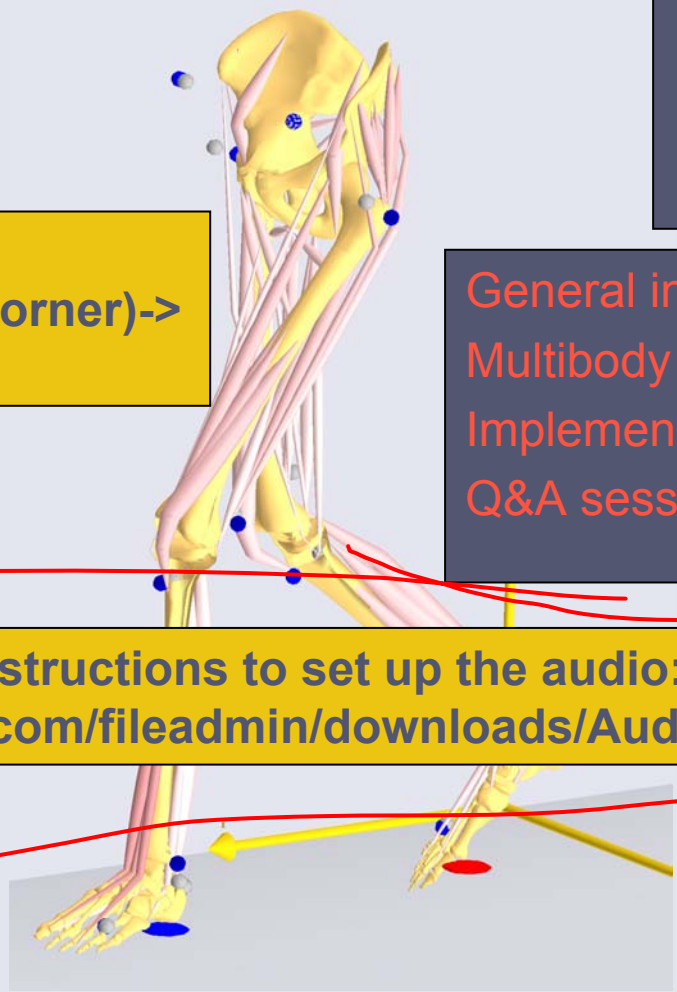
Gait Modeling

The web cast will start in a few minutes….

To fit your screen:
Sharing (upper right corner)->
View->Autofit

General intro (~5 min)
Multibody systems (~15 min)
Implementation and demo (~15 min)
Q&A session (~10 min)



Please follow the instructions to set up the audio:
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Presenters

John Rasmussen
(Presenter)

Arne Kiis
(Host)

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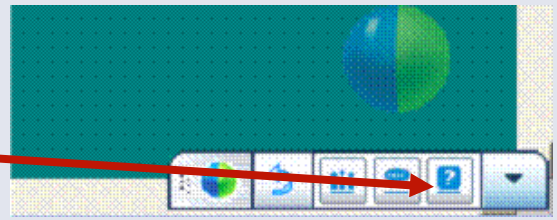
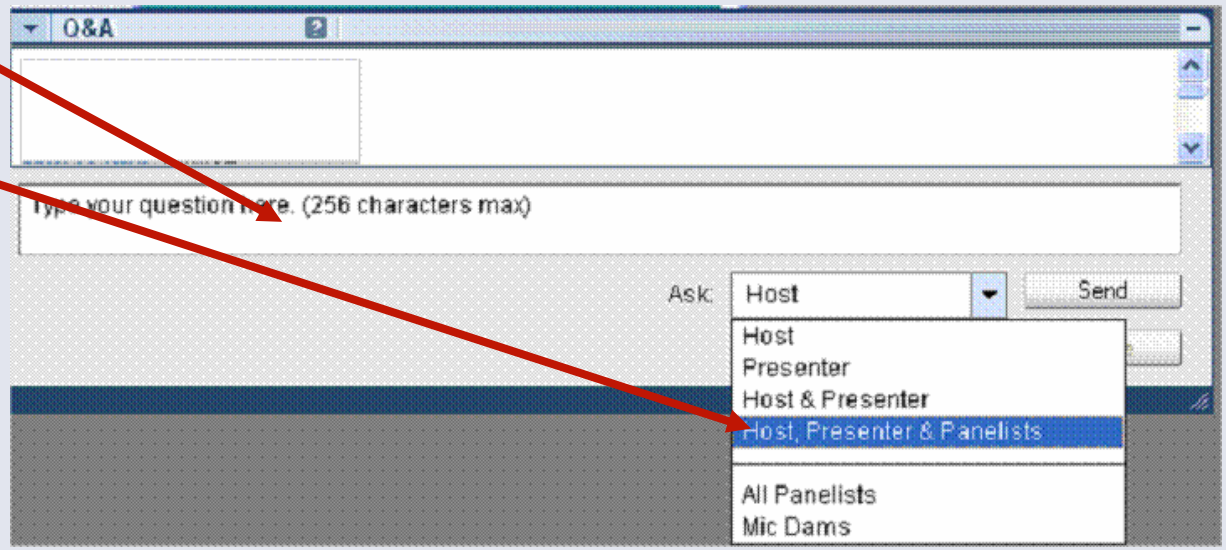
Q&A Panel

