보행, 의지

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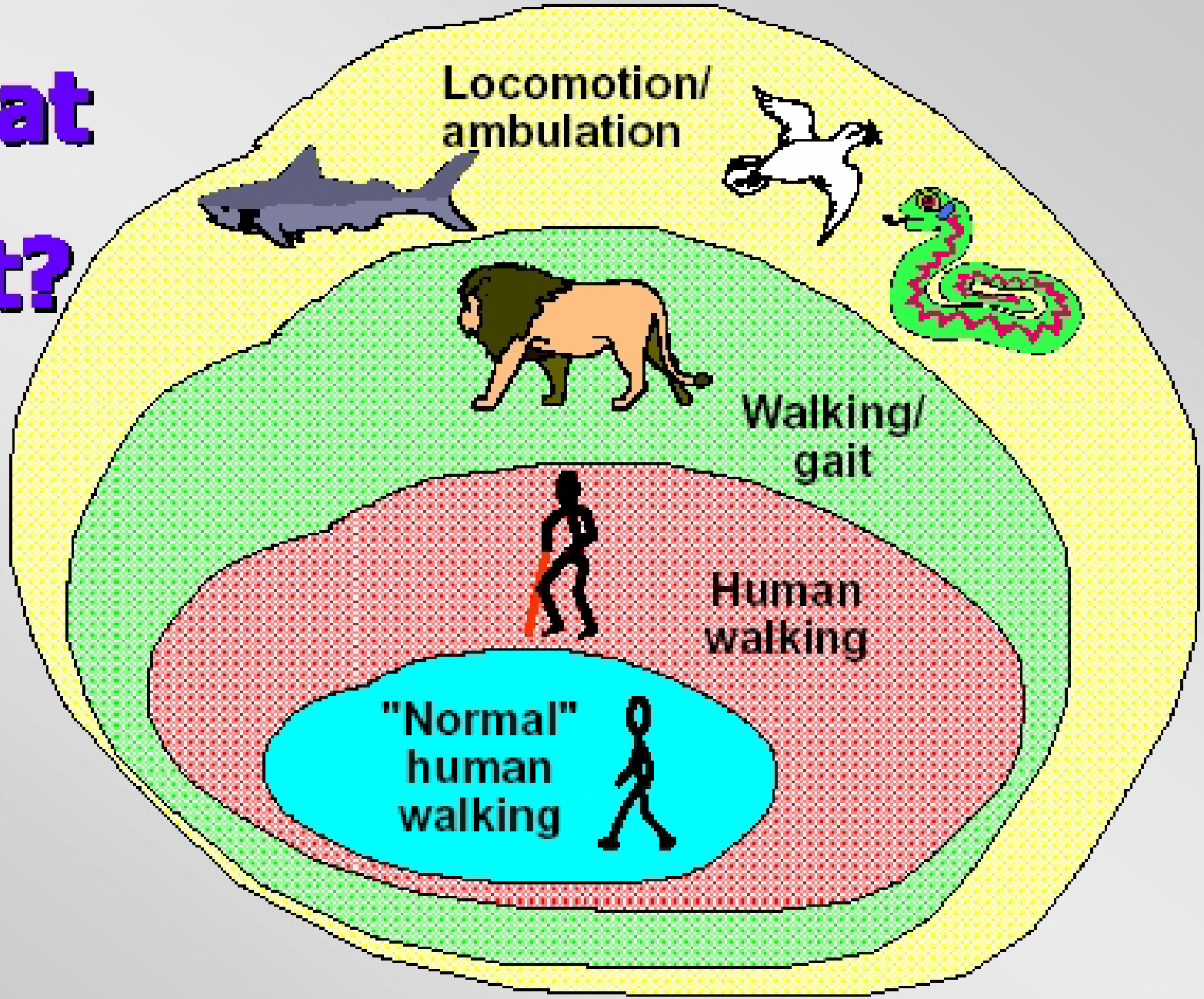
What is gait?


Locomotion/
ambulation
Walking/
gait
Human
walking
"Normal"
human
walking

보행이란? 보행을 규정짓는 몇 가지 개념들...

- 보행은 두 발/다리로 걷는 것이다.
- 보행의 목적은 몸을 이동하는 것이다.
- 보행의 개념을 위해서 인체를 vehicle, passenager로 나눈다.
- Vehicle 은 움직여야 한다.

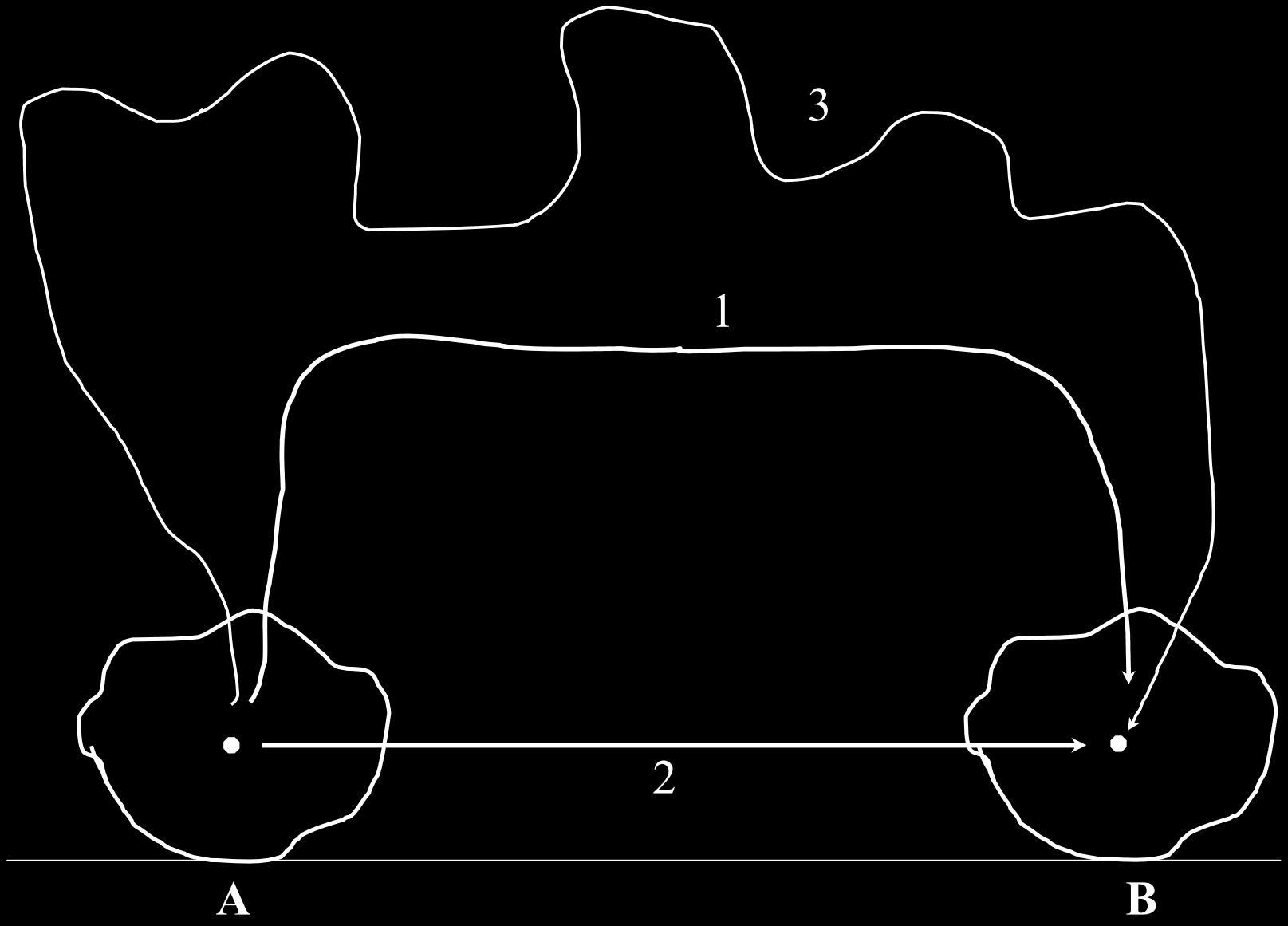
Stance and Swing

- 한 발/다리은 전진하고 반대다리는 이를 위하여 지지해야 한다.
- 전진한 다리는 반대 다리의 전진을 위해 지지다리가 되어야 한다.
- 양다리가 체중을 주거니 받거니 하면서 체중을 주고는 전진하고 전진하고 나서는 다시 받는다.
- 전진하는 시기가 swing phase 이고, 지지하는 시기가 stance 이다.
- 이 stance/swing 이 끊임없이 반복되는 것이 보행이다.

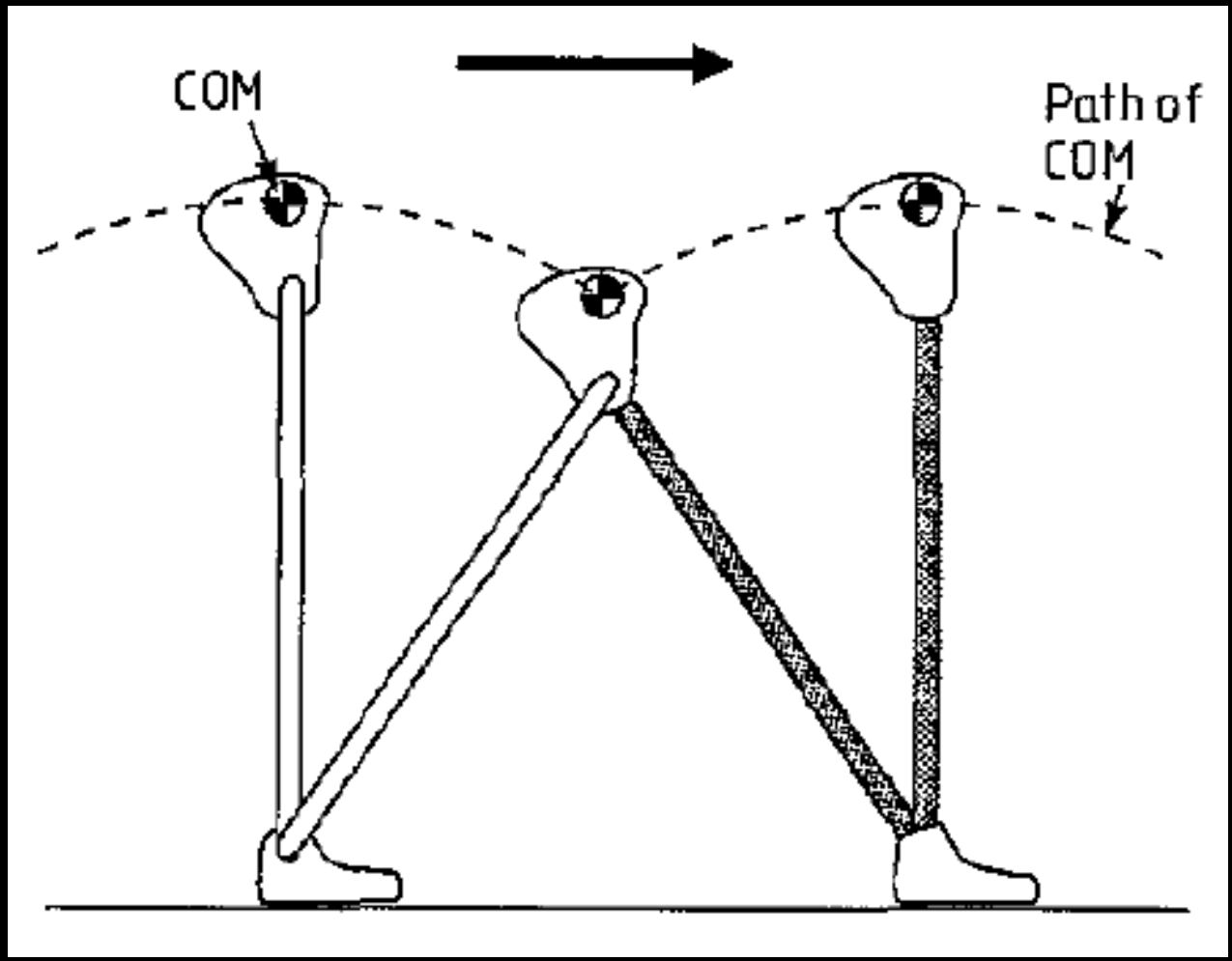
- What Is Normal Gait?

  -- Gait of Normal People.

