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

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ÖSSUR VARI-FLEX WITH EVO IN RUBBER FOOT AND SKI BOOT

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ANALYZED DATA

Kinematics

Angles

- Ankle
- Knee
- Hip
- Elbow
- Shoulder
- Pole-treadmill
- Ski-treadmill

Distances

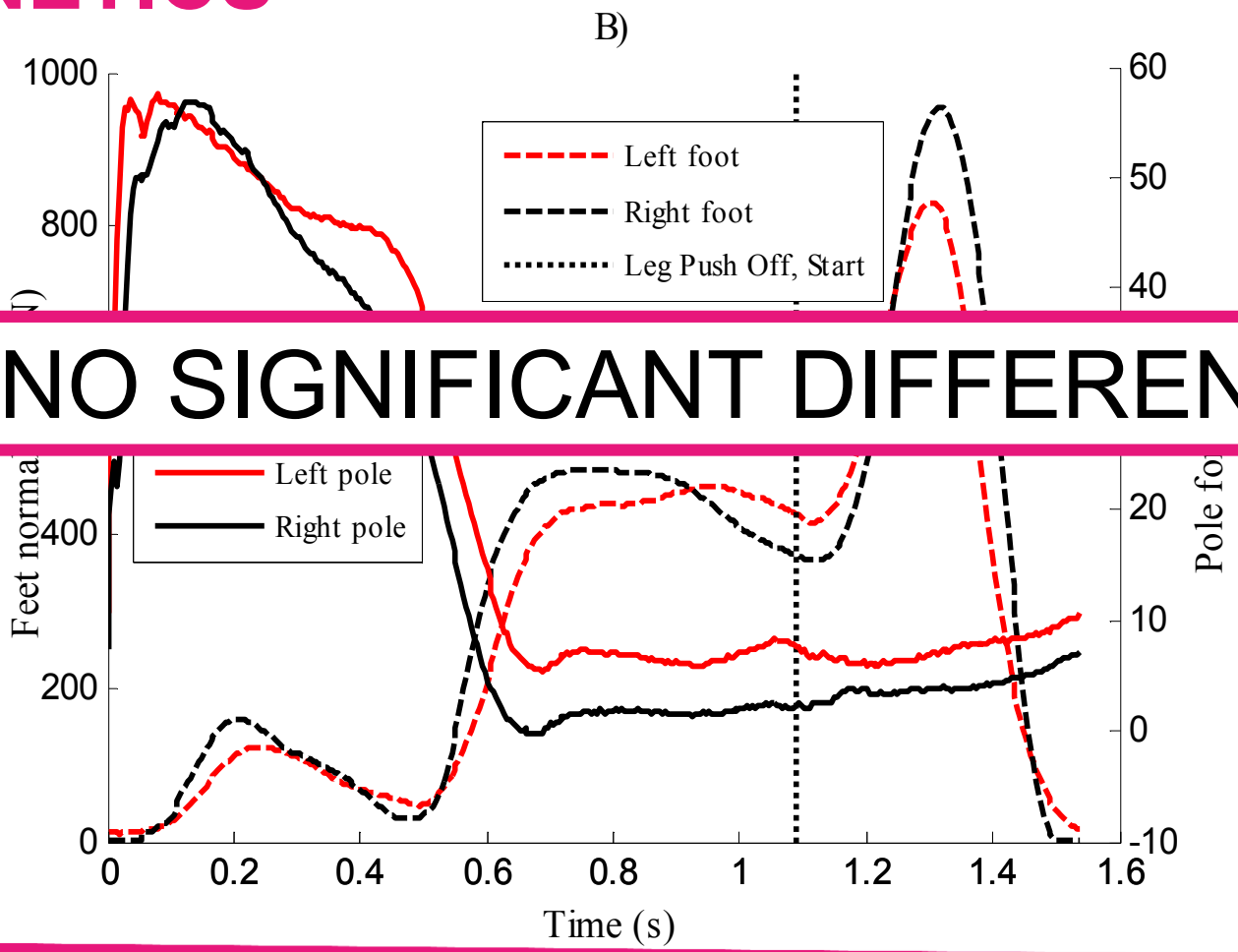
- Hip-toe along treadmill
- Shoulder-wrist al. treadmill
- Shoulder-wrist lateral
- Heel – ski
- COM in frontal plane relative to hips