- Søren Tørholm and Michael Damsgaard.
- 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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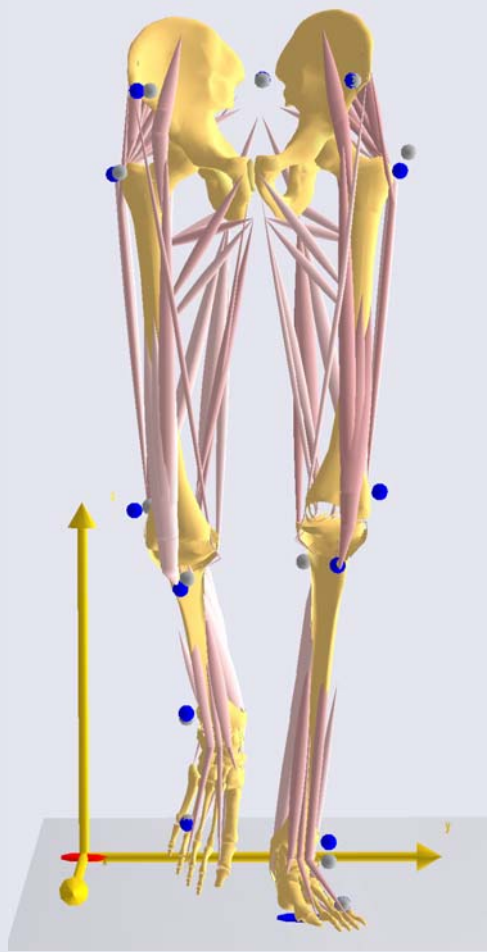
Agenda

1. Why do we want musculoskeletal gait analysis?
2. Current model and results.
3. New models and facilities under development.

Gait analysis

- Probably the most clinically mature use of biomechanics.
- Traditionally an assessment of kinematics and external forces (GRF).
- These form the input to musculoskeletal analysis and may allow us to assess internal forces as well.
- - if we can do it properly



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AnyBody:

The Research Group:

- Aalborg University, Denmark

Activities:

- Model development
- Basic methodology
- New applications

Results are public domain
Models are in clear text
Documented on www

The company:

- AnyBody Technology A/S

Activities:

- The AnyBody Modeling System
- Training, support and consultancy

The software is proprietary
Free demo licenses
Host of this webcast

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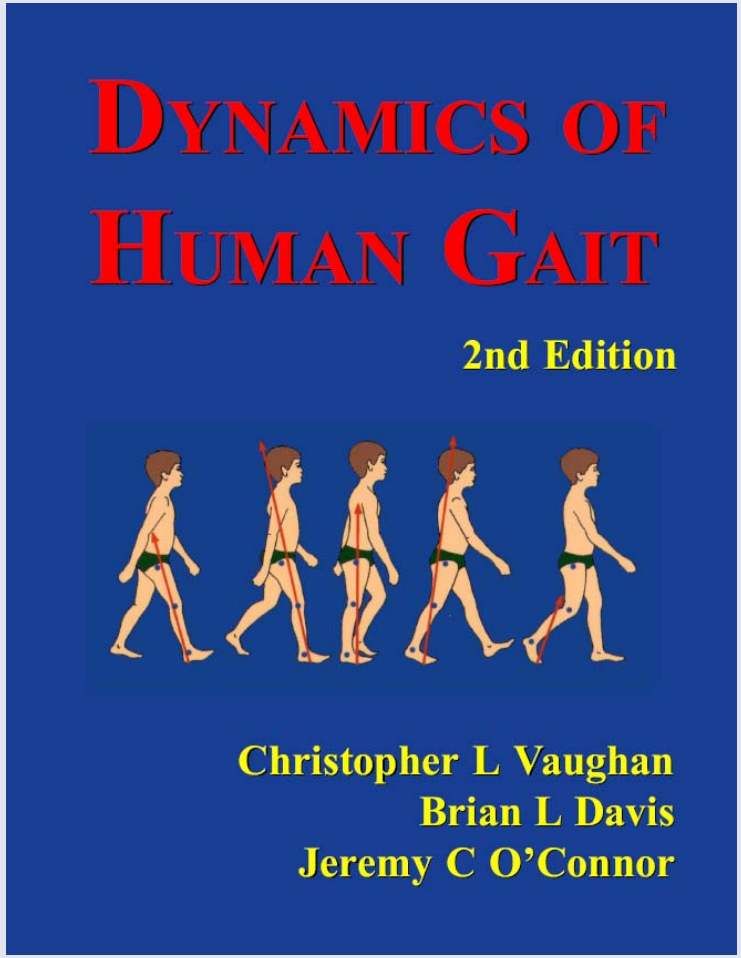
The existing gait model

- Two legs
- Muscle configuration according to Delp with a few modifications.
- Gait data from Kit Vaughan.
- Hill-type muscle models.
  - Contraction dynamics.
  - Pennation angles
  - Fiber composition
  - Etc.