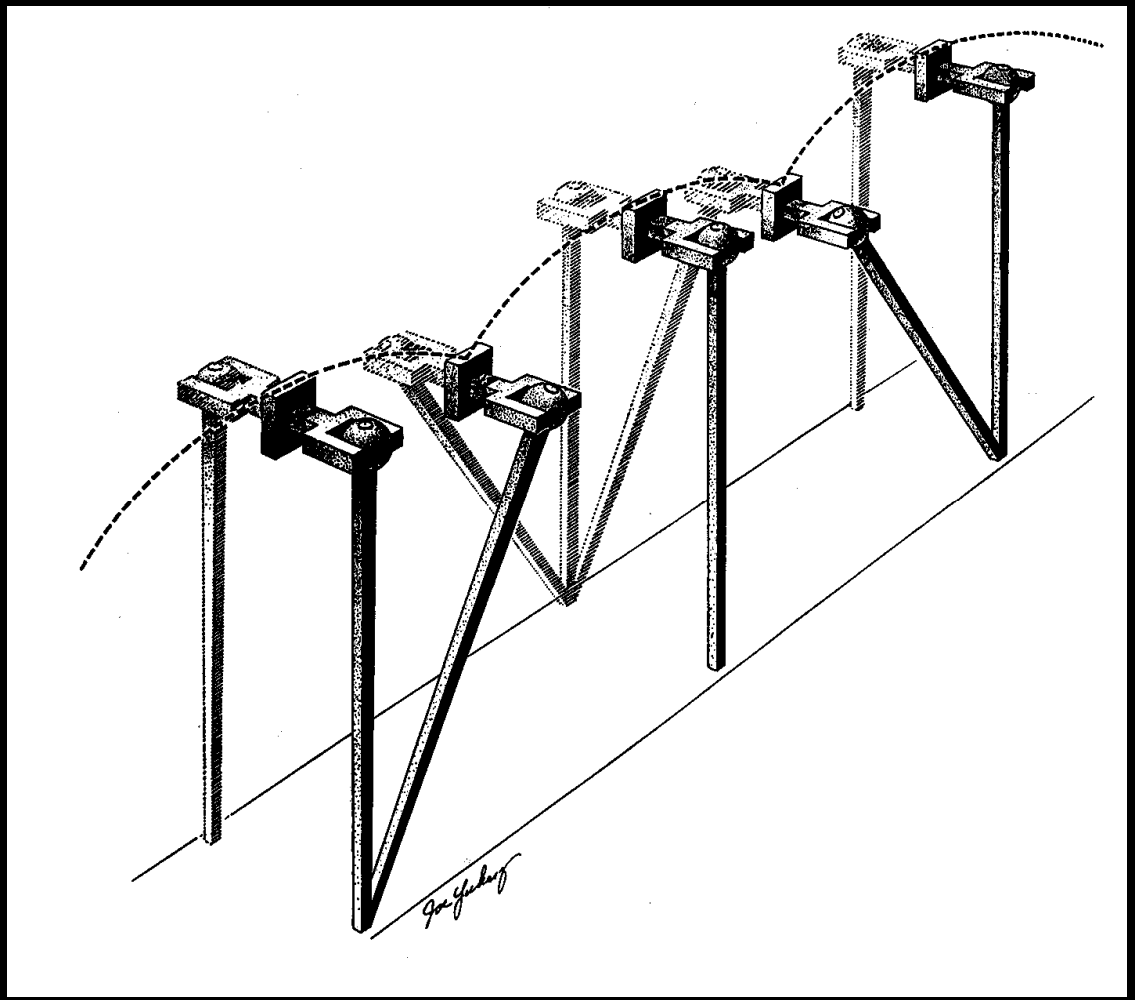
- What Makes Normal People Walk Normally?

