Rethinking back support: Sacral, lumbar or "live backs": NECE / ErgoExpo 2007 workshop slides

Rethinking back support... ... Sacral, lumbar or "live backs"?

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• How do we think we sit?  
• How do we actually sit?  
• How should we sit?  
• What is the difference?  
• What really matters?

Rani Lueder, CIEE, CPE

• Consulted and served as principal of Humanics ErgoSystems since 1982.  
• Specialized in occupational ergonomics and ergonomics research and design of products and places for adults, children and people with disabilities.  
• Edited and co-authored three books in ergonomics.

If all you have is a hammer, ... you think everything is a nail.

Creates its own reality
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Prof. Kageyu Noro

• Professor Emeritus, School of Human Sciences, Waseda University.
• CEO and CTO, ErgoSeating, Japan.
• Directed the University of Waseda’s prestigious Seating Research Laboratory for more than 20 years.
• Edited and co-authored fourteen books in ergonomics.
• Organized many conferences on seating and posture.

Steven Reinecke

• Served as Vice-president and Chief Technical Officer of several medical device manufacturers for products that treat low back pain from surgical to non-invasive treatment modalities
• Over 20 US and international patents
• Prior to that, he conducted research at the Department of Orthopedics at the University of Vermont.

Shunji Yamada, MS Eng.

• Technical Advisor to ErgoSeating in Japan.
• Served in an Executive Board Member of Toyo-Kogyo Industries, Inc.
• Received his MS in Engineering from Case Western Reserve.

Zazen sitting

Research activities of...
• Seating Research Labs, Waseda University
• ErgoSeating (Applied research supported by Waseda University)

Static Postures
Results In:
Local Muscle Fatigue
Strained Ligaments

Zabutons

Cindy Burt, OTR/L, CPE

- Created and manages UCLA’s ergonomics program for their 27,000 employees
- Teaches ergonomics to Occupational Therapy students at the University of Southern California in Los Angeles.
- Previously managed the work injury rehabilitation program at UCLA’s Medical Center

How do we really sit?

Thank you!

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Over 1,000 postures people can sustain

Our seats reflect our assumptions

Neutral postures

- Balance muscle loads
- Reduce physical demands
- Relieve physical stress


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As we shift posture, dynamics change


Thank you!

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New research findings: The impact of sacral and pelvic support on the spine

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Sacral support since the 13th century

muscles skeleton

Contact Surface Zafu and Monk

Zafu floats the spine
Pelvic rotation determines the extent of lumbar lordosis.

Pelvic rotation: 0° Standing, 5° Zen Sitting, 24° Chair Sitting.

Pelvic Sacrum:
Lumbar lordosis: 前弯
Kyphosis: 後弯

Pelvic rotation determines the extent of lumbar lordosis.

Advantages of sacral support:
1. Stops pelvic rotation
2. Promotes muscular contraction
3. Reduces pressure on the buttocks

Health and comfort

Design guidelines for back supports

Pressure Distribution:
Good
Bad
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A new seat comfort concept:
- Pressure distribution
- Peak value of pressure
- Pelvic tilt angle

Conventional vs. The new concept model

A sample chair for the experiment (not for sale)

Comfort cup

Upper back - postural support when reclining

Low back comfort... sacral and pelvic support

High Performance Seatpan (HPS)

Realization of premium comfort

Cradle
Zen Meditation

An Overview Of Low Back Pain

- Low back pain significantly affects 70-80% of adult population
- Most frequent cause of lost work days, after common cold, in persons under 45
- Incidence same in sedentary individual. vs. those performing heavy labor jobs

NECE2007: Rethinking Back Support: Sacral, Lumbar, or “Live backs”?

Steven Reinecke

Comfort cup
Low Back Pain:

- Acute LBP (< 3 Months)
- Chronic LBP (> 3 Months)

Comfort --- Low Back Pain

Proper Spinal Curvature

- Kyphosis: 3x (+) IDP
- Lordosis: (-) IDP

Posture

Poor Posture & Forward Flexion

Mechanical Diagnoses
- Disc derangement
- Nerve root entrapment/impingement
The physician can determine this with a CT scan or MRI, where you can see the intradiscal material impinging against the spinal cord.

This posture is also important because it affects the load concentrated on the spinal column. Think of your spine, upper body, and back muscles as a seesaw. The spine or vertebra is the fulcrum point of the seesaw, the upper body is one side, while the back muscles are the other side. In order to balance, the resultant force on both sides must be equal.

If you were to sit in a forward flex position, (as depicted in the top Free body diagram) you can see that the constant force of the upper body moves further away from the spine. In order for the body to balance, the back muscles increase in force to counteract this load because the back muscles can not move further away from the fulcrum point. Unfortunately when the back muscle force increases, the resultant force on the spinal disc increases greatly. In order to keep the load low, you must maintain an upright posture. (as depicted in the bottom Free body diagram)

What Feels Good is not always Good

Static Postures Results In:
- Local Muscle Fatigue
- Strained Ligaments

The best way to control these detrimental effects is to change one's posture. By changing the back and giving the previously loaded muscles and ligaments time to recover.

