The Seated Human

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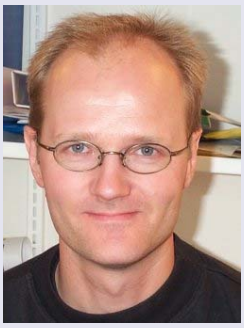
Presenters



John Rasmussen
(Presenter)

Arne Kiis
(Host)

Mark de Zee
(Panelist)

Søren Tørholm
(Panelist)

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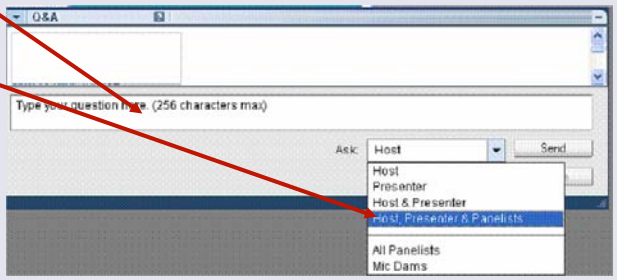
Q&A Panel

- Launch the Q&A panel here.
- Type your questions in the Q&A panel.
- Send the question to ”Host, Presenter & Panelists”
- Notice the answer displays next to the question in the Q&A box. You may have to scroll up to see it.



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1/3: The seated human

- A joint effort with the furniture industry.
  - RBM A/S
  - AP Furniture A/S
- A human sitting in a generic chair.
- Adjustable chair position and support conditions.
- Adjustable friction.
- Purposes
  - Investigation of the biomechanics of sitting
  - Design of better chairs

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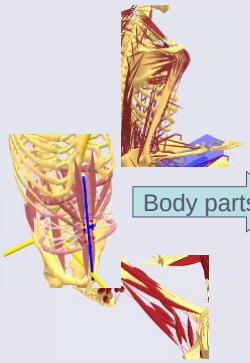
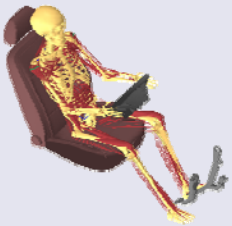
The model repository

Public domain model repository



Body parts



Environment

User development

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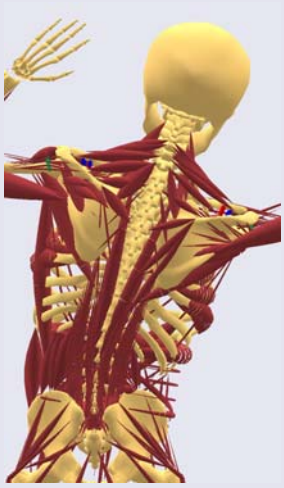
The Spine Model

The spine model comprises sacrum, all lumbar vertebrae, a rigid thoracic section, and a total of 158 muscles.

Model developed by M. de Zee and L. Hansen

Thoracic and cervical parts are under development.



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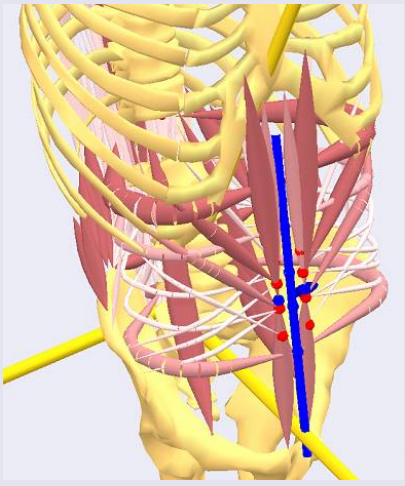
Abdominal model

- Rectus abdominis
- Obliquus externus
- Obliquus internus
- Transversus

- Abdominal pressure included.



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Lower extremity model

- Bones: pelvis, thigh, shank and foot.
- The hip joint is modeled as a spherical joint, while the knee and ankle are hinge joints.
- A version with “correct” knee kinematics is under development.
- ~ 40 muscle elements in each leg.
- Thanks to Mark Thompson, Oxford University, for his help on developing the lower extremity model.