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

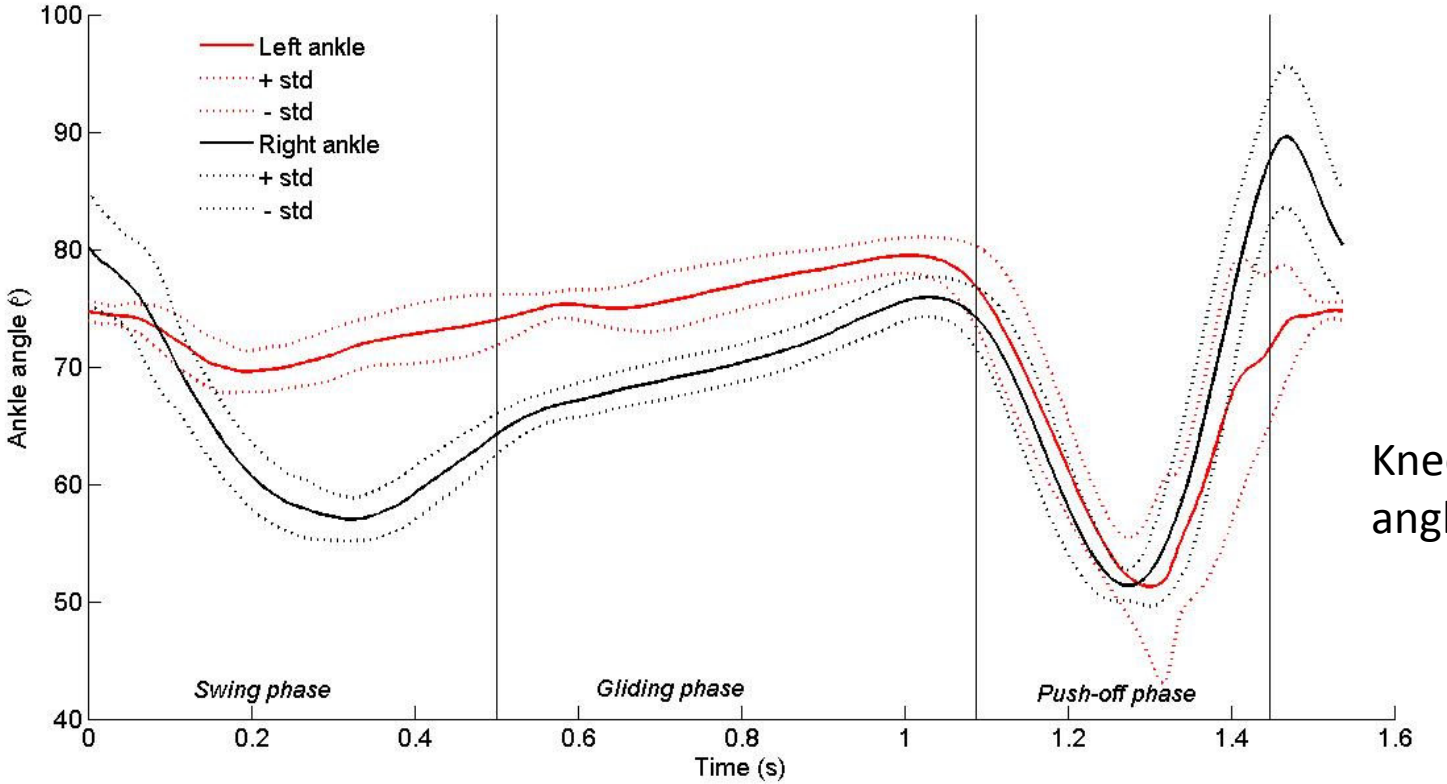
Significant difference left and right (> +/- 1std)

