise and is continuously activated.

Sitting on a chair makes the feet and legs change their relation to the trunk. When standing, the centre of mass of the entire body is located over the feet, the supporting area. In sitting the centre of mass of the trunk is over the pelvis with the ischial bones as the supporting area. The smooth, balancing and correcting motion which takes place in standing is not present in sitting. The interaction between the legs and the upper body changes. When the feet are not under the pelvis their function of being sensitive "organs" for maintaining the balance of the body is "eliminated".

Instead of relying on the feet for balance, we sit on the tiny ischial tuberosities. These two bones "stand" on the seat surface and since the trunk is on top of the pelvis the entire upper body balances on the ischial tuberosities. Balanced seating requires a well-positioned pelvis. If the pelvis does not have a functional and stable position, the upper body cannot be kept in an upright position for more than shorter moments and one must use many muscles for keeping the posture. The leg's connection with the pelvis is through ligaments, joint capsules and muscles. Because of this connection, the position of the feet and legs, as well as their muscle activity, influence the position of the pelvis directly or indirectly. In most sitting positions the tendency of the pelvis is backward rotation. This tendency can be either blocked or forced by the legs, something we do continuously. It is a natural part of sitting.

Sit straight! Sit properly! Sit still! Most of us have said this to our children, especially when they sit and eat. But what is "proper" seating? If we tell a four-year-old to sit properly he will probably become confused. If we don't know what it means to sit properly, how can we expect a child to know? To sit

“properly” is possibly a posture that feels good - for the moment. Whenever our posture-sensing organs register something negative in a position we will re-position the body, over and over again.

### **Factors Causing Fatigue**

I am sure you have experienced how awfully tiresome it can be to sit, especially when you don't want to sit. Imagine sitting and listening to a lecture which is not at all stimulating. It has been going on for "ages". You are sitting in the middle part of the lecture room, which is crowded with people, so you can't "sneak out"...and it's thirty minutes to the next break! Sitting makes the body's physical stability increase. If you lean against a backrest you become highly stabilized. This is like putting the body in a state of physical "rest". You can easily fall asleep when stability increases and few things keep you awake – things like a lively, positive lecturer! Have you ever thought of the fact that an active and inspiring lecturer makes us decrease our physical stability. We forget the backrest and sit more upright, maybe we even lean forward towards the speaker - the person who is so interesting. Physical activity is strongly linked to mental activity and vice versa. Imagine you are sitting in a car and you are the driver. You and your friend have been travelling for many hours and the last hour you have both been silent whilst driving on a highway. The engine is humming and the wind whispering. The weather is grey and it's raining lightly. Your eyelids begin to feel heavy. When you feel you can hardly keep your eyes open, you pull over, park the car and take a short walk - to "stimulate the brain", to "wake up". Physical inactivity and mental under-stimulation, or monotony, in sitting leads to fatigue and decreased alertness. The brain "shuts the systems down".

Another situation can be when you sit on a chair designed for more active seating, such as a chair in a restaurant. It can be frustrating to be "forced" to stay at the table after a heavy meal. If the people you have around you are boring, you just don't have anything in common with them, I'm sure you would rather be somewhere else. After a while it becomes awful to sit upright on "the hard chair". You begin to plan... What would be the best way to get some rest... slide under the table or just gently fold forwards and rest on the remains of the dessert...

Other problems occur for those who travel on long flights in economy class. A twelve-hour flight is a very long time to be sitting in a small space. You may have the middle seat, making it much more difficult to change position. If you are even more unfortunate, you may have been allocated a middle seat between two passengers with no interest in talking to you. This psychologically under-stimulating and physically "locked-in" position may come close to what some people using wheelchairs experience every single day.

### **Factors Causing Fatigue in Sitting**

- too much physical stability
- too much physical freedom
- uncomfortable pressure and shearing
- monotony / boring environment
- wrong chair for the activity
- sitting too long time!

### **Normal Desire in Sitting**

STABILITY	Find a Stop
FREEDOM	For Motion
BALANCE	In Relation to Gravity
CONTROL	Dynamic and Static Muscle Activity
COMFORT	Muscle Activity Level
	Pressure and Shearing
	Communication
	Environment
TIME	Time Tolerance Level!

**Seating Unit Design Principles**

<b>Part</b>	<b>Body</b>	<b>Feature</b>	<b>Result</b>	<b>Trunk Influence</b>
<b>Seat</b>	Legs	Functional Thigh Support	Stability/Comfort/Safety	Backrest Contact
	Pelvis	Prevent Forward Sliding	Stability	Block Collapse
	Pelvis	Pressure Decrease	Safety/Comfort	Maintain Posture
	Legs/Pelvis	Pressure Distribution	Comfort/Safety/Stability	Grounding
	Legs/Pelvis	Backward Slope	Prevent Forward Sliding	Stability/Collapse
	Legs/Pelvis	Forward Slope	Anterior Pelvic Tilt	Freedom/Upright
<b>Back</b>	Sacrum	Placing in Space	Grounding for L5	Upright/Stability
	Pelvis	Sacral Level Supporting	Pelvic Stability	Grounding
	Mid Thorax	Support	Stability	Relaxation
	Upper Thorax	Support/Balance	Stability/Freedom	Relax->Active
	Trunk	Reclining	Stability/Frw. Sliding	Rest/Collapse
<b>Seat/Back</b>	Trunk	Tilt-In-Space	Stability/Pressure	Relaxation
	Pelvis/Legs	Tilt-In-Space	Pressure Decrease	Rest
<b>Armrest</b>	Arms	Functional Height	Stability	Assist Uprighting
	Arms	Adequate Plate Softness	Comfortable	Assist Uprighting
	Arms	Functional Contour	Stability	Assist Uprighting
	Hands	Armrest Length	Stable Support	Frw. Transfers

**Reference**

Engström B.; Ergonomic Seating – A True Challenge / Wheelchair Seating and Mobility Principles  
ISBN 91-972379-3-0, Publ. 2002, Posturalis Books, Sweden

**Speaker Biography**

I am a freelance P.T., Lecturer and Author. Through my company "Bengt Engström Seating", founded 1990 located in Sweden, I present different types of practical seating and wheelchair seminars on a worldwide basis. I am an author of a few books about Ergonomic Seating and Wheelchair Adaptation. As a Consultant I have often been involved in product design, co-operating with various manufacturers internationally.

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