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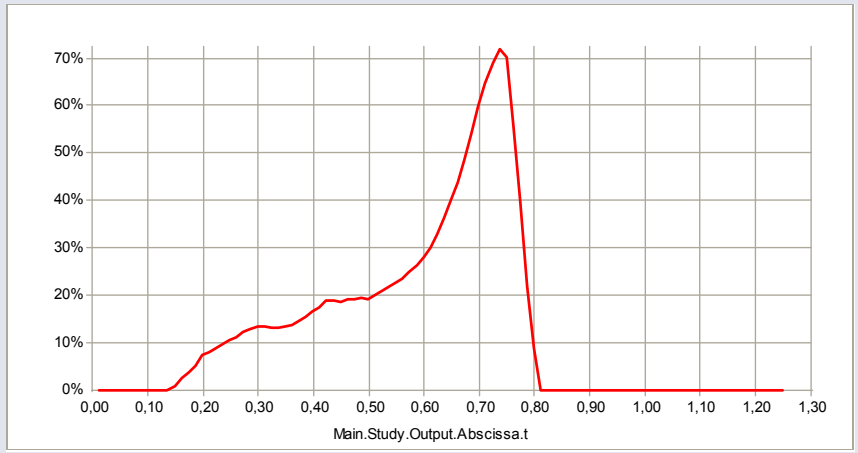
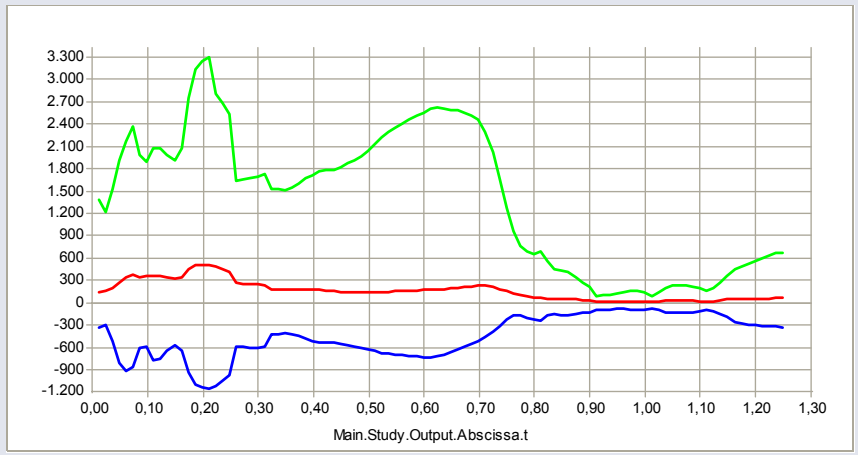
Quick demo:

The gait model

Mixed results

- Some muscle activation patterns are very nice.
- Hip reaction forces do not compare well with data by Bergmann and Heller (Hip98).
- Which improvements are needed?
  - Muscle recruitment?
  - Activation dynamics?
  - Model data?
  - Kinematic data?
  - GRF?