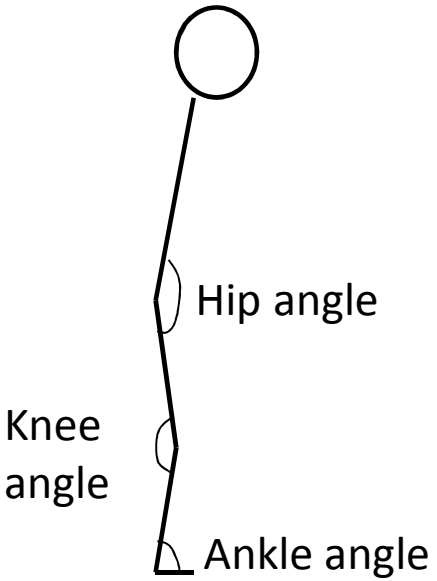
KINETICS



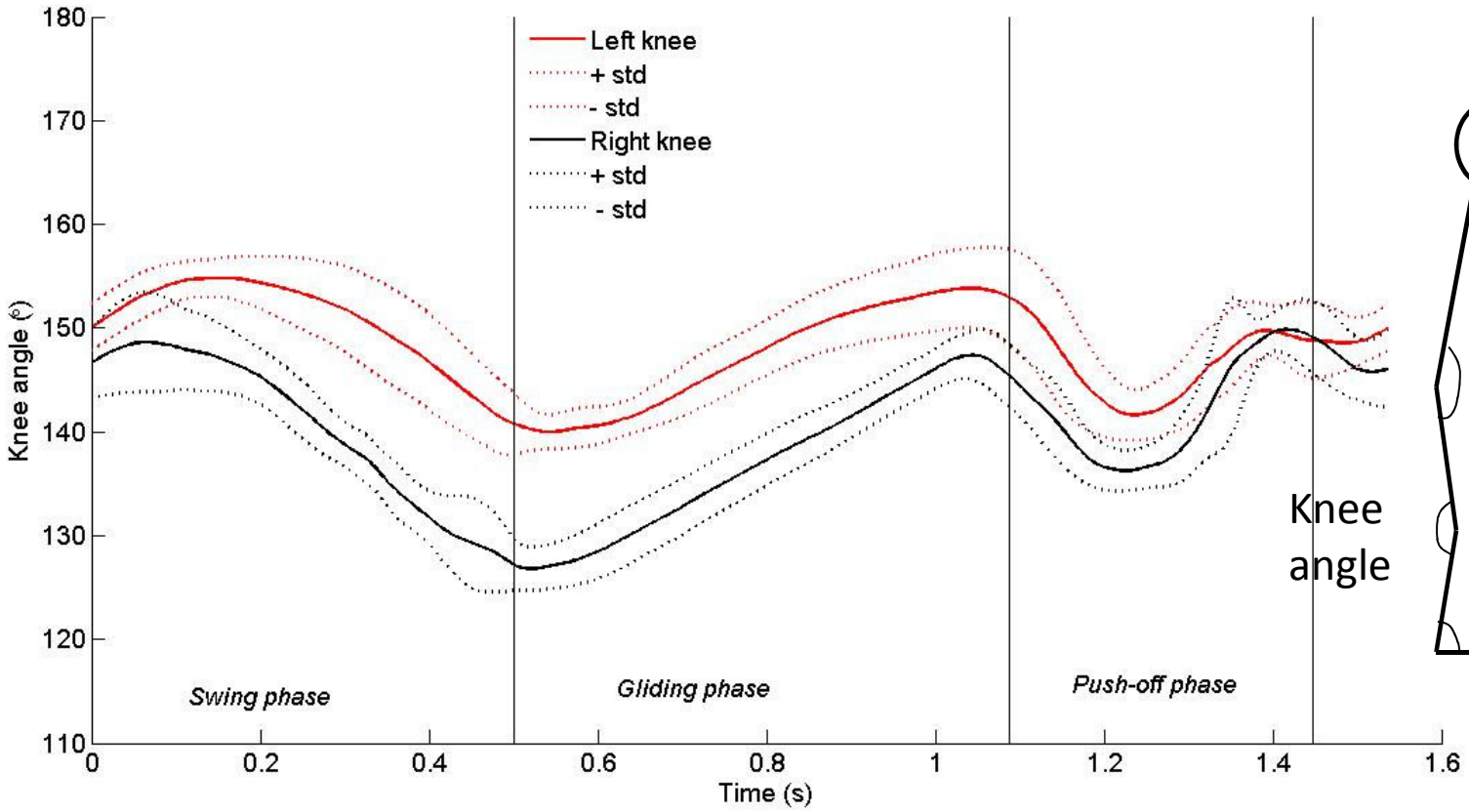
NO SIGNIFICANT DIFFERENCE

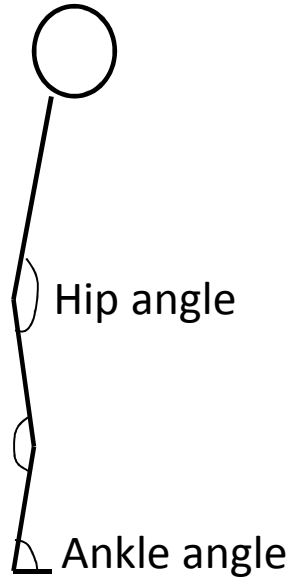
ANKLE ANGLE


Left ankle
+ std
- std
Right ankle
+ std
- std
Ankle angle (°)
Time (s)
Swing phase
Gliding phase
Push-off phase