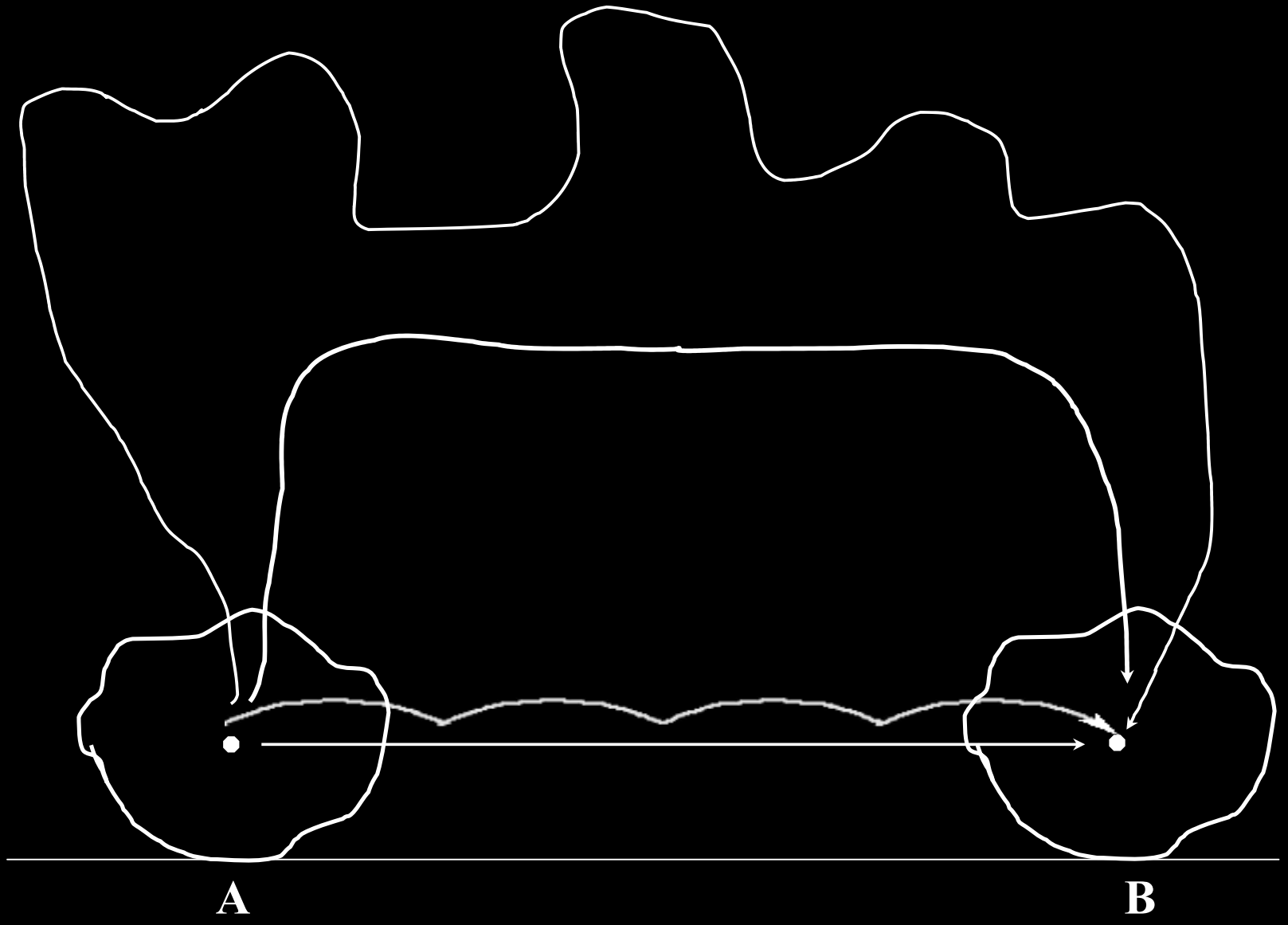

3
1
2
A
B

Simple Model of Bipedal Walking

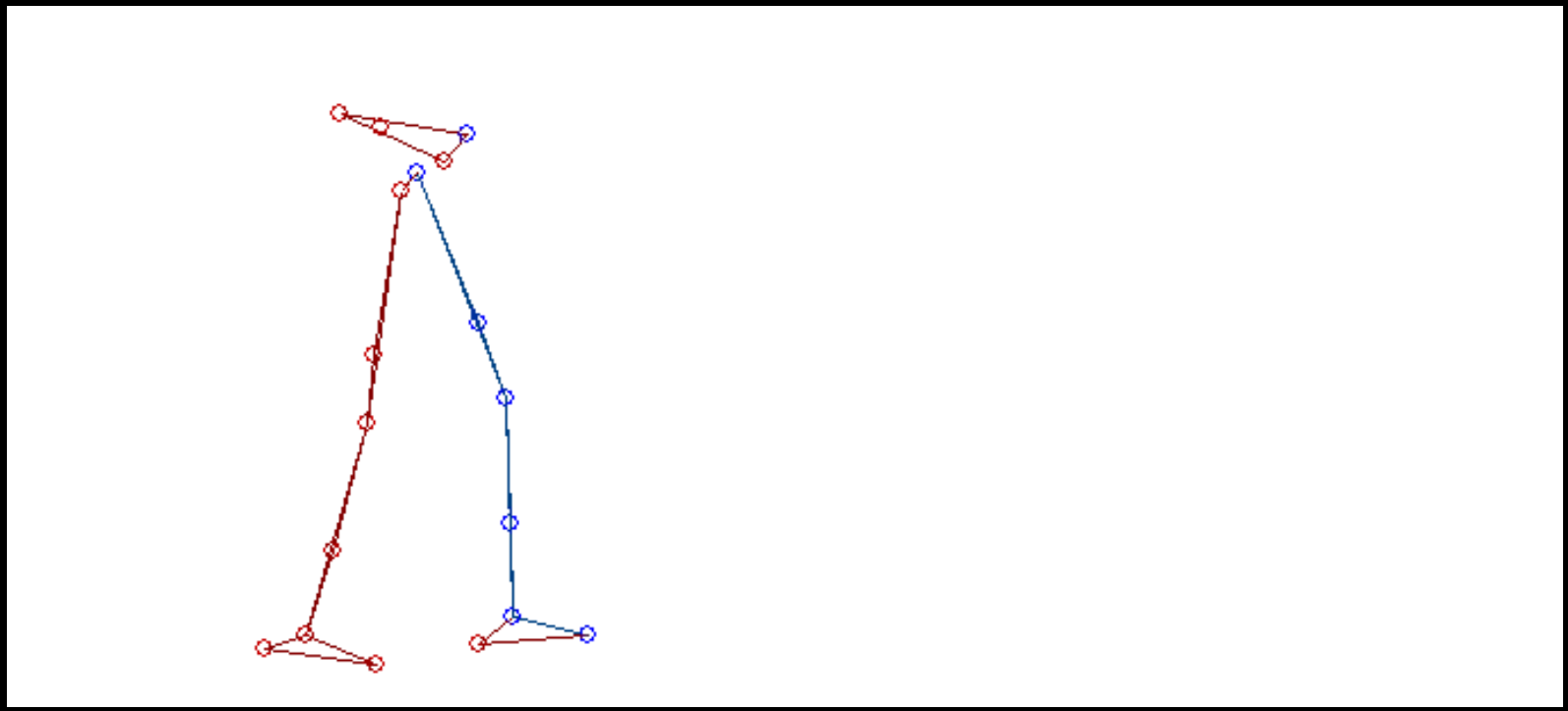


Hypothetical “Compass” Gait

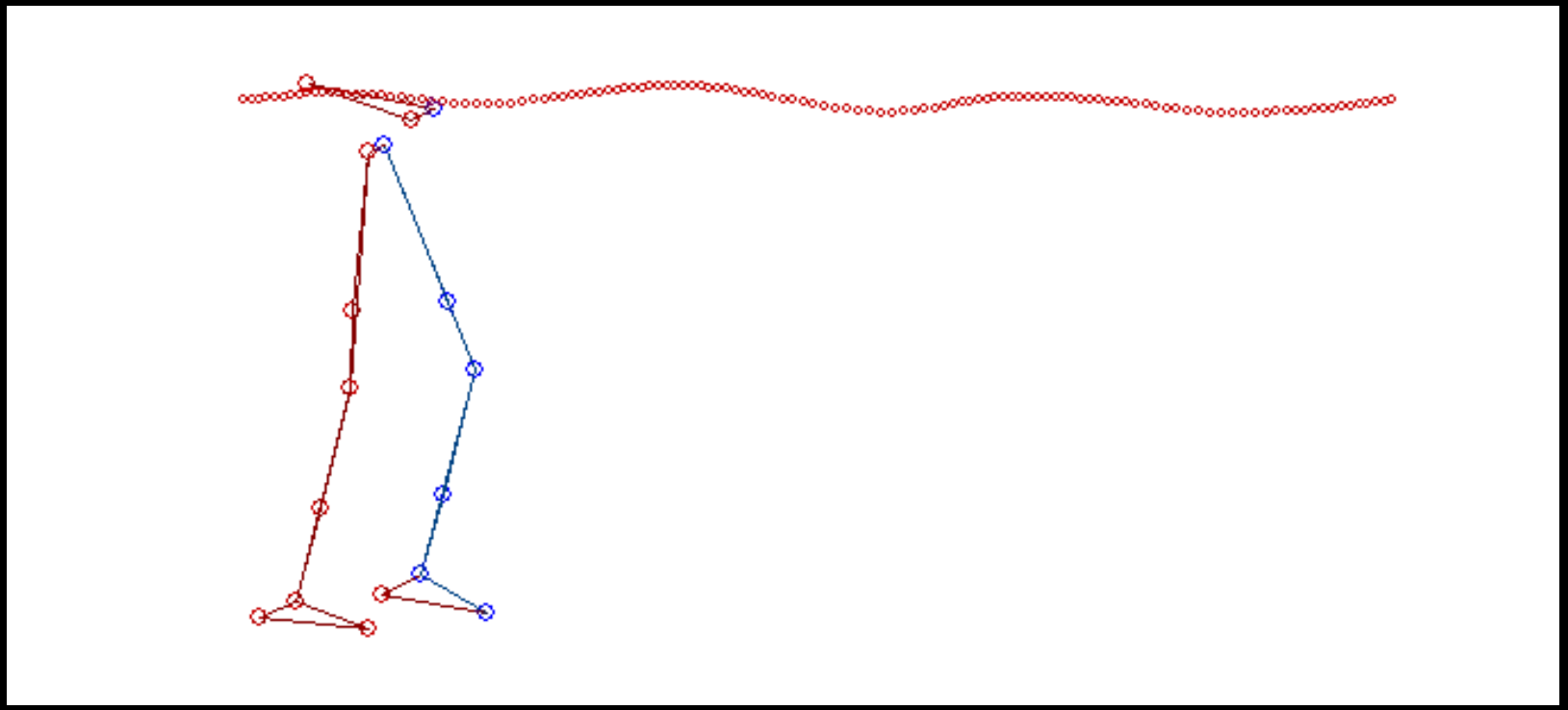


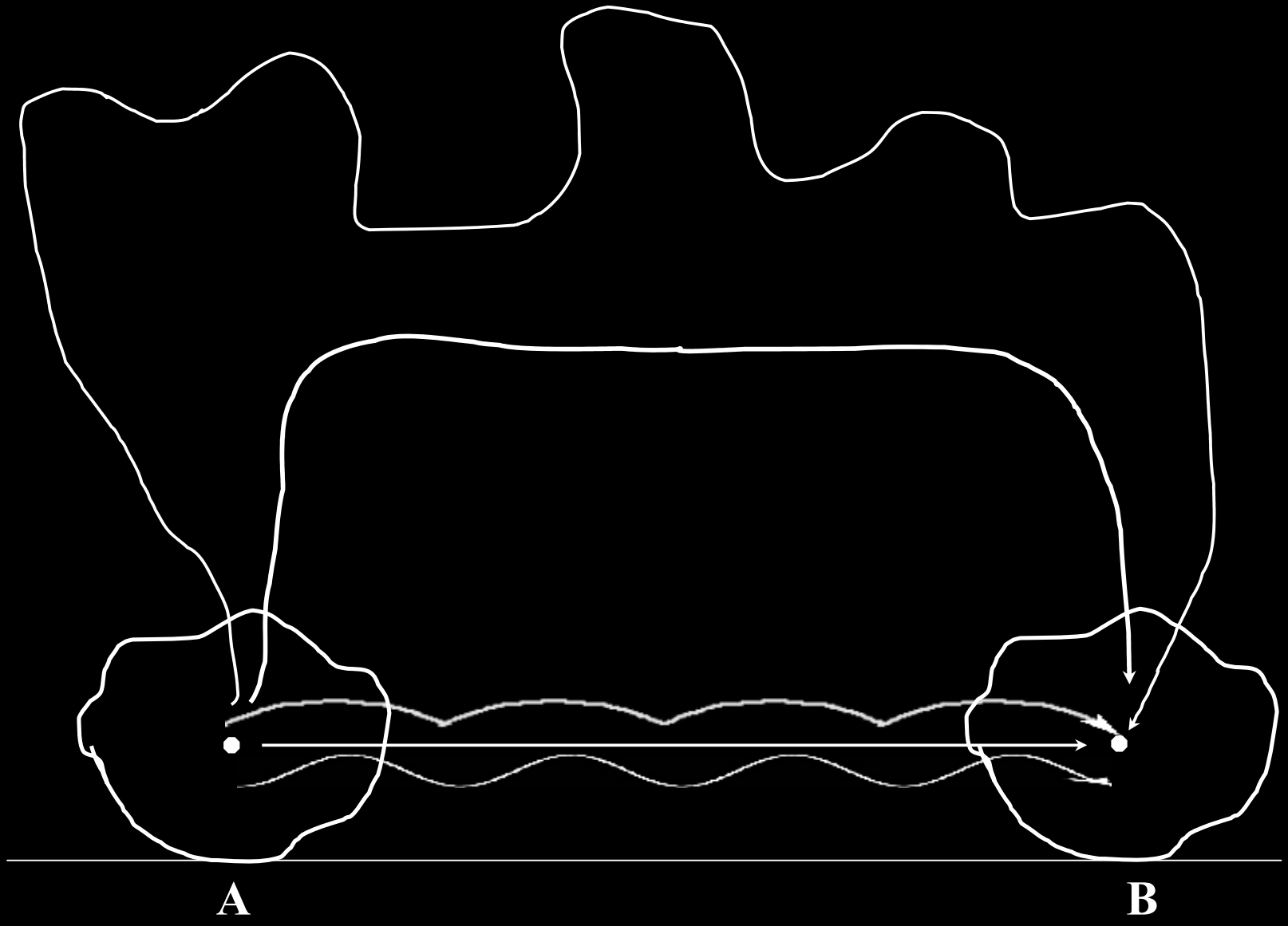

A
B

Normal COG Movement

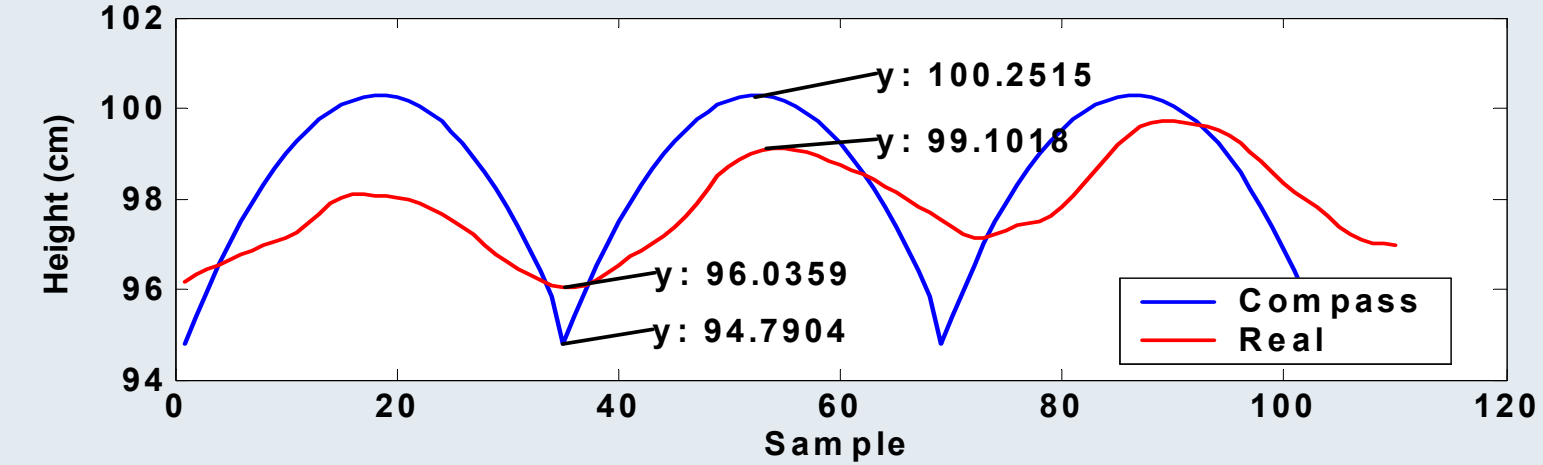


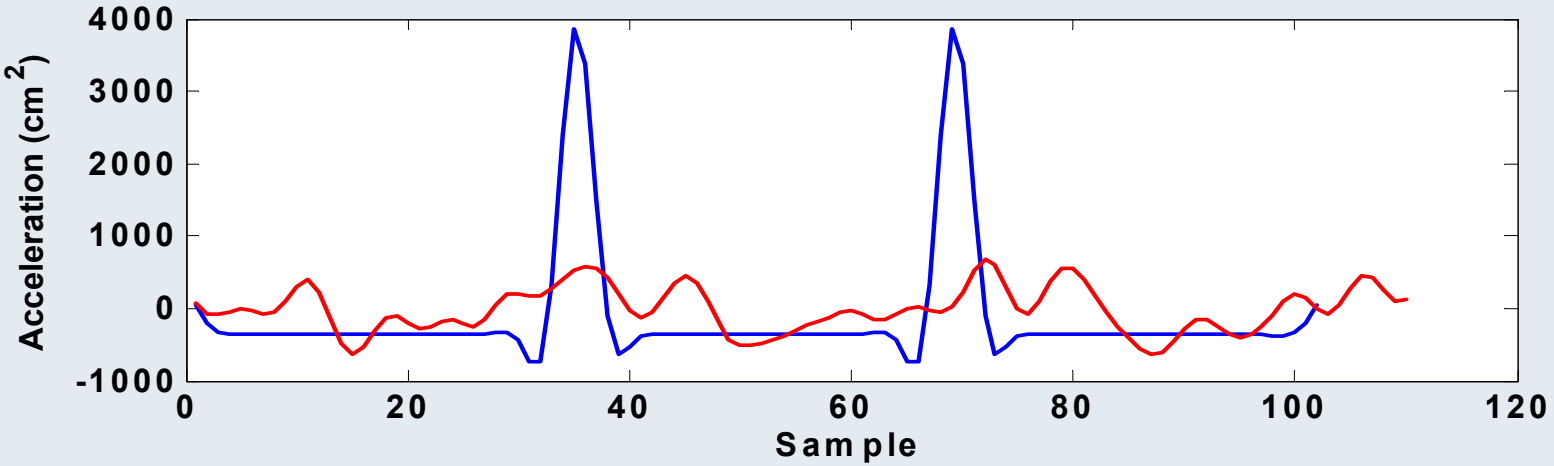
Normal COG Movement




A
B

Normal COG Movement