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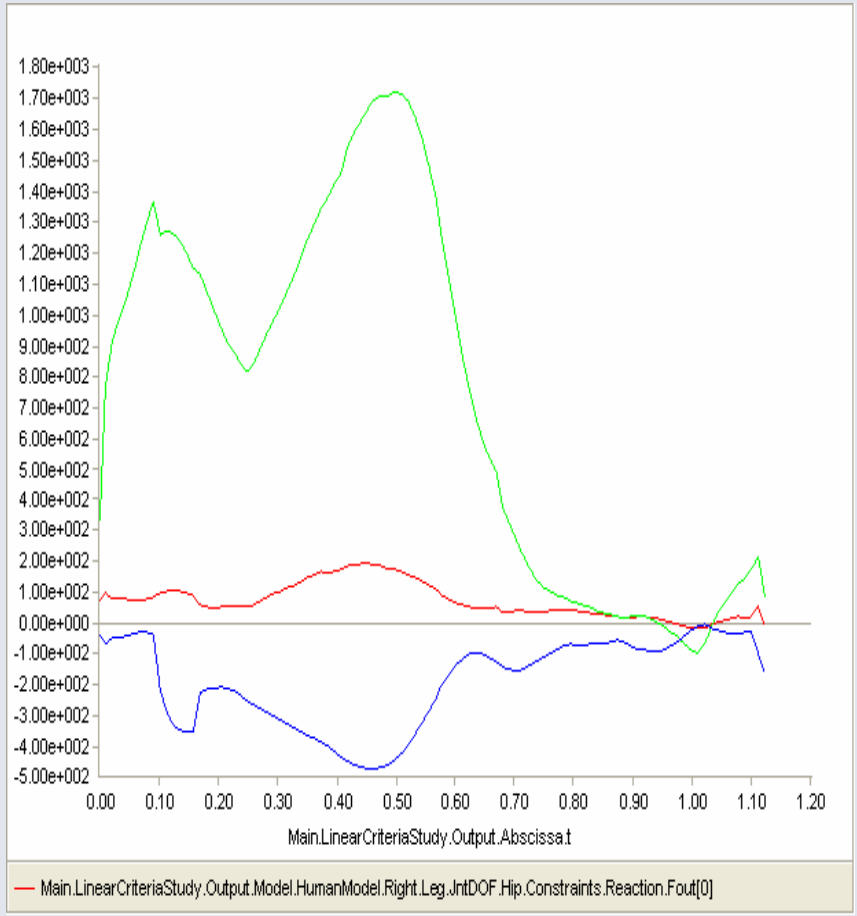
GRF errors

- Change to another set of GRF improves the hip forces a lot.



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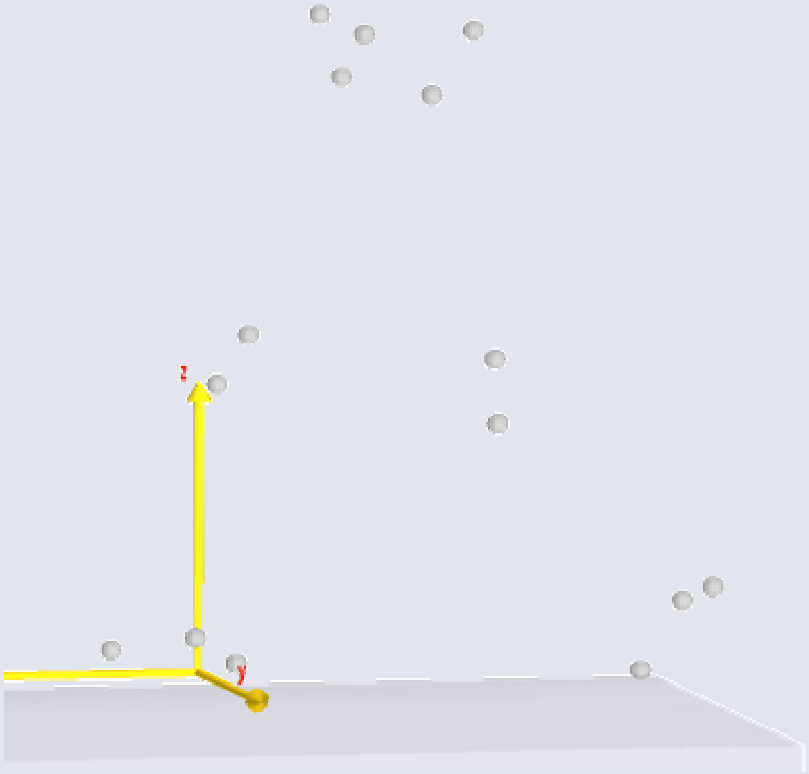
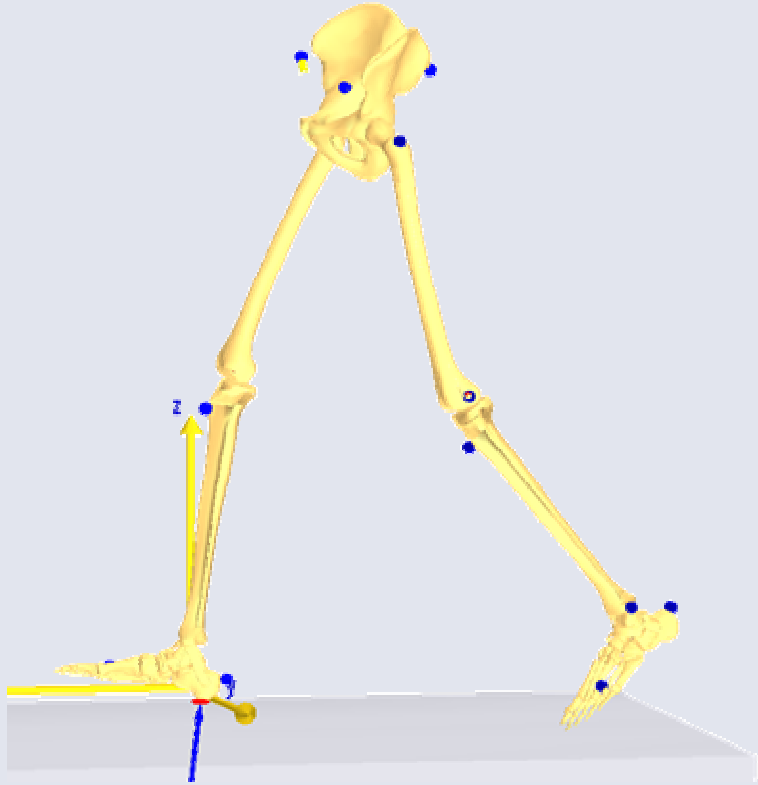
Kinematic errors