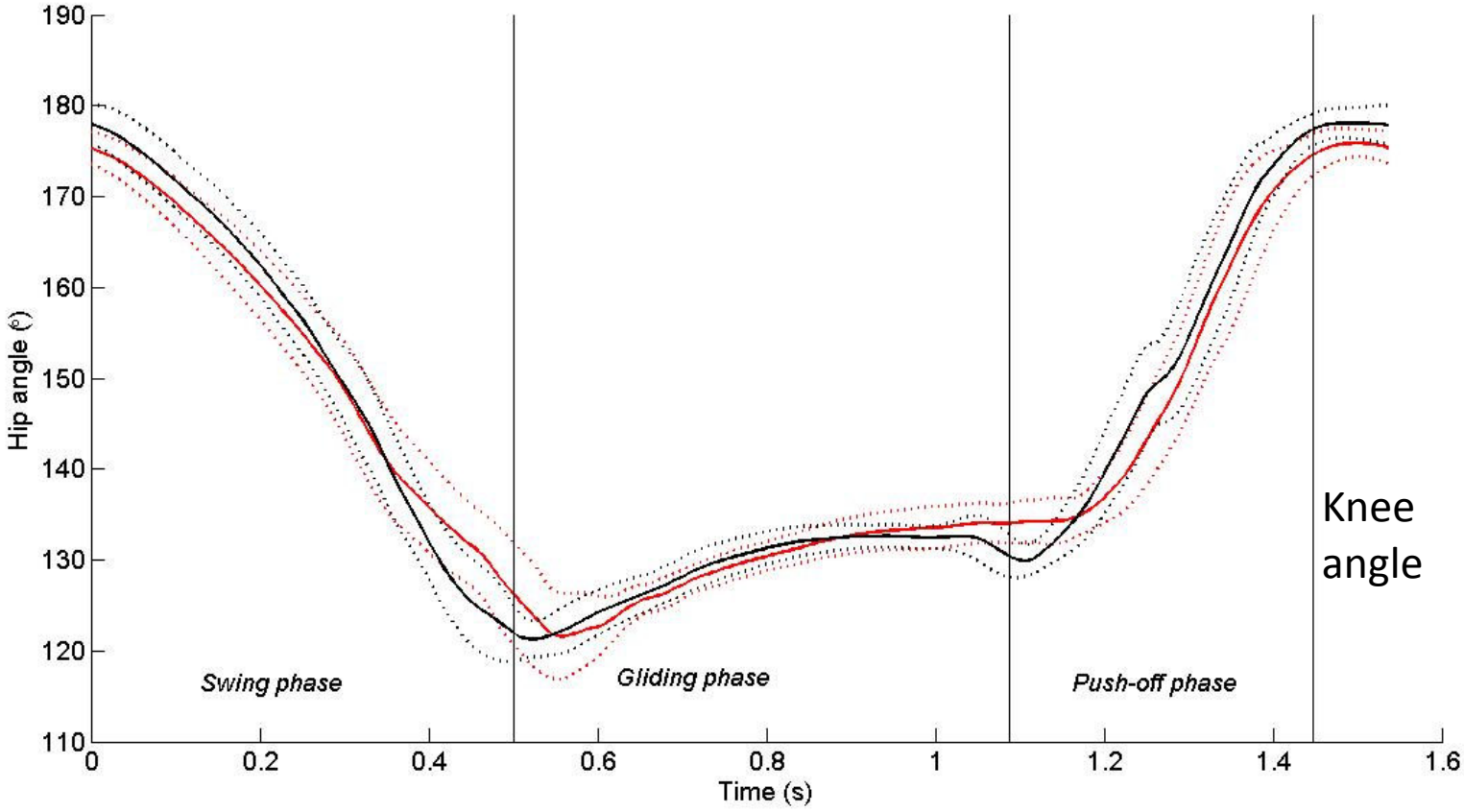

Hip angle
Knee angle
Ankle angle

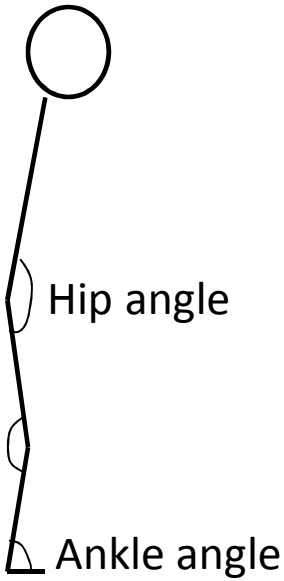
KNEE ANGLE


Left knee
+ std
- std
Right knee
+ std
- std
Knee angle (°)
180
170
160
150
140
130
120
110
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
Time (s)
Swing phase
Gliding phase
Push-off phase

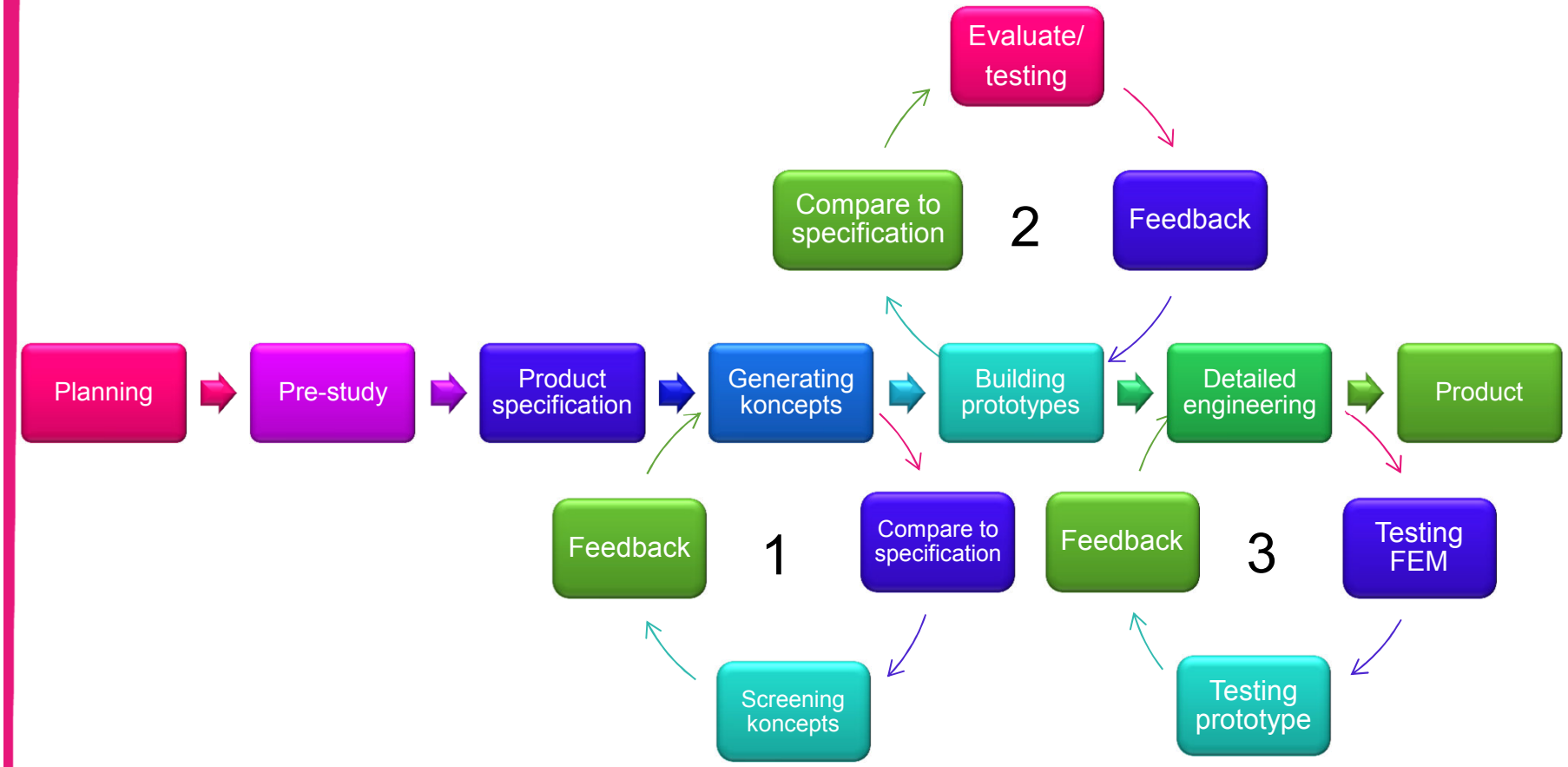

Hip angle
Knee angle
Ankle angle

HIP ANGLE


190
180
170
160
150
140
130
120
110
Hip angle (°)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
Time (s)
Swing phase
Gliding phase
Push-off phase


Hip angle
Knee angle
Ankle angle

PART 2:
PRODUCT DEVELOPMENT PROCESS



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PRODUCT SPECIFICATION

- AVOID EARLY TOE DOWN

- Use Össur VariFlex
- Durable
- Reliable
- Suited for all weather conditions
- Low weight
- Easy to use
- Simple construction

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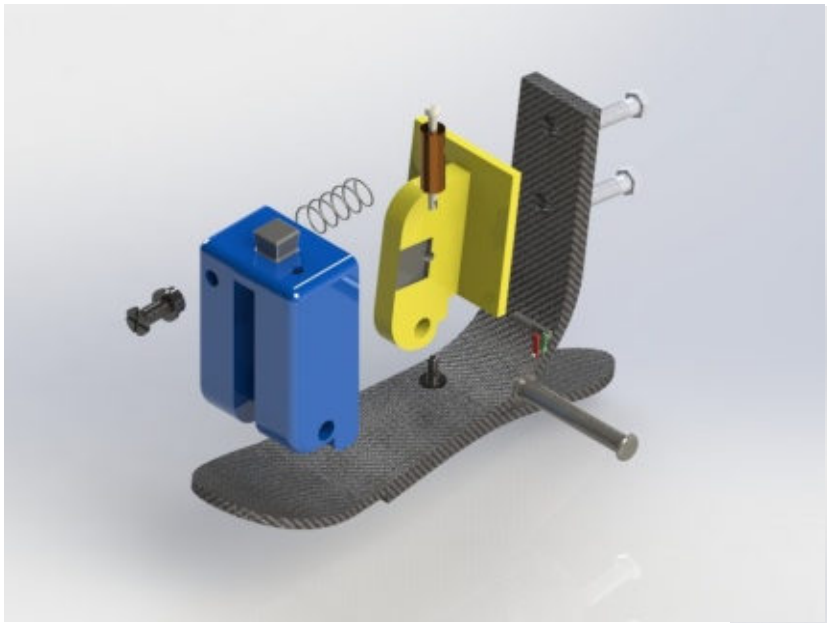
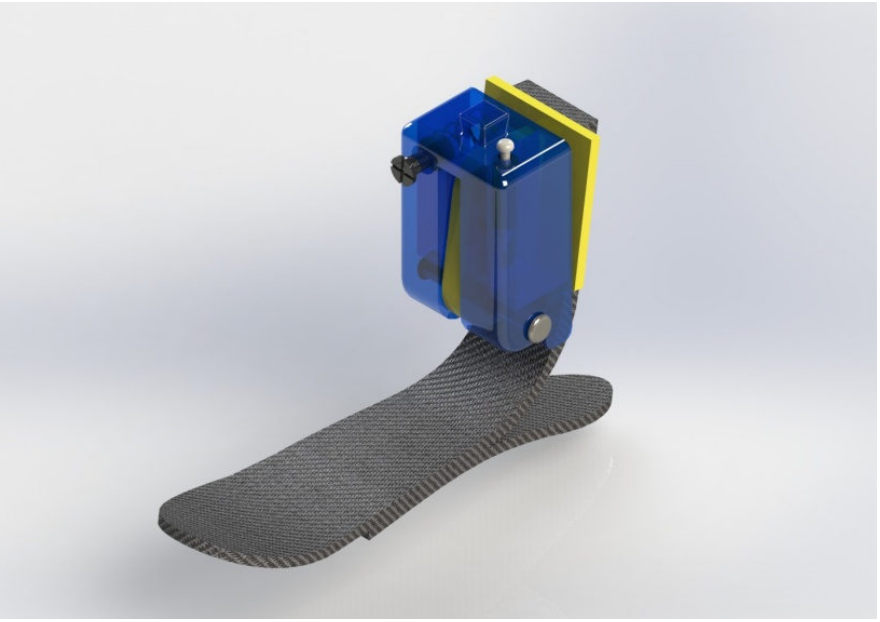
ITERATION 2 – BUILDING PROTOTYPES





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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…

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THANK YOU FOR YOUR ATTENTION !

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