Ergonomic Seating?

The Perfect Chair?
The Perfect Work Posture?
Backs, Sitting & Ergonomic Chairs

- Up to 50% of MSDs
- Lifetime risk - 80% of people
- Maximum risk - 20-45 years old
- Risk factors:
  - Frequent heavy lifting
  - Poor posture
  - Static sitting

We Need to Sit

- Energy – sitting requires 20% less energy than standing.

We Need to Sit

- Efficiency - if supported and reclined, intradiscal pressure is less than that for erect standing.

We Need to Sit

- Effectiveness - sitting increases postural stability for fine motor tasks.

Why Do We Sit?

- Equality – sitting reduces anthropometric variability.

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Why an Ergonomic Chair?

- **Economics** - the average office loses over $7300 per employee per year in poor productivity and medical and Workers' Compensation claims (The Bureau of Labor Statistics).
- Over 50% are low-back injuries. Poor chair design contributes to poor seated
posture which plays a major role in these injuries (e.g. Secretary Back Syndrome).

**Musculoskeletal Discomfort**  
(Ong et al., in *Work with Computers*, 330-337, 1989)  
- Survey of 672 full-time computer users:  
- Complaints related to poor ergonomic furniture, including the chair.

**Musculoskeletal Discomfort**  
- Survey of 170 women typists working at computers  
- Mismatch between chair height and desk height and poor furniture design related to symptoms.

**Ergonomic Survey of the Social Services Administration, USA**  
(Lueber, 1997)

**Ergonomic Chair Design?**  
- Who advertises their chair as “not an ergonomic design”?  
- Can you choose the best chair solution from “off-the-shelf” ergonomic chairs?

**How Should We Sit?**  
Risk = Posture X Exposure

**ANSI/HFS  100-1988**

**Myths of Ergonomic Seating**

1. Ergonomic seating always requires a single, ‘cubist’ (90° upright) postural orientation that is independent of the user’s task (Dainoff, 1994).  
2. You can judge how ergonomic a chair is by briefly sitting in it.  
3. Users should be able to adjust everything.  
4. Users don’t need training on how to sit in a chair (Dainoff, 1994).  
5. One chair design will provide the best fit for all users.

**Proper Ergonomic Posture?**

- Anthropometric reference diagram (90° angles) IS NOT a required ergonomic posture!  
- Reclined postures often are preferred (Grandjean, 1988).

**Lumbar Support**

- In unsupported sitting or forward leaning the lumbar spine may be
in kyphosis, which is indesirable.

- During supported sitting the lumbar spine should be maintained in lordosis by an adjustable lumbar support.

**Seat Pan Design**

- Proper sitting requires pelvic rotation that creates lumbar lordosis.

**Ischial Tuberosities**

- Sitting concentrates the forces on the ischial tuberosities (sit bones).

**Seat Pan Design**

**Posture and Lumbar Disc Pressure**

(Nachemson, 1974)

- Lumbar disc pressure varies with back posture and the load in the hands.
- Lumbar disc pressure is lowest for a supported, reclined posture.

**Back Muscle Pain**

Backrest angle and muscle activity

(Andersson and Ortengren, 1974)

- Lumbar, thoracic, and cervical muscle activity all decrease with increasing backrest inclination up to 110°.

**Work Postures**

(Park et al., 2000)

- Effects of work postures on muscle activity tested

**Preferred Seat Angle**

- Both lumbar disc pressure and back muscle activity are lowest with a supported recline angle of 110° - 130°.

**Adjustable Back Support**

(Coleman et al., *Ergonomics* 41: 401-19, 1998)

- Studied 123 office workers (43 men, 80 women) over a 5 week period: a high proportion of chair users make height adjustments to their lumbar back support.
- Adjustment frequency is higher for older workers than younger workers.
Chair Support
- Buttocks and back need support.

Keegan’s Normal Posture
- Abdominal angle is \( \sim 135 \, ^\circ \).

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Balan’s Chair: Normal Posture
- Research findings don’t support claims that this design will decrease low back pain (Lander et al., *Spine* 12: 269-72, 1987).

Mandal’s Forwards-tilting Posture
- A proper spinal posture can be maintained by forwards sitting if the person has a seat pan that tilts and they use an angled worksurface.

Lots of balls?
- Sitting on balls can put the body in Keegan's normal posture, but isn't a solution for extended use.

Saddle chairs
- Work by Keegan and Mandal forms the basis for saddle chairs.

Sitting in Context
- Whether or not a chair design is ergonomic can depend on the task.

Neutral Posture
- Neutral posture in microgravity is similar to the seated postures shown (Congleton, 1999).

Neutral Posture in Microgravity
- Neutral posture in microgravity can be seen for a sleeping astronaut.
- Is this really the posture we should adopt in gravity?

Posture and Lumbar Disc Pressure
(Wilke et al., 1999)
Lumbar intradiscal pressure can be recorded at L4-L5 during different standing, sitting and lifting postures.

**Posture and Lumbar Disc Pressure**  
(Wilke et al., 1999)

- Intradiscal pressure during reclined, supported sitting is 50% less than that for erect standing.