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Muscle recruitment method

Minimize

$$G(\mathbf{f}^{(\mathbf{M})})$$

Subject to

$$\mathbf{Cf} = \mathbf{d}$$

$$f_i^{(M)} \geq 0, \qquad i \in \{1,..,n^{(M)}\}$$

Objective function. Different choices give different muscle recruitment patterns.

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Minimum fatigue formulation

Minimize maximum relative muscle load or minimize fatigue or maximize endurance

Minimize

$$\max\left(\frac{f_i^{(M)}}{N_i}\right), \quad i \in \{1,..,n^{(M)}\}$$

Muscle force

"Max muscle activity"

Muscle strength.

Subject to

Equilibrium equations

$$\mathbf{Cf} = \mathbf{d}$$

Muscles cannot pull

$$f_i^{(M)} \geq 0, \quad i \in \{1,..,n^{(M)}\}$$

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Brief demonstration

- Adjustment of seat inclination.

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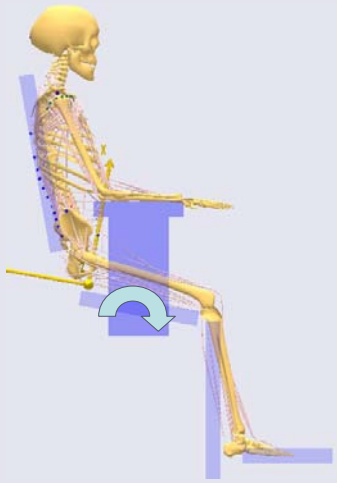
2/3: Sitting dogma: "Inclining the seat forward is good for your back"

- Claim made by Mandal (1981).
- Caused the furniture industry to enable seats to tilt forward.
- The claim was never properly investigated.
- Users tend to not like inclining seats.
- Is it really a good idea?



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Issues

- If the seat has low friction, you will slide down and must use muscle force to keep you in place.
- If the seat has high friction, you will not slide, but there will be some amount of shear force on your thighs.
- We shall investigate muscle actions and spinal forces for reasonable combinations of seat inclination and friction coefficient.

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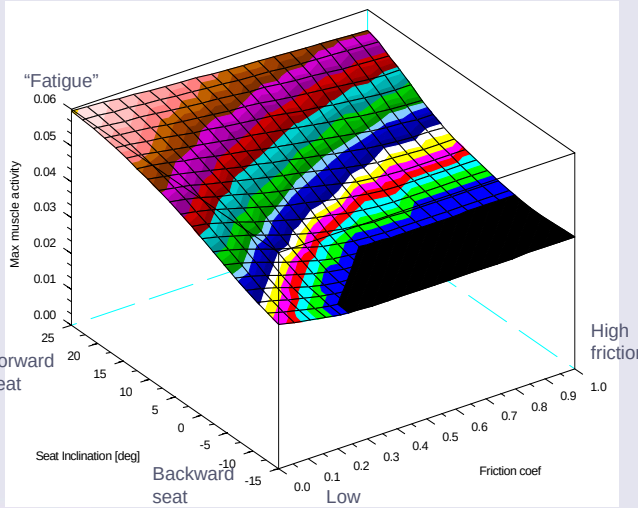
Overall muscle activity



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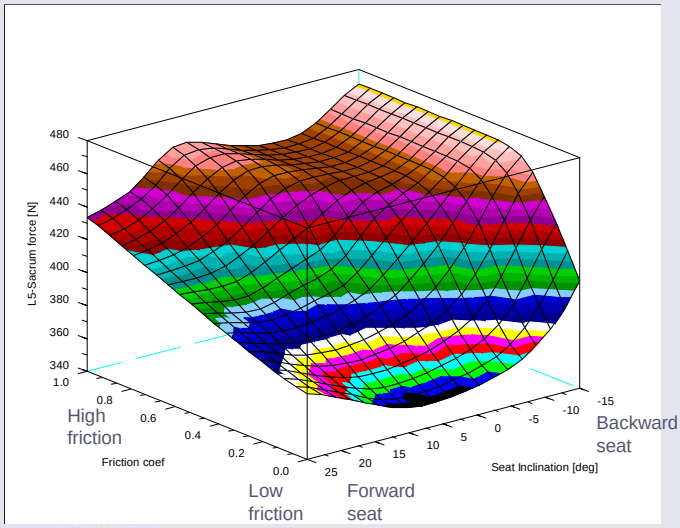
L5-Sacrum reaction force