- 18 markers will give us 54 measured coordinates.
- The model has a total of 24 degrees of freedom.
- We are picking a subset of these for driving the model.

Kinematics



All markers from the dataset are present in the model (grey spheres).



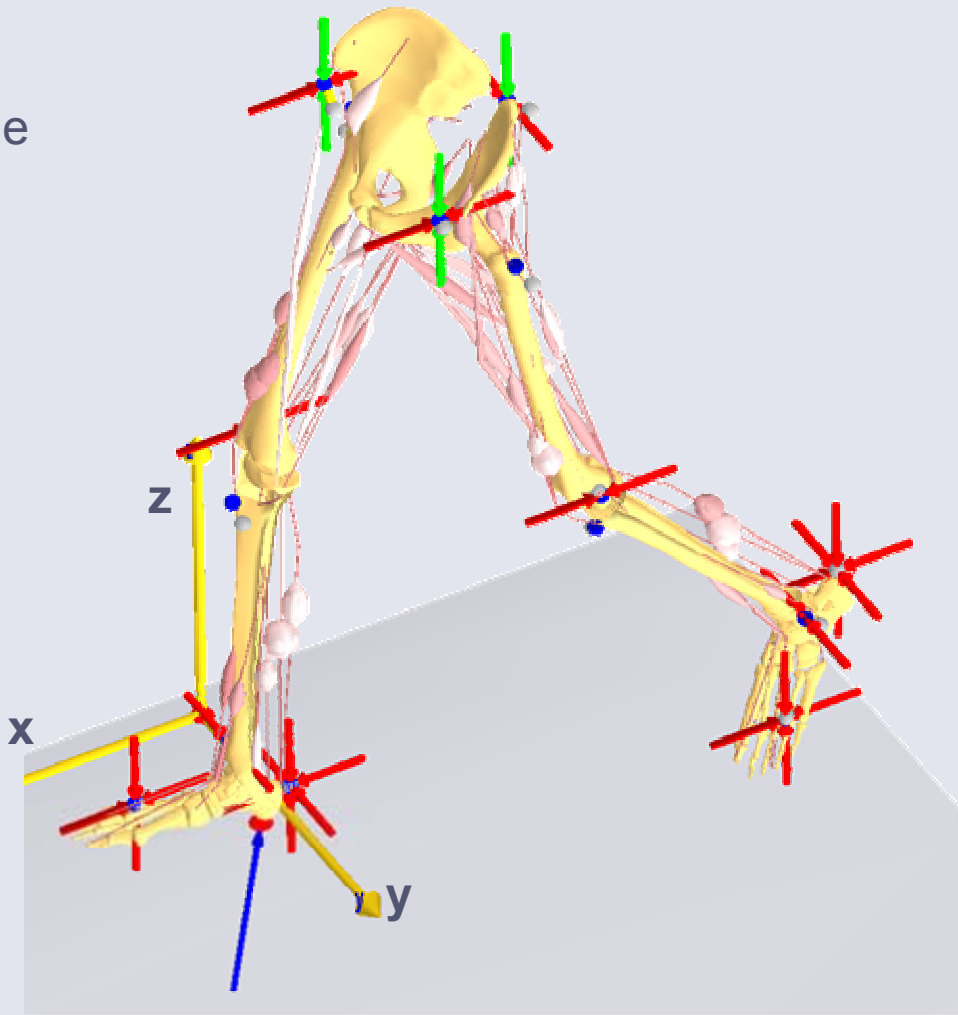
Corresponding markers are defined on the bones (blue spheres).

18 Drivers

The model is driven by requiring coincidence between the free floating markers (grey) and the markers on the bones (blue) for selected DOFs.

Red arrows
- Sacrum in (y)
- Right and left ASIS in (x)
- Right and left knee in (x)
- Right and left malleolus in (y)
- Right and left metatarsal in (x, z)
- Right and left heel in (x, y, z)

Green arrows
- Right and left ASIS and Sacrum in (z), combined as RAsisZ+LAsisZ=SacrumZ



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Problems with this approach

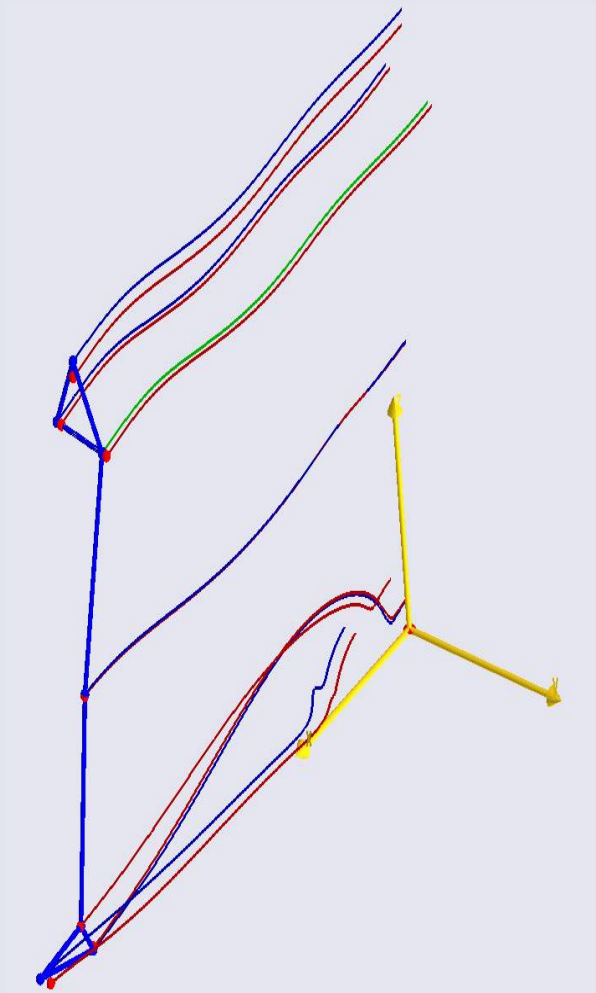
- It is difficult to select the subset of coordinates to drive.
- It is sometimes necessary to drive combinations of coordinates.
- Small changes in the model may require shift in selected coordinates
- We are throwing away good information.

The new stuff

- Michael Skipper Andersen.
- Background in robotics, control theory and signal processing.
- Ph.D. Project: *Numerical modeling of kinematically over- and under-determinate musculoskelatal systems.*
- Right now looking at gait data from Bergmann and Heller (Hip98).

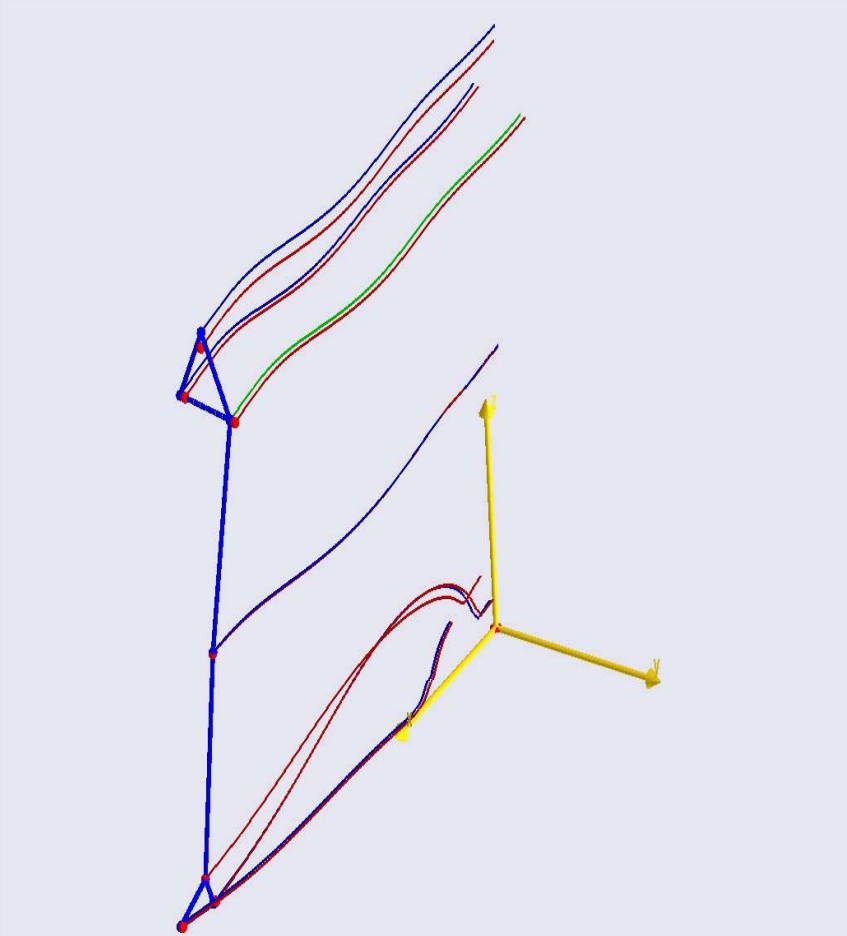
Hip98 data driven with a subset of marker coordinates

- Red curves: Measured marker trajectories.
- Blue curves: Trajectories of the points on the musculoskeletal model.
- Notice the deviation in toe position.