**Dynamic vs. Static Sitting**  
(van Dieën et al. Ergonomics, June, 2001)

- Tested 3 chairs:
  - Fixed Angle – FA (95°)
  - Dynamic Angle – DA
  - Dynamic Angle – DB
- Subjects worked for 3 hours on CAD, Word processing and reading tasks.
- Spinal elongation measured.
- Neck posture measured.
- Back EMG measured.

**Dynamic vs. Static Sitting**  
(van Dieën et al. Ergonomics, June, 2001)

- Spinal elongation significantly greater for dynamic chairs.
- Neck posture unaffected by dynamic sitting.
- Back EMG depends on the task.
- Dynamic office chairs should NOT be locked.

**Preferred Seat Angle**

- Both lumbar disc pressure, back muscle activity, and comfort ratings are lowest with a supported recline angle in the range of 110° - 130°.

**Lumbar Support**

- During supported sitting the lumbar spine should be maintained in lordosis by a contoured chair back lumbar support.
Reclined Sitting
- Reclined sitting preserves Keegan’s normal posture but opens the popliteal arch and ankle angles, as well as allowing the back to recline against a contoured support.

Neutral Sitting Posture
- Neutral sitting posture for 5th and 95th percentiles (Congleton, 1999).

Chair Backrests
- Tested effects of 6 different chair backrest designs on back support.
- Backrest design significantly affects measured dorsal (shoulder blade) and lumbar contact time.

Effects of a Chair Headrest
(Monroe et al., 2001, Proc. HFES, 1,1082-6)
- Studied effects of a reclined posture with headrest on typing.
- Found significantly less muscle activity with this posture for the:
  - Neck (>35% reduction)
  - Back (>64% reduction)
- No difference in typing accuracy.

Popliteal Arch
- Compression at the popliteal arch (back of the knee) can impair leg circulation and cause nerve compression.

Popliteal Angle
- The popliteal arch (back of the knee) should not be in contact with the chair seat pan.
- The popliteal angle should be > 90°.

Seat Height
- Seat height should be adjustable and set to allow feet to be placed
on a stable surface.

- When seat height cannot be suitably adjusted, use a footrest.

**Crossing Legs**

- Poor posture

**Headrests and Neck Posture**

- Sitting head height for 5th and 95th percentiles.
- Adjustable height headrests are necessary for a properly supported neck posture.

**Adjustment Features for an Ergonomic Chair**

- Seat height
- Back rest height
- Swivel - ability to turn while seated
- Back tilt adjustment
- Adjustable arms
- Seat tilt adjustment
- Ability to lean back
- Ability to “track” posture changes
- Carpet casters/hard floor casters
- Intuitive, easy-to-use controls

**Ergonomic Chair Controls**

- Ensure that chair controls don’t require awkward adjustments.
- “The key is...to design adjustability controls that are easy to understand and easy to use (Helander et al., 1995)
- Controls with long levers most preferred.
- Controls are operable while sitting.

**Ergonomic Chair Controls?**

**101 Rotations!**

- Watch out for chair controls that require awkward adjustments.

**Ergonomic Chair Control Adjustments**

(Helander et al., 1995)

- 24 different types of chair controls on 26 different chairs investigated in 3 experiments (20 Ss).
• Controls with long levers most preferred.
• The more the controls, the more the adjustments and the longer the adjustment time.

Benefits of Chair Arm Rests
• Improved wrist deviation?
• Improved shoulder abduction?
• Improved forearm support?
• Improved typing comfort?

Cornell Chair Arm Study
(Barrero, Hedge & Muss, 1999)
• 24Ss study
• Men/women
• 5/50/95th %iles
• 4 chair arm designs
• Keyboard on flat keyboard tray

Cornell Chair Arm Study
(Barrero, Hedge & Muss, 1999)
• No significant differences between chair arm designs in wrist posture during typing at a keyboard on a flat tray.
• No differences in upper body posture.
• Wrist posture is outside of a neutral zone of wrist movement.

Chair Armrests
• Look at user's arm positions on a chair arm rest when the chair is adjusted for sitting comfort.

Discourage Poor Seated Posture
Neutral Working Posture
Ergonomic Chair Designs
(BSR/HFES100, 2002; ISO 9241-5, 1998; CSA-Z412.00, 2000, & BIFMA, 2001)
• "The purpose of good seating is to provide stable body support in a dynamic posture which is comfortable over a period of time, physiologically satisfactory, and appropriate to the task or activity which is to be performed."

Ergonomic Chair Requirements
(BSR/HFES 100, 2002)
• Adjustable Seat Height
  • 11.4 cm in range 38-56 cm
- Seat Pan Angle Recline and/or decline
  - <= 6° total
- Seat Pan-Backrest Angle
  - >=90°
- Seat Pan-Backrest Recline
  - 0-15°
  - recommended range = 0-30° (if >30° a head rest is needed)

**Ergonomic Chair Recommendations**
(BSR/HFES 100, 2002)

- Seat Pan Depth
  - <=43cm
- Seat Pan Width
  - >=45cm
- Backrest Height and Width (top of backrest)
  - >= 45 cm above compressed seat height (CSH)
- Backrest Lumbar Support
  - 15-25 cm above CSH
- Backrest width
  - >=36cm
- Armrest height
  - 17-27cm (fixed)
  - 18-27cm above CSH (adjustable)
- Armrest span
  - 46cm
- Chair casters
  - Appropriate for type of flooring at workstation