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Some observations

- Backward inclination and high friction is more comfortable (less fatigue).
- Moderate forward inclination and low friction minimizes spinal reaction force.
- Forward inclination is uncomfortable due to increased fatigue.
- The spinal reactions are low in any case compared to, e.g. stooping or lifting.

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3/3: Conclusions and outlook

- We can investigate a whole lot of relevant issues:
  - Spinal loads
  - Shoulder loads
  - Fatigue
- Feedback SIG:
  - Many problems are rooted in the head posture.
  - A neck model would be useful.

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Why the neck?

- Lots of people have neck and shoulder problems.
- Muscle infiltrations.
- Headaches

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Why the neck?

- Our heads are comparatively heavy.
- Muscles must stabilize the cervical spine.

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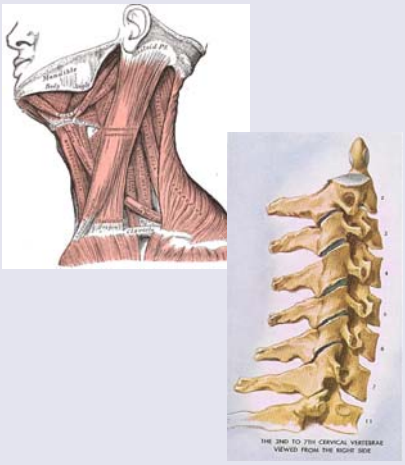
Development of the neck model

- Complex mechanical system.



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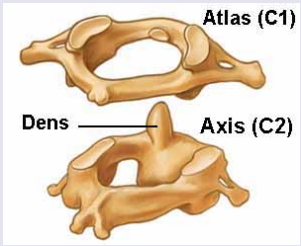
Development of the neck model

- Seven vertebrae



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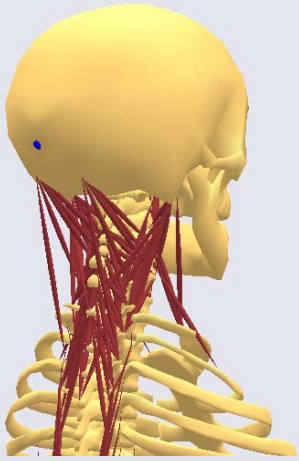
Development of the neck model

- We need approximately 140 muscles.



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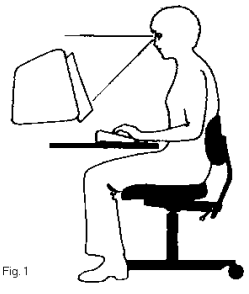
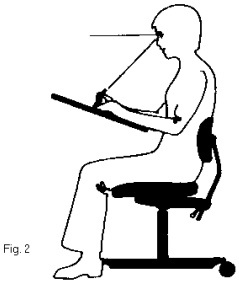
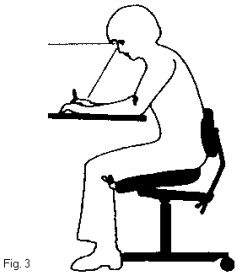
Use of the model







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Online resources

- AnyBody Technology
  www.anybodytech.com
  - Free demo licenses
  - Tutorials and documentation
  - Replay of webcasts
  - Further info: Email: anybody@anybodytech.com
- The AnyBody Research Project
  www.anybody.aau.dk
  - Public domain library of body models and applications (**including the seated human**)
  - Publications – many for direct download.

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Forthcoming webcasts

- 4 December 2006:
  A generic detailed rigid-body lumbar spine model by Mark de Zee
- 17 January 2007:
  Scaling strength in human simulation models by Kenneth Meijer
- 22 February 2007:
  Kinematic analysis of over-determinate Systems (the mocap interface) by Michael Skipper Andersen

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