LOWER LEG PROSTHESIS FOR CROSS-COUNTRY SKIING CLASSICAL TECHNIQUE

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What is good?
ASSYMMETRIC MOVEMENT PATTERN
- UNILATERAL LEG AMPUTEE

• Reported in gait and running (Prince 1992, Burkett 2003)
  – Increased with running speed
• Affects joint and muscular loads
  – Performance
  – Efficiency - economy?
  – Risk of injuries
AIM OF CASE STUDY

1. To better understand the amputee-prosthesis integration - by investigating symmetry

2. Design of the prosthesis adapted for cross-country skiing classical technique
ÖSSUR VARI-FLEX WITH EVO IN RUBBER FOOT AND SKI BOOT
# ANALYZED DATA

## Kinematics

<table>
<thead>
<tr>
<th>Angles</th>
<th>Distances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ankle</td>
<td>Hip-toe along treadmill</td>
</tr>
<tr>
<td>Knee</td>
<td>Shoulder-wrist al. treadmill</td>
</tr>
<tr>
<td>Hip</td>
<td>Shoulder-wrist lateral</td>
</tr>
<tr>
<td>Elbow</td>
<td>Heel – ski</td>
</tr>
<tr>
<td>Shoulder</td>
<td>COM in frontal plane relative to hips</td>
</tr>
<tr>
<td>Pole-treadmill</td>
<td></td>
</tr>
<tr>
<td>Ski-treadmill</td>
<td></td>
</tr>
</tbody>
</table>

## Kinetics

- Pole forces axial
- Pole forces al. treadmill
- Pole impulse al. treadmill
- Feet forces (normal forces)
- Feet COP forward/backward motion
- Feet COP lateral/medial motion

- Significant difference left and right (> +/- 1std)
KINETICS

B)

NO SIGNIFICANT DIFFERENCE
ANKLE ANGLE

![Graph showing the ankle angle over time with phases labeled as Swing phase, Gliding phase, and Push-off phase.]

- Left ankle
- Right ankle
- + std
- - std

Knee angle
Hip angle
Ankle angle
HIP ANGLE

Swing phase
Gliding phase
Push-off phase

Hip angle
Knee angle
Ankle angle

Time (s)

Hip angle (°)
PART 2: PRODUCT DEVELOPMENT PROCESS

1. Planning → Pre-study → Product specification → Generating koncepts
   → Building prototypes → Detailed engineering → Product

2. Evaluate/testing → Feedback → Compare to specification

3. Feedback → Compare to specification → Testing prototype → Testing FEM
PRODUCT SPECIFICATION

- AVOID EARLY TOE DOWN

• Use Össur VariFlex
• Durable
• Reliable
• Suited for all weather conditions
• Low weight
• Easy to use
• Simple construction
ITERATION 2 – BUILDING PROTOTYPES
FEEDBACK

• Complex design
  – Difficult to repair
  – Difficult to manufacture
• Expensive
• Reliable?
  – avoid electronic components
ITERATION
- BUILDING SIMPLIFIED PROTOTYPE
FUTURE
- BUILDING FUNCTIONAL PROTOTYPE

FIELD TESTING
Is this good?

Does this prosthesis enhance motion symmetry?

The process continues…
THANK YOU FOR YOUR ATTENTION!