“Movement Heals Humans”
Spine is Designed for Activity

- **Flexible Strength:** Provides Primary Support & Mobility on many Planes
- **Structure:** Houses and Protects Major Central Nerves
- **Complexity Makes Susceptible**

Functional Motion: Spinal region

- Cervical
- Thoracic
- Lumbar

Vertebral Motion

- Flexion
- Lateral Bend
- Axial Rotation
- Coupled

Vertebra

- Body
- Transverse Process
- Lateral Bend
- Facet Joints
- Rotation
- Spinous Process
- Flexion

Anatomy of the Vertebra

- Similar but unique size, shape, angulation at each level
- Variations in structure effects functionality
Biomechanics: Form and Function

- **Cervical (ROTATION, FLEXION)**
  - 7 segments
  - C1 (ring) pivots on C2

- **Thoracic (STABILITY)**
  - 12 segments
  - Very little motion

- **Lumbar (WEIGHT BEARING, FLEXION/EXTENSION)**
  - 5 segments
  - Weight bearing
  - Paired facet joints allow flexion/extension
  - Very little rotation

As we look at existing chairs, most have a fixed plane backrest with little accommodation to the individual segments of the spine, in response to their predefined range of motion.

As one flexes forward, we see the greatest change in curvature within the lumbar region. In this case, we only see the lower back being supported.

However, as a person reclines, the greatest change will again occur within the lumbar region, and with this change, the lower back becomes unsupported.

What typically happens is the person actually conforms to the chair, thereby not getting the benefits of changing the spinal curvature.

To address this issue, backrests today provide a lumbar "cushion" which provide proper support in the reclined position.

However, these lumbar "cushions" will only provide minimal support for both the lower and upper back in the forward and upright position.

So what should the future of seating include?

Good support that provides load sharing of the upper and lower back thereby reducing the level of pressure within the intra-disc of the spine and transferring the load to the backrest's secondary support system.

A backrest which will provide the appropriate range of motion for each of the different regions of the spine. Flexion extension of the lumbar region with minimal change in curvature of the thoracic region.

And finally, a chair that promotes motion during the course of the day, minimizing motionless postures. By allowing motion, we prevent the excessive strain to isolated muscles and ligaments. While also improving nourishment to the intra-vertebral disc.

The Ideal Seat!

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**Zabutons: sacral and pelvic support**

- Background
- Previous research
- Ergo-zabuton validation trials
- Research conclusions

November 29, 2007

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A variety of females' sitting styles reflect Japanese seating culture

Source: ErgoSeating's in-house research (Kageyu Noro, 2007)
Problems with floor seating

Floor sitting postures such as cross-legged seating:
- Increase risk of musculoskeletal disorders (e.g., low back pain)
- Tend to tilt the pelvis back → kyphosis


A challenge to a renewed version

- To develop designs that support the sacrum and pelvis more effectively.
- To accommodate females’ common sitting postures (incl. cross-legged, split & side sitting)
- To meet functional criteria (e.g., compact & easy to carry)

Characteristics of the Ergo-zabuton

Project design director: Dr. Kageyu Noro

1 Sacral / pelvic support
2 Ischial / buttocks support
3 Pommel
4 Three dimensional slope
5 Cushion: hard under buttocks, soft in front

Seat pressure distributions

The combination of pommel and 3D slope promoted more effective seat pressure distributions
(a) With pommel and 3D slope
(b) Without them

Data collection: Posterior pelvic tilt

Tilt angles at the left represent averaged values from 14 subjects.

Research Conclusions
The ErgoZabuton…
1. Promoted lumbar lordosis through reduced pelvic tilt.
2. More effectively distributed seat pressures (based on seat pressure distribution data)
3. Was rated more comfortable (seat trials, 54 subjects).

Thank you for your attention!

Rethinking Back Support

USER PREFERENCES: ACTIVE VS FIXED SEATING
Cindy Burt, MS, OTR/L, CPE

How we sit depends on…
What we need to do.

How we sit depends on…
How we do it.

How we sit depends on…
How well we can see.

How we sit depends on…
How far we need to reach.
How we sit depends on...

How long we have to do it.

There are lots of ways to sit...

Dynamic sitting

And then there’s...

Passive sitting

Dynamic Chairs

- Active back
- Active back and seat
  - Synchronous
  - Non-synchronous

Active Back

- Back moves
- Seat pan locked

Active Back

Back changes shape
Active Back and Seat

Synchronous: Seat and back move as unit

Active Back and Seat

Non-synchronous: Back and seat move independently

Active Seating

Non-traditional seating
- Ball chair
- Sitting disc
- Swopper chair

Active Seating

Non-traditional seating
- Stokke Gravity chair
- Recliner

Active Seating

Non-traditional seating

Fixed Seating

Non-dynamic seating
- Courtrooms
- Schools and lecture halls
- Restaurants

Dynamic seating locked

How we sit is determined by...

Our posture, culture and habits
How we sit is determined by…

Our work demands

How we sit is determined by…

Our stability

Workers Move in Space to Work

...with or without their chair

Workers prefer fixed backs when…

They reach beyond limits of chair.

Workers prefer fixed backs when…

They complete frequent bilateral hand tasks.

Workers prefer fixed backs when…

They complete precise work.
They are obese.

Their workstation is too high.

They have limited stability.

They have back pain.

They have poor sitting balance or control.

They aren't encouraged to move.
Workers prefer fixed backs when...  They don’t know how to adjust their chair.

Why Do We Want Back Support?
- Decreased disc compression
- Sit upright longer
- Improved posture

From Corlett & Eklund (1984)
How does a backrest work?
Graphic with permission

Supported Active Sitting
- Chair
  - Pelvic control
  - Lumbar support
  - Thoracic support
  - Adjustable seat pan length

Supported Active Sitting
- Chair
  - Dynamic reline
  - Self-adjusting mechanism
  - Usability
  - Quality

Supported Active Sitting
- Workstation
  - Consider height
  - Reach zones
  - Design

Supported Active Sitting
- Worker considerations
  - Posture
  - Vision
  - Health and fitness
  - Knowledge
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Active Sitting Environment

- Proper chair
- Adjustable workstation
- Health and wellness programs
- Training programs

Questions?

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