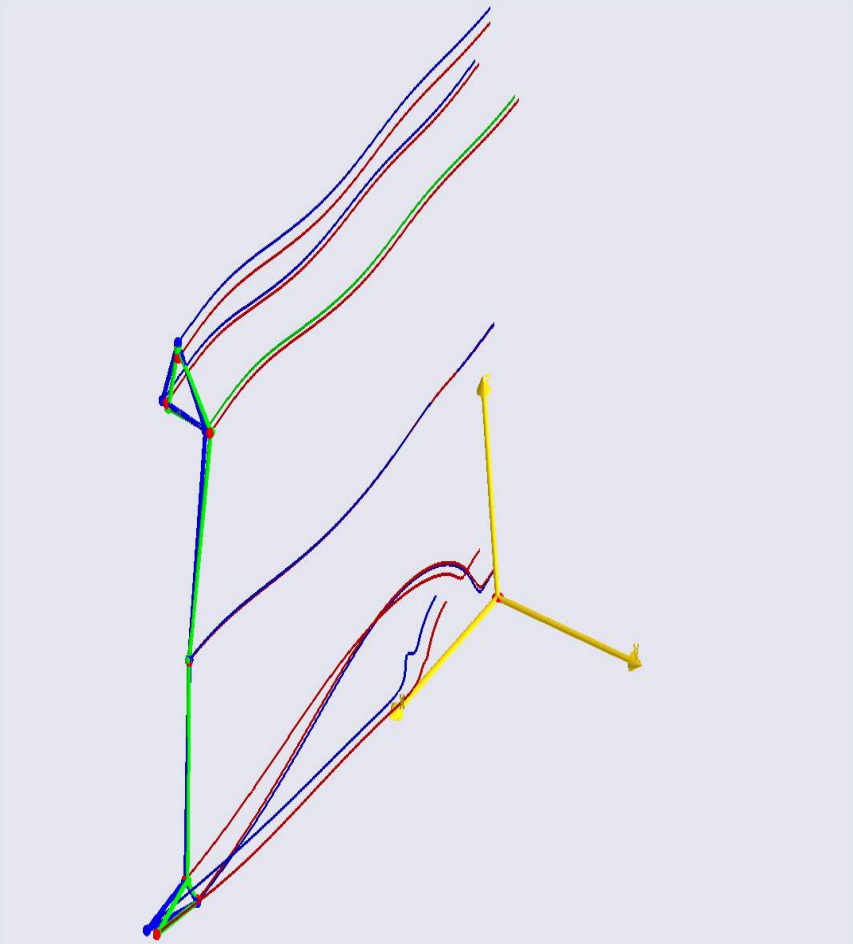
Improvement by combinations

- The result can be much improved if we link linear combinations of markers instead of single coordinates.
- This increases the amount of possible combinations and makes it difficult for the user.



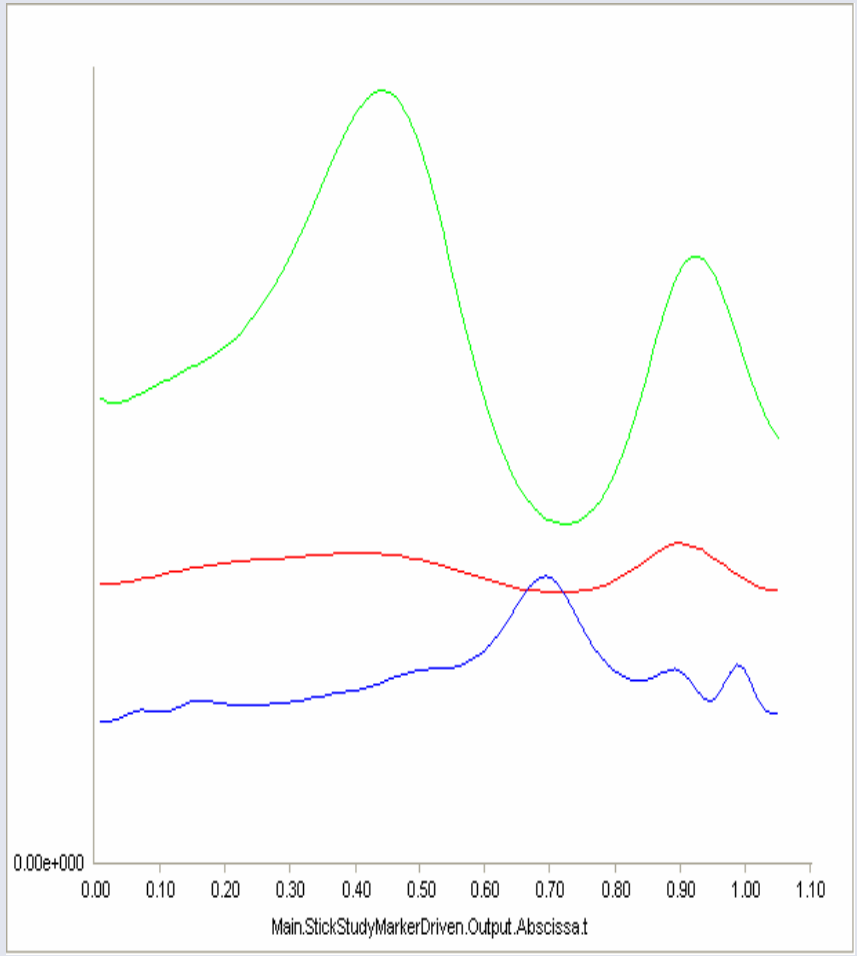
Automatic optimization

- Red: Measured marker trajectories.
- Blue: Trajectories of the points on the musculoskeletal model when driving with a subset of the markers.
- Green: Trajectories of the points on the musculoskeletal model when optimizing the square sum of errors (SQE).



More details

- Advantages:
  - An automatic procedure.
  - Does not require subset selection.
  - Uses all information
- Curves:
  - Green: Subset of coordinates
  - Red: Linear combinations
  - Blue: Optimized SQE
- Plans: Will be implemented as a general kinematic feature in AnyBody.



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Conclusions

- Careful gait modeling can produce plausible results.
- Kinematics currently requires tricky selection of coordinates to drive.
- The result is sensitive to this selection.
- A new method will improve this situation.

- **We believe we can make this a reliable clinical tool that can greatly enhance the benefit of gait analysis.**

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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
  - Publications – many for direct download.

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Q&A Panel

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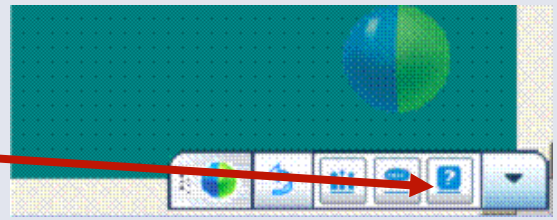

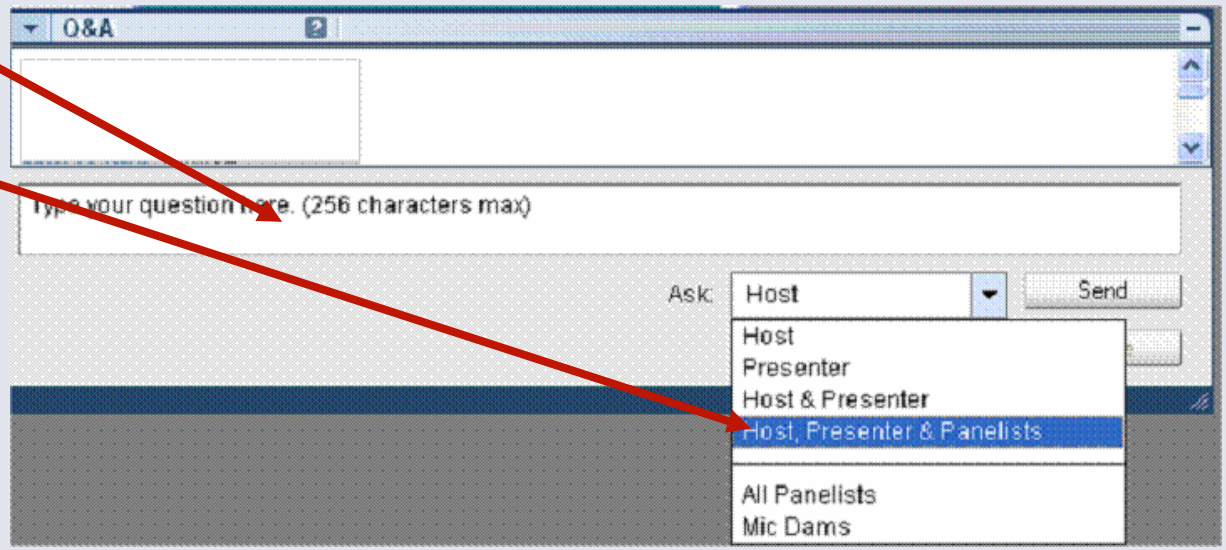

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Forthcoming webcasts

- 25 September 2006:
  How to synthesize posture and movement with inverse dynamics
- 4 October 2006:
  Validation of musculoskeletal models

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