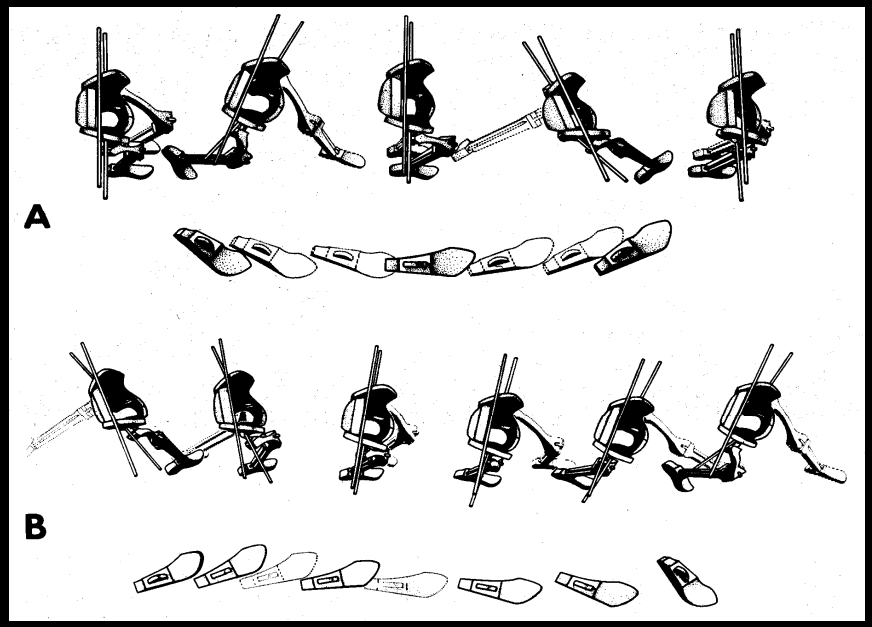


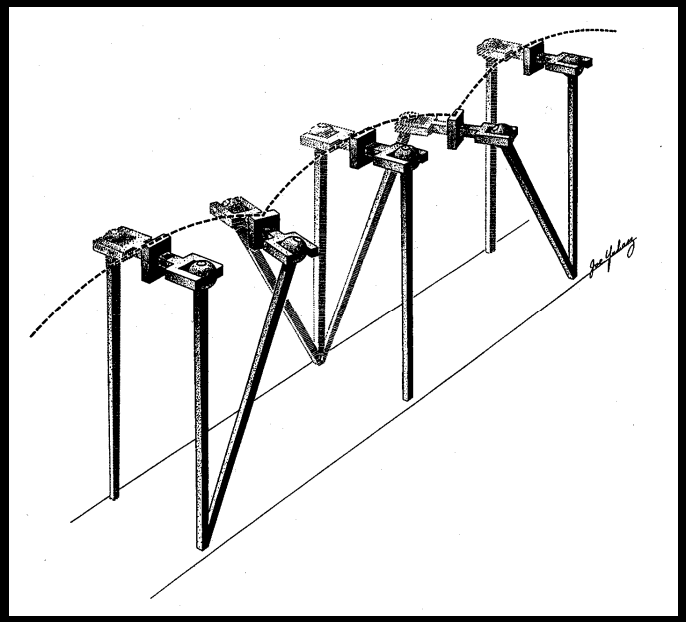
Six Determinants of Gait

- In mid-70’, Imman and Ralston

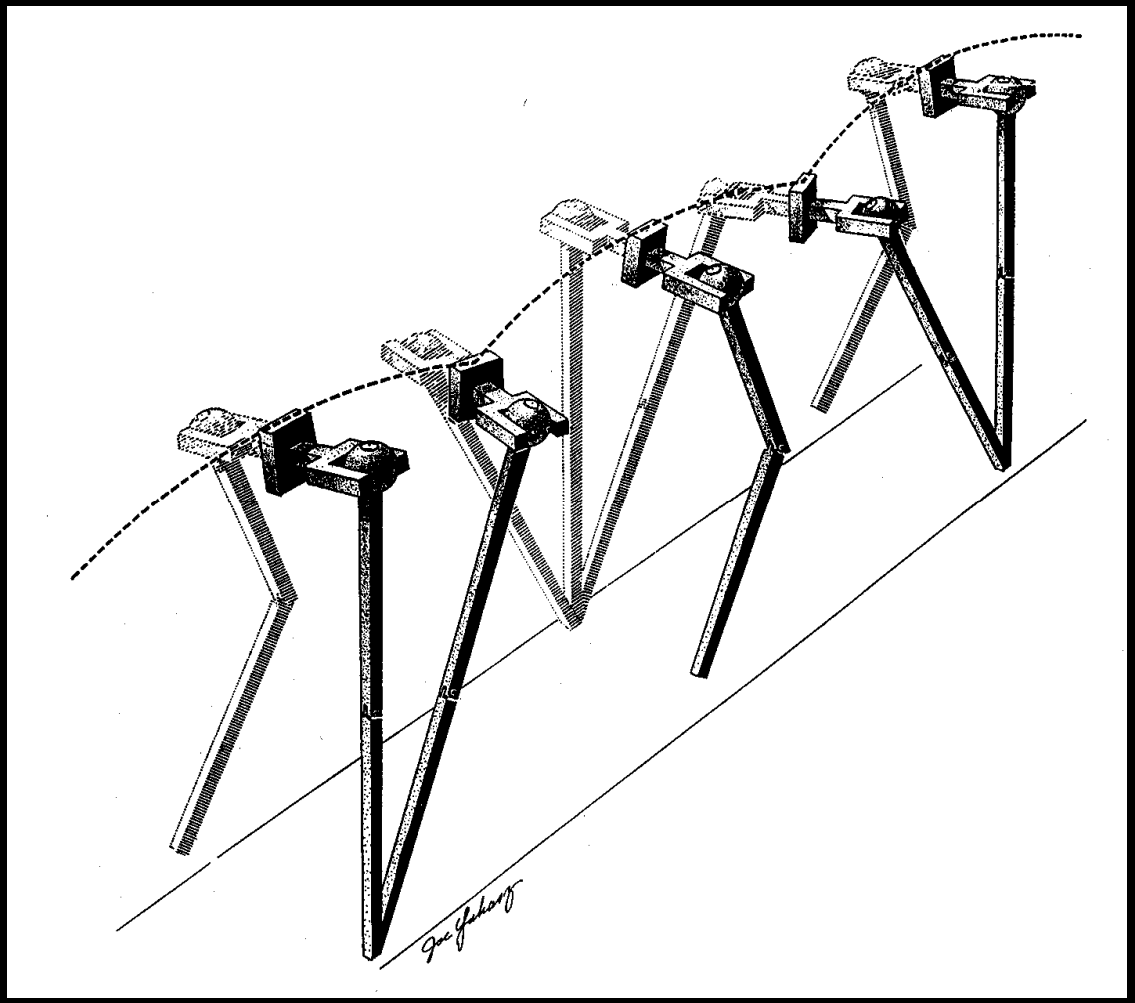
1. Pelvic rotation in the transverse plane.
2. Pelvic obliquity in the coronal plane.
3. Knee flextion in stance phase
4. Knee motions
5. Ankle motions
6. Lateral displacement in the coronal plane.

Effect of Pelvic Rotation

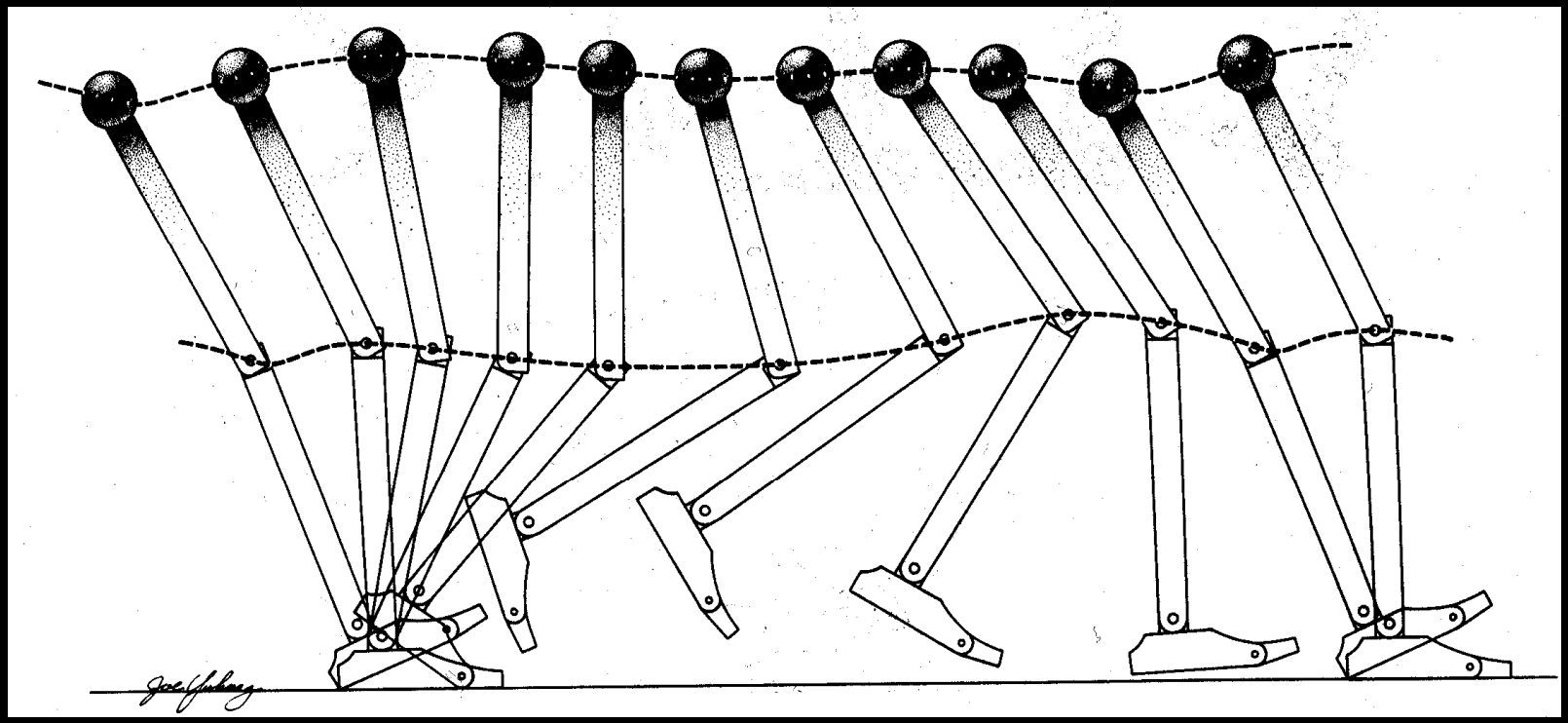


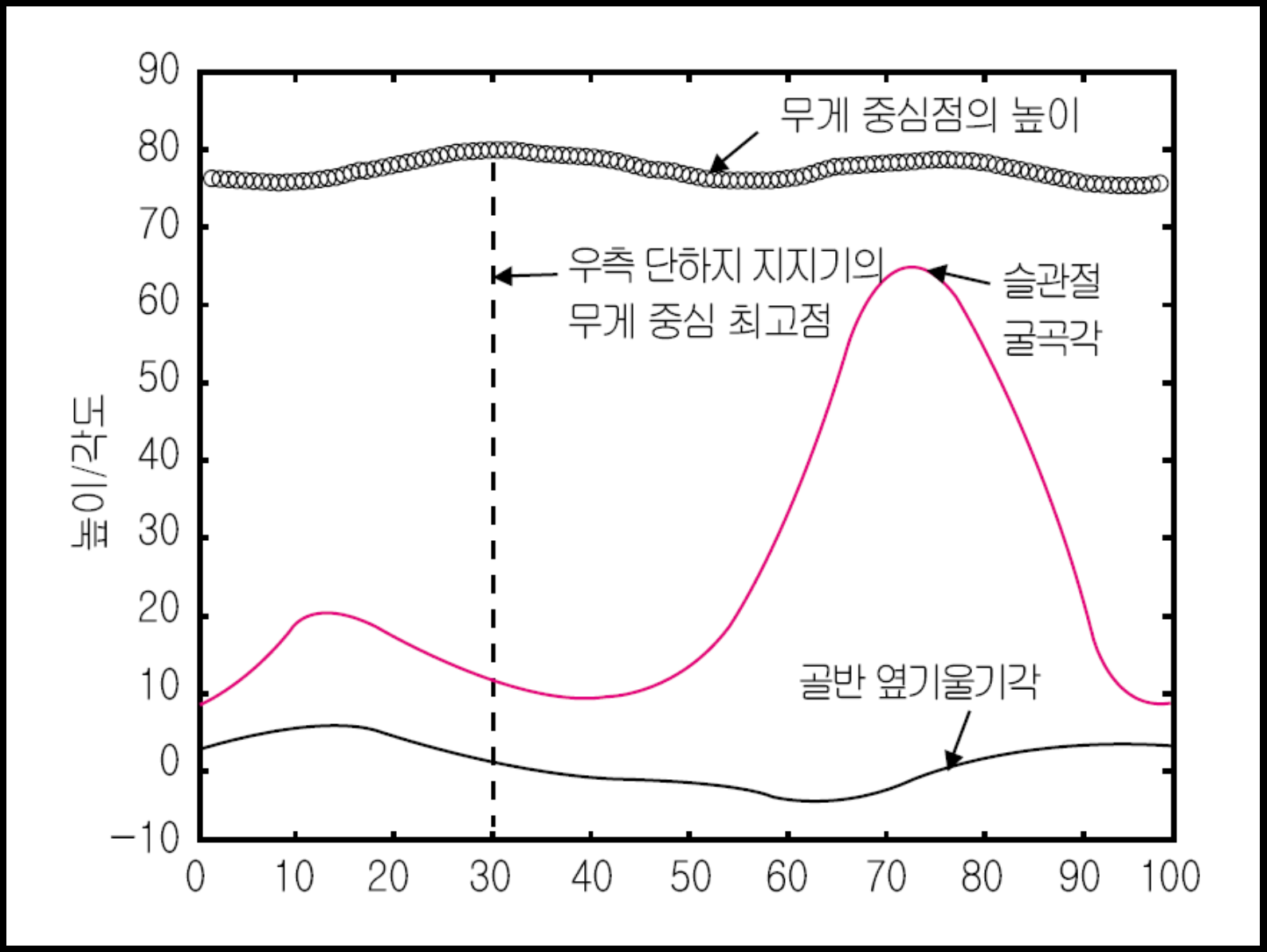


Effect of Pelvic Obliquity

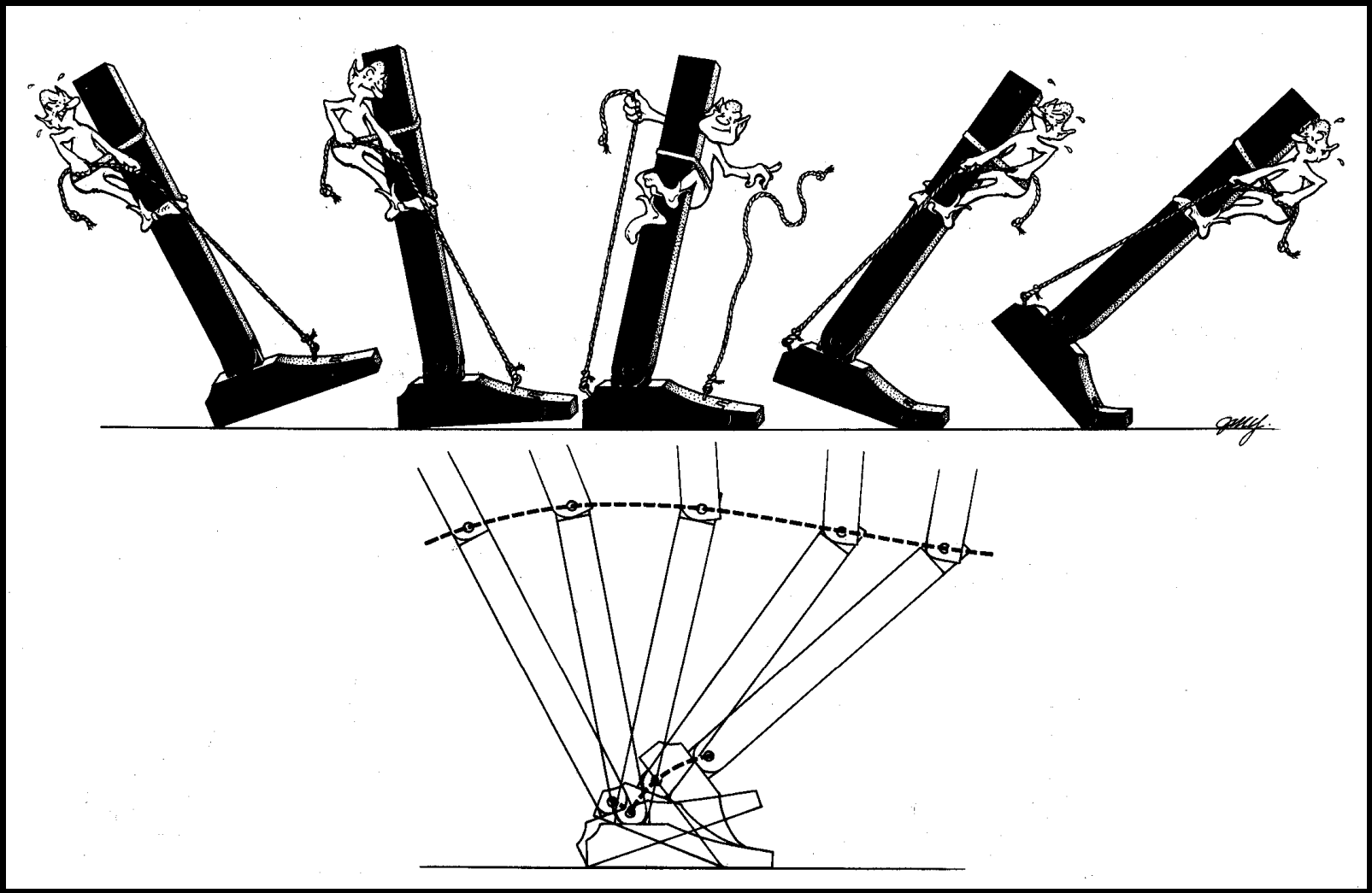


Effect of Knee Flexion

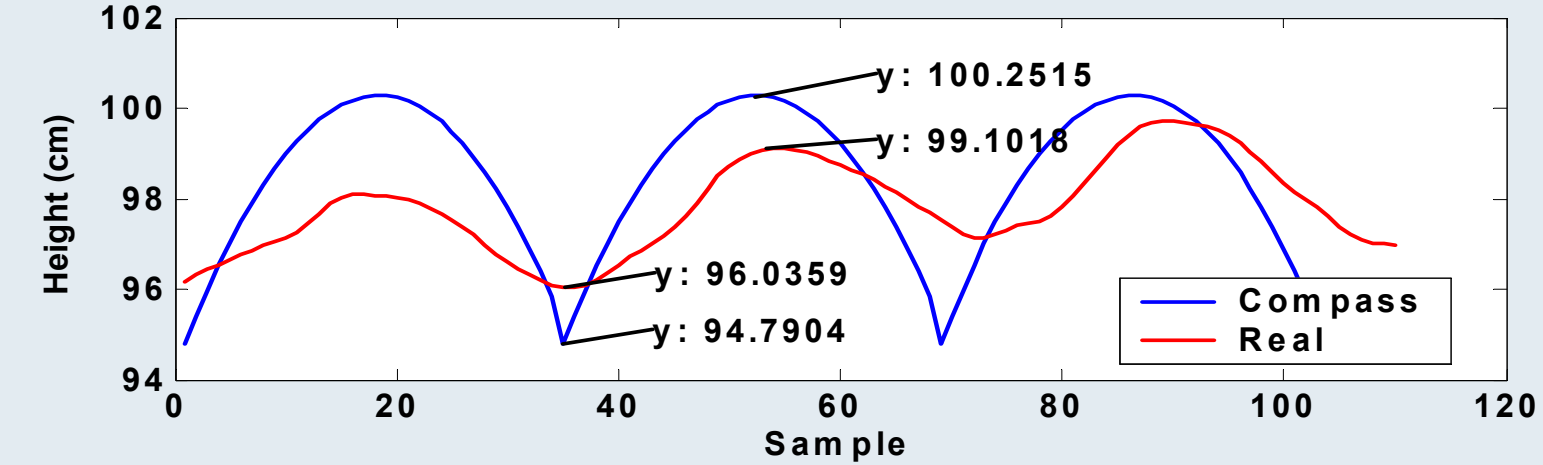


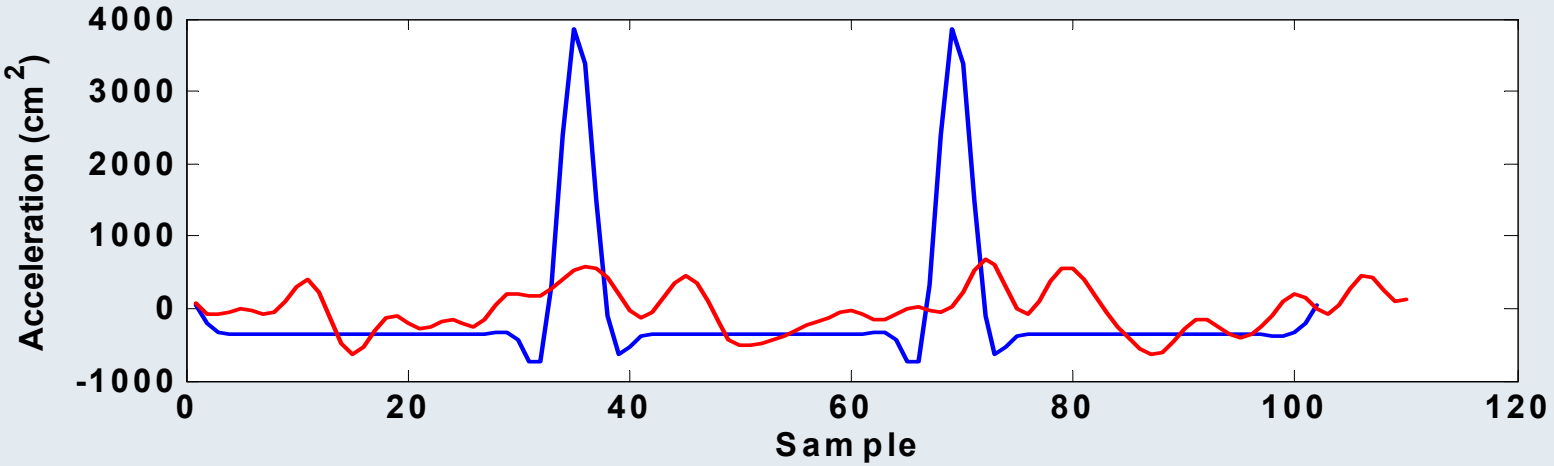

무게 중심점의 높이
우측 단하지 지지기의
무게 중심 최고점
슬관절
굴곡각
골반 옆기울기각
높이/각도
90
80
70
60
50
40
30
20
10
0
−10
0
10
20
30
40
50
60
70
80
90
100

Effect of Ankle Motion

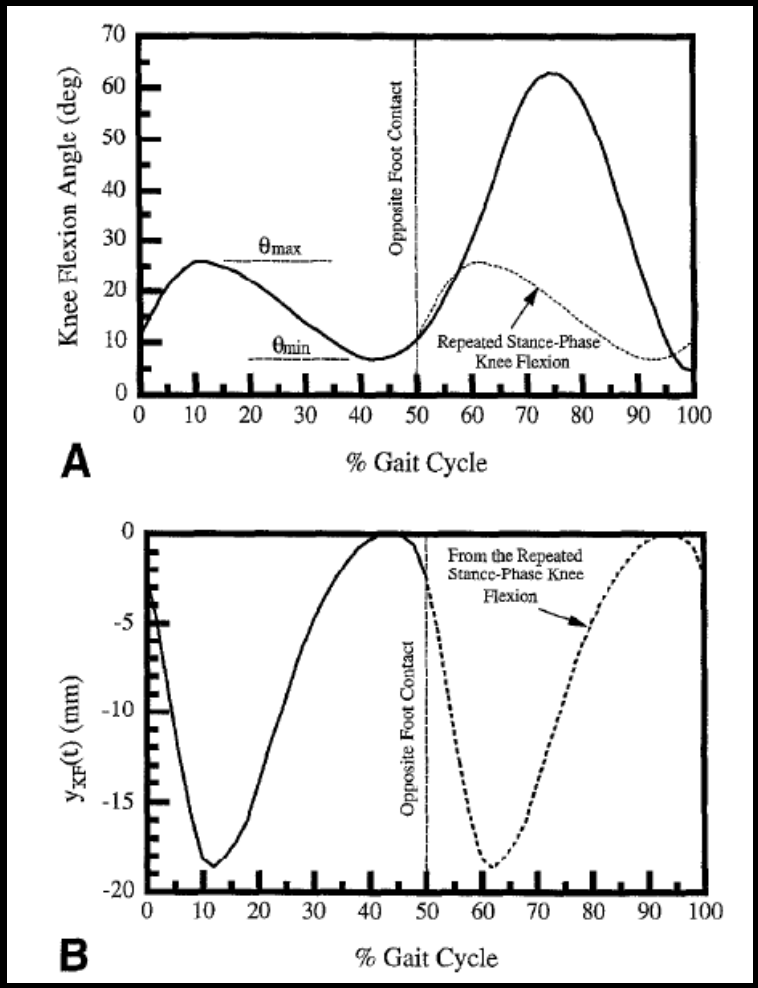


Normal COG Movement



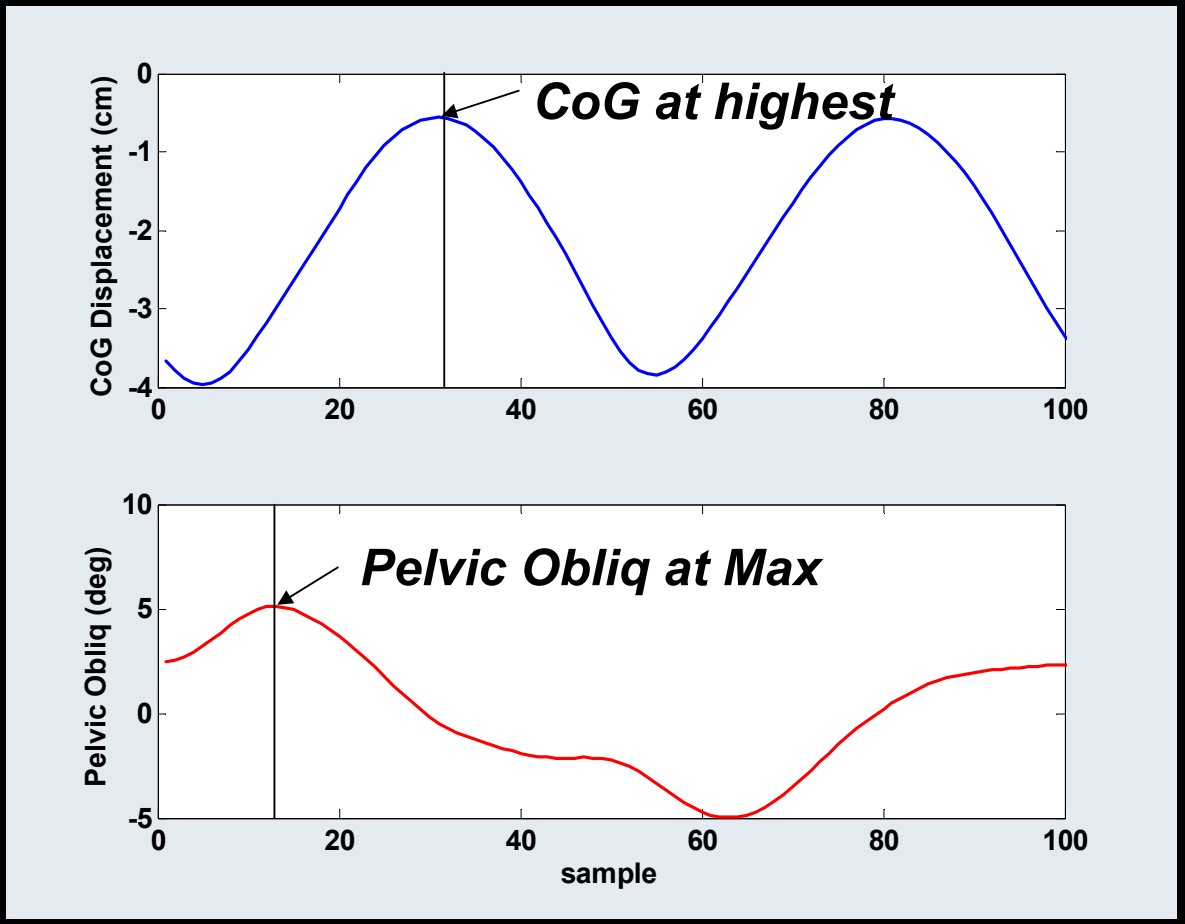


Facts against Inman's theory



Gard et al. 1999 APMR

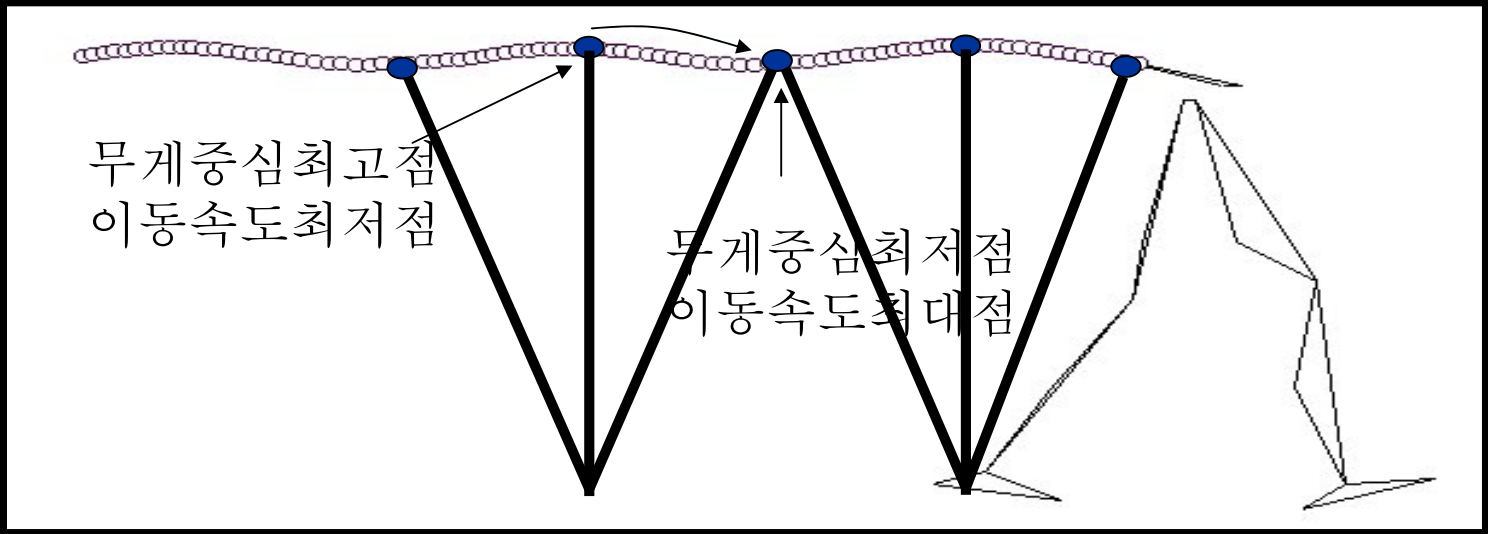
Facts against Inman's theory

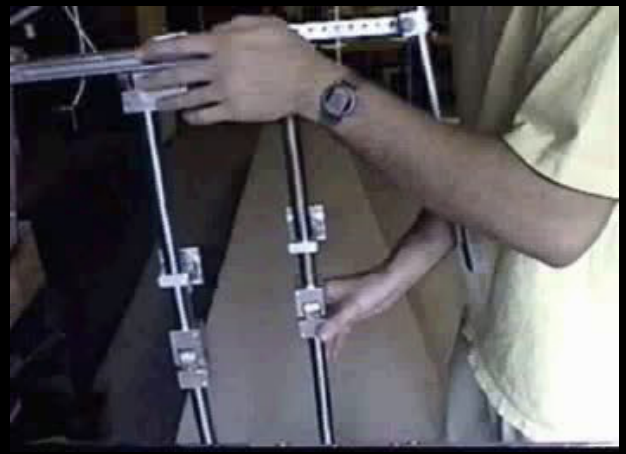


Vertical Excursion of COG

- The smaller, the better and more efficient?
- Maybe not!!
- “Inverted Pendulum” model

Inverted Pendulum Model

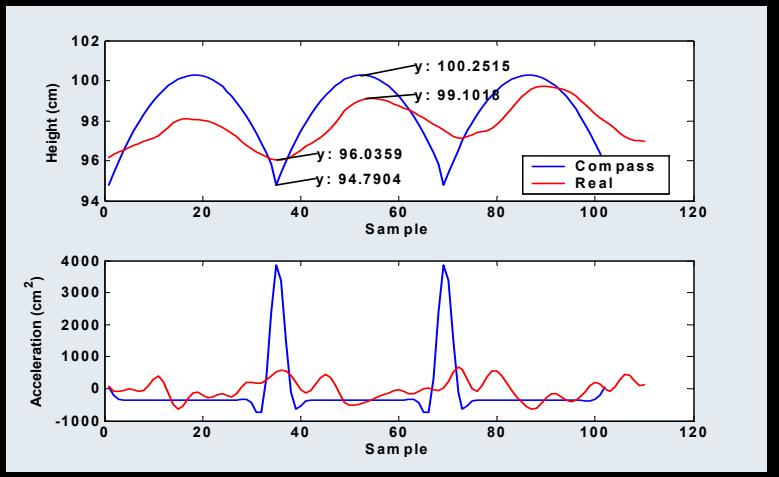


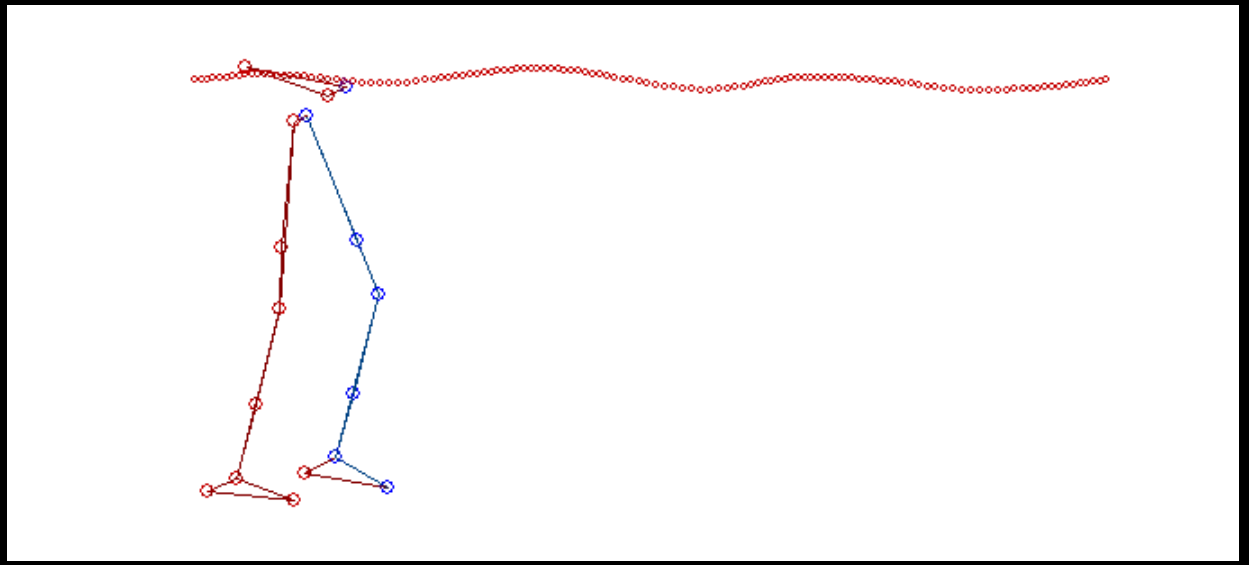


Vertical Excursion of COG

- The smaller, the better and more efficient?
- *Ortega et al. 2005 J Appl Physiol*
- Relationship between vertical movement and metabolic cost with "flat-trajectory walking“ – Minimum COG excursion
- 2 times of Energy at 69% dec of excursion

Normal Gait


y: 100.2515
y: 99.1018
y: 96.0359
y: 94.7904
Compass
Real
Height (cm)
Sample
Acceleration (cm 2)
Sample

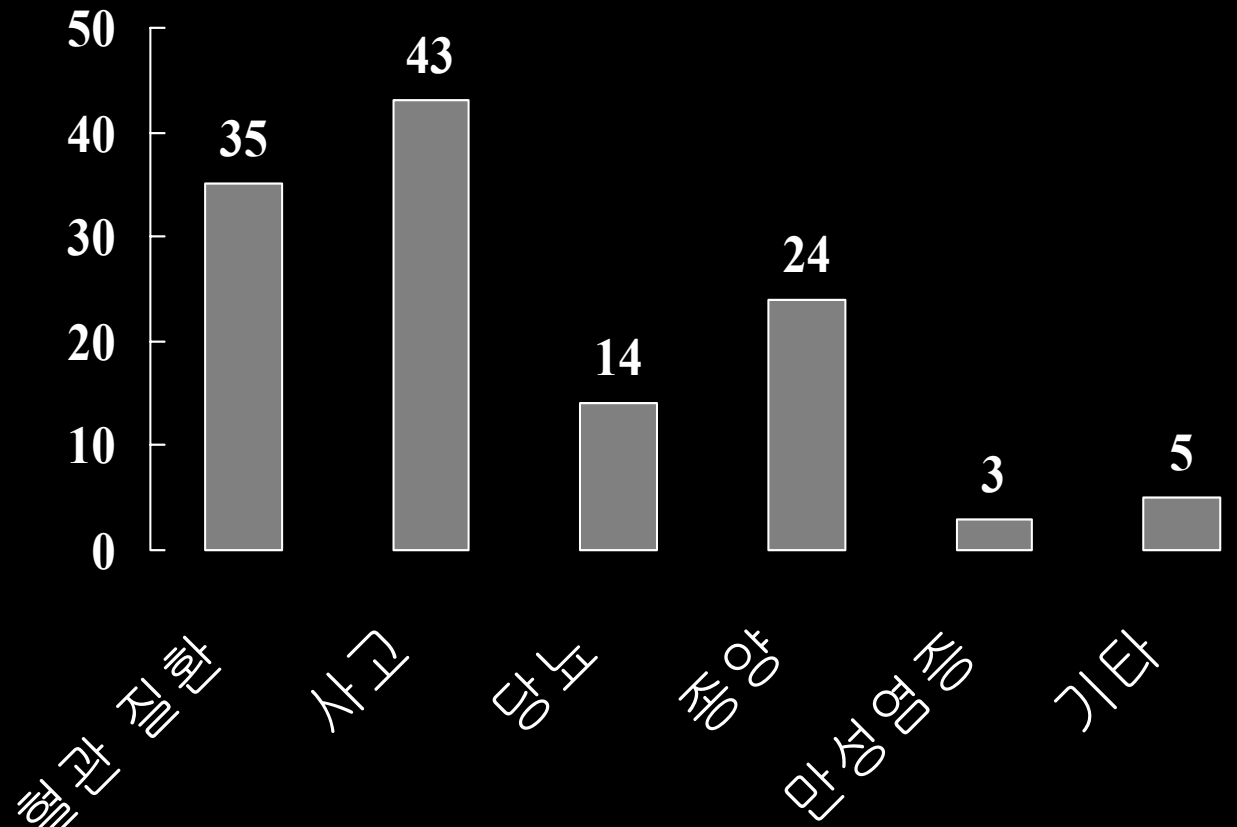


정상 보행의 조건
Requirements

- Stable stance without collapse, fall
- Clear swing without obstruction or retardation
- Safe and smooth (non traumatic) transference of body weight from a leg to the other

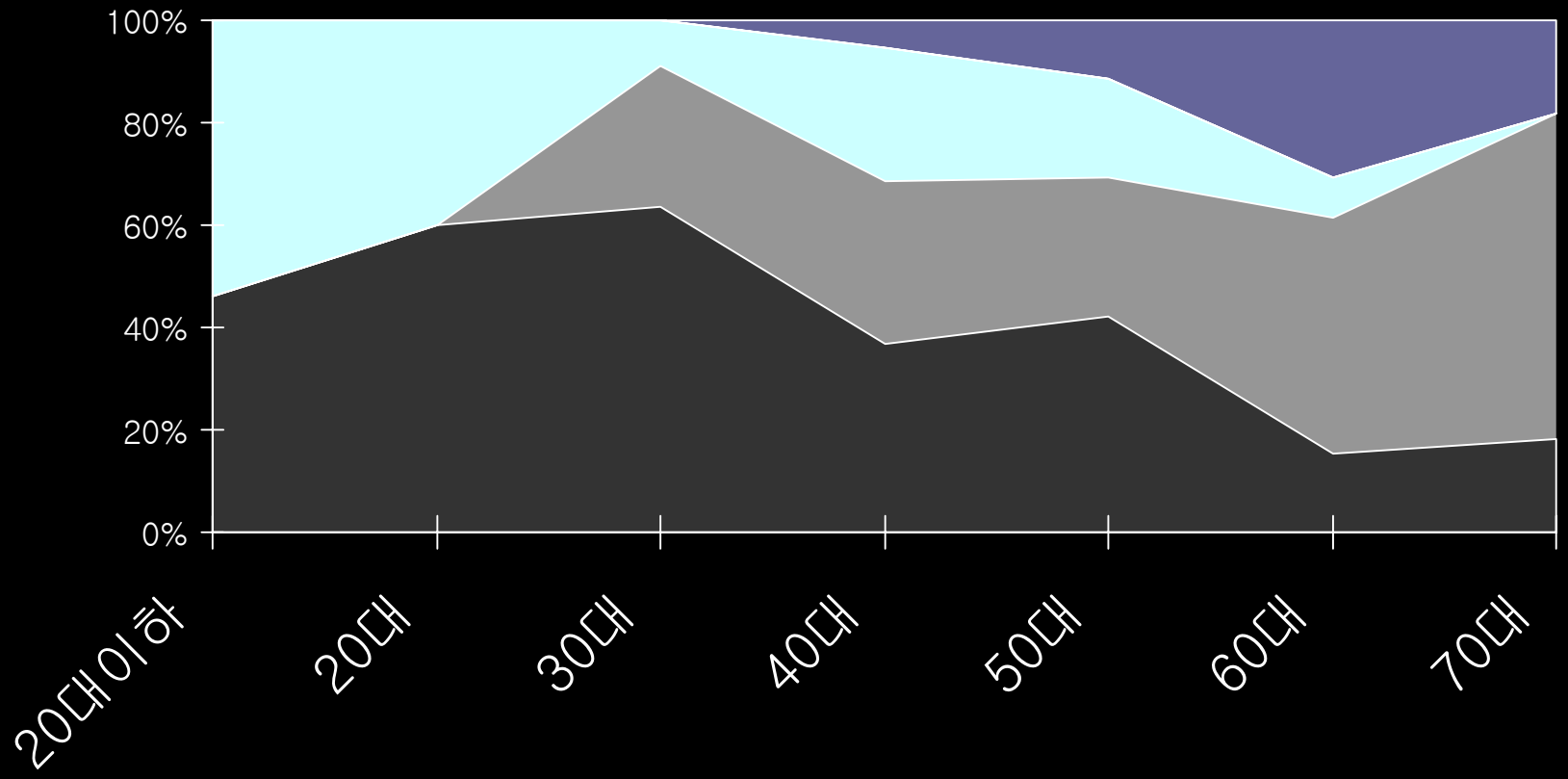
의지 (Prosthesis)

절단원인의 분포(하지 절단)



(1998 서울대병원 재활의학교실 보복부 연구보고)

연령과 원인 분포 (하지 절단)



(1998 서울대병원 재활의학교실 보복부 연구보고)

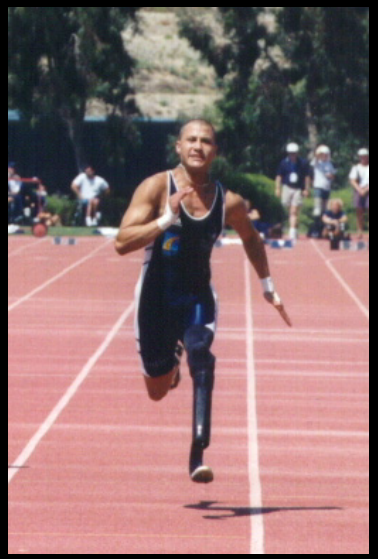
Below Knee Amputation (Transtibial Amputation)

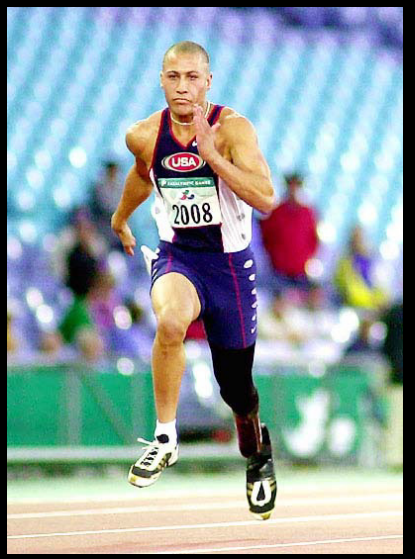
Above Knee Amputation (Transfemoral Amputation)

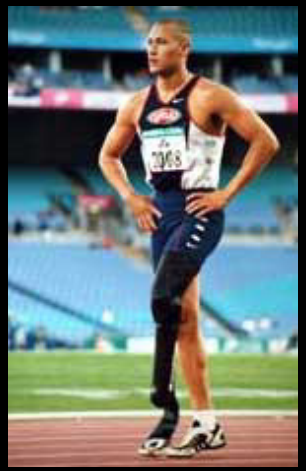
Boyd Amputation (Ankle level)

The World's Fastest Amputee

- Marlon Shirley: 10.97 seconds in the 100m T44 class sprint at the Utah Summer Games held in Cedar City, Utah, USA.

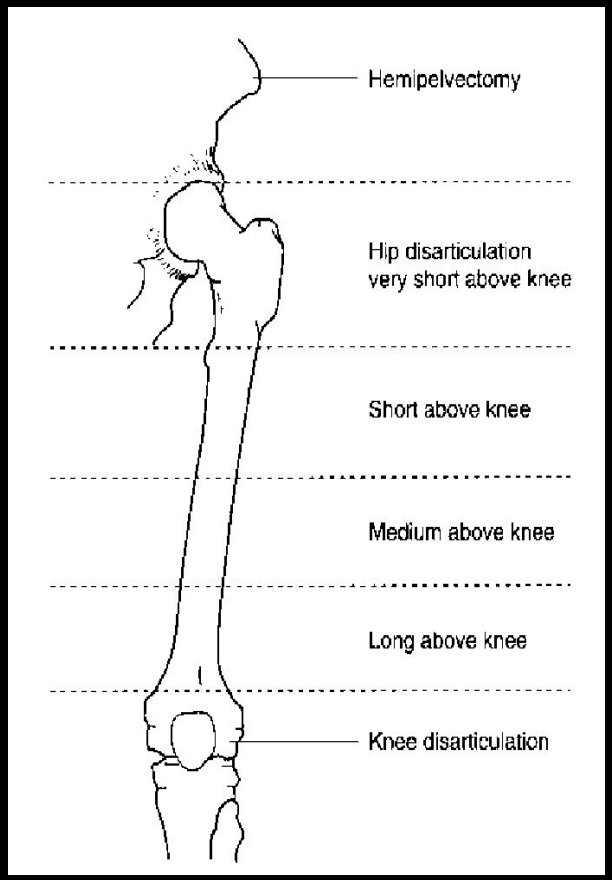




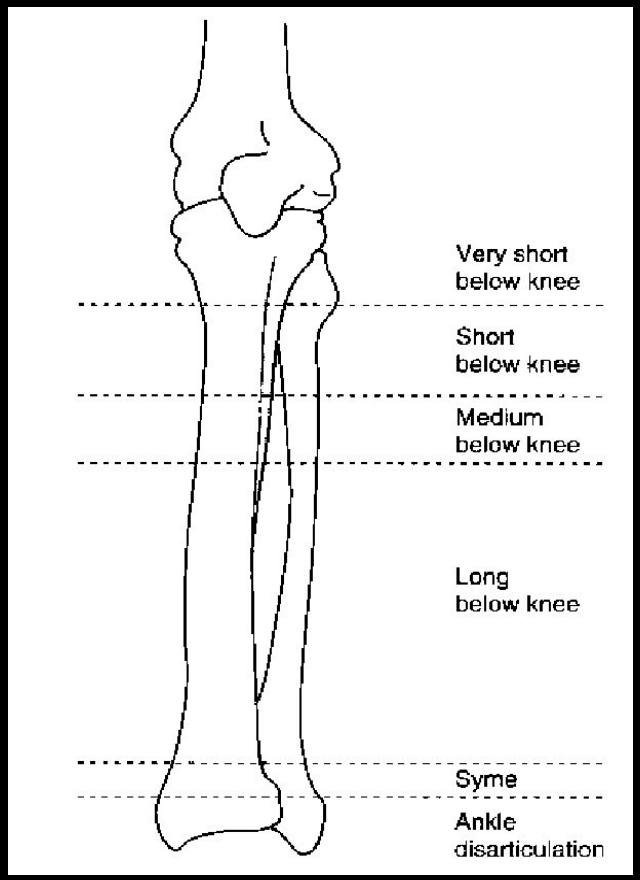


Level of Amputation

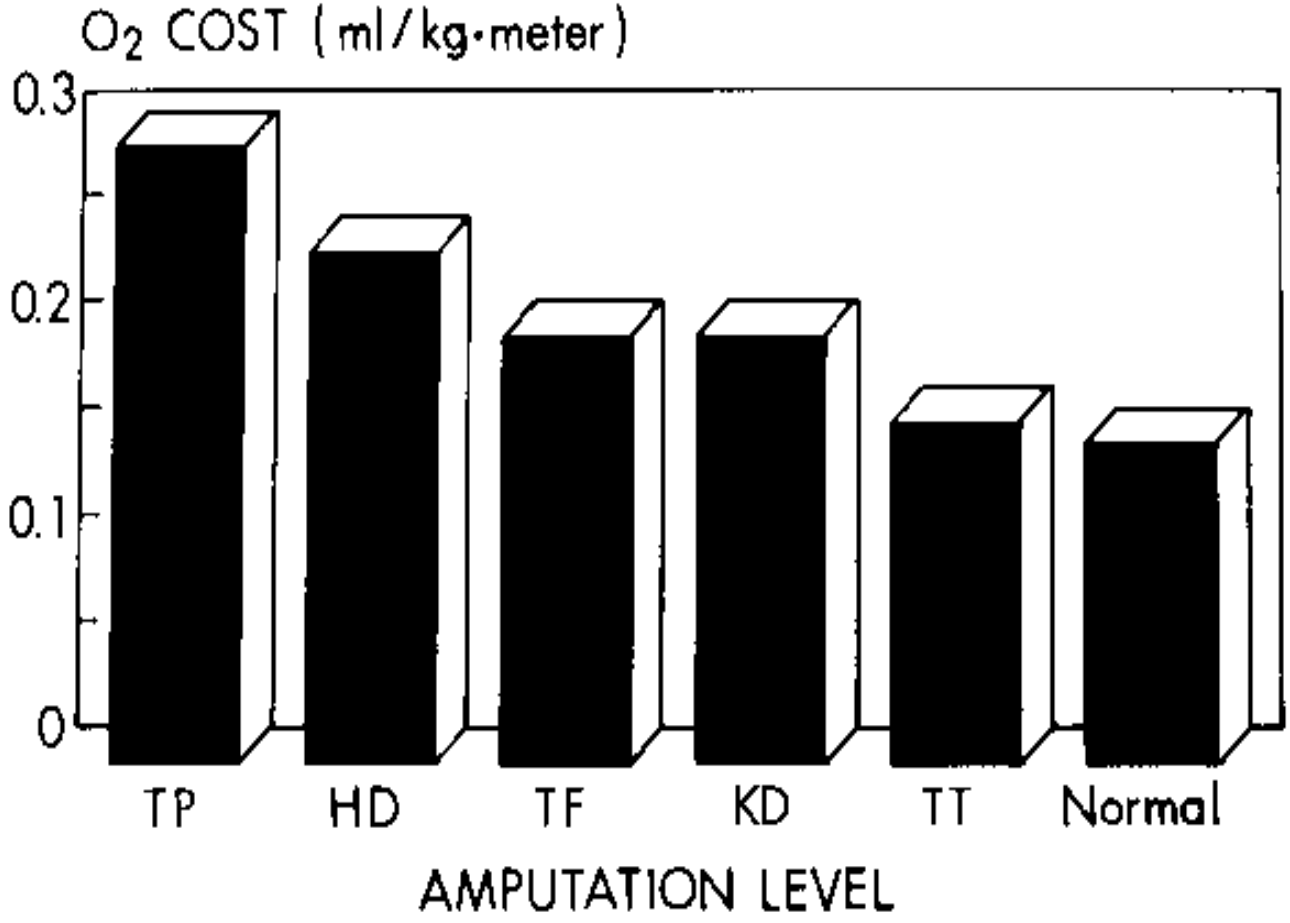
Above Knee (AK) or Transfemoral amputation



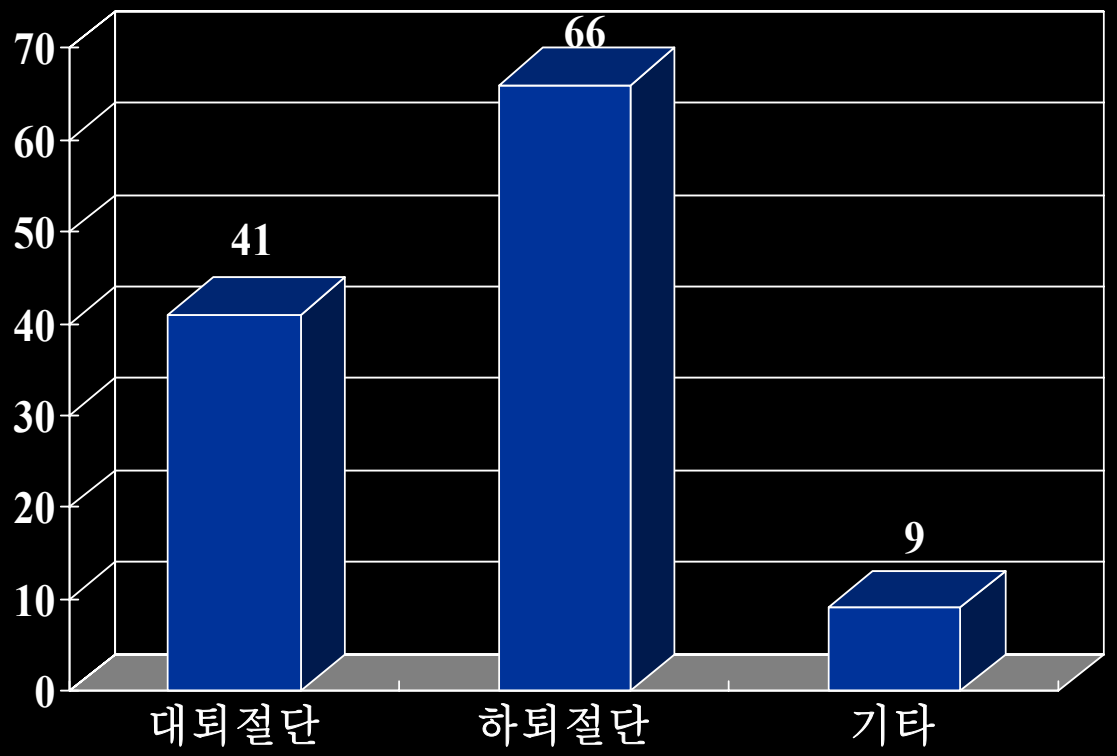
Below Knee (BK) or Transtibial amputation



Energy Consumption



절단 부위 (하지 절단)



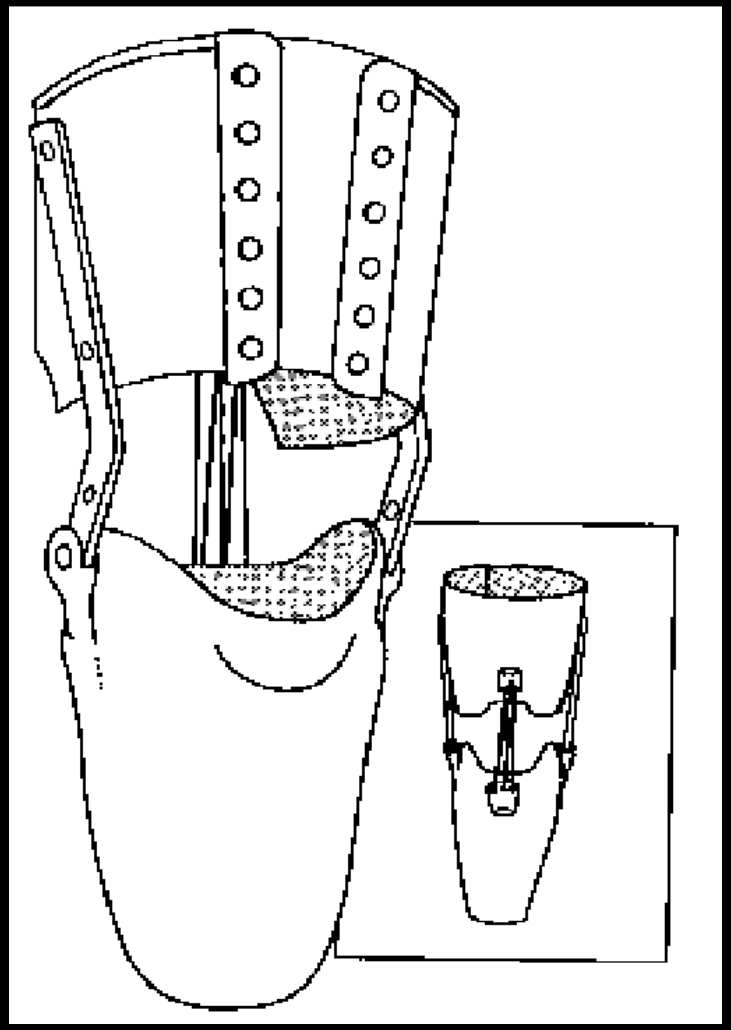
(1998 서울대병원 재활의학교실 보건복지부 연구보고)

Prosthetic Component - Transtibial

- Socket: interface
- Suspension: attach
- Shank: long bones
- (Joints)
- Foot&ankle assembly

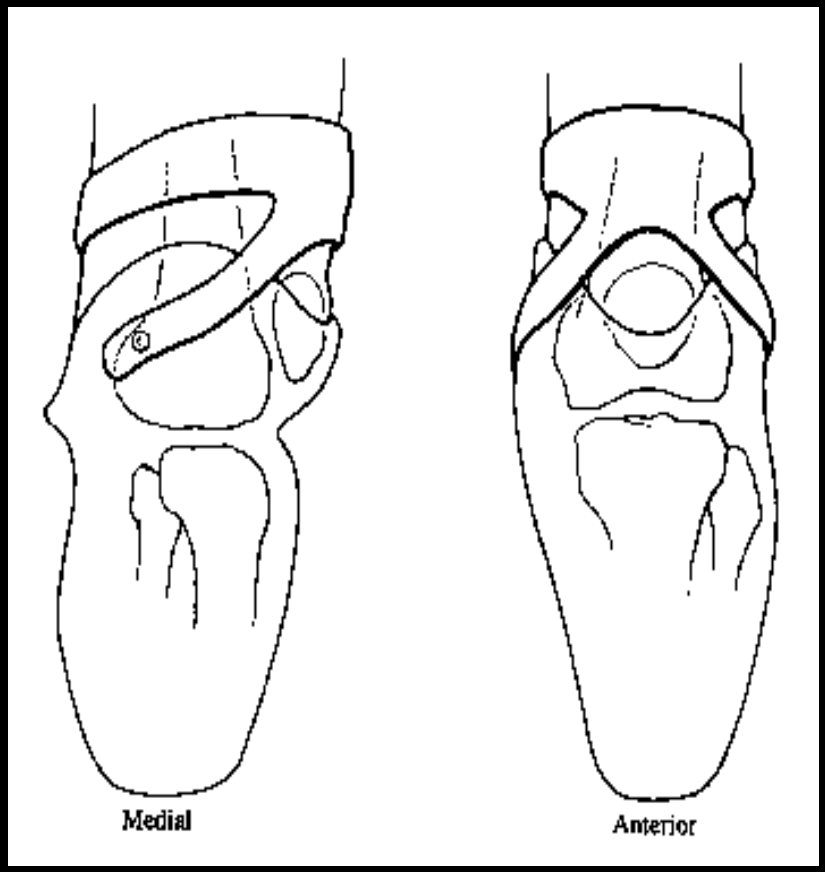
Suspension

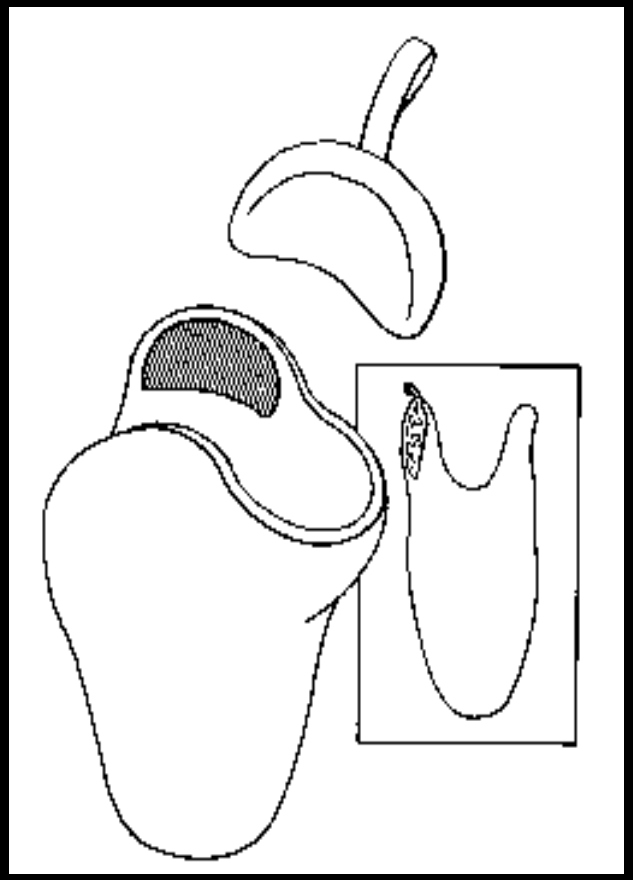
Thigh Corset



Prosthetic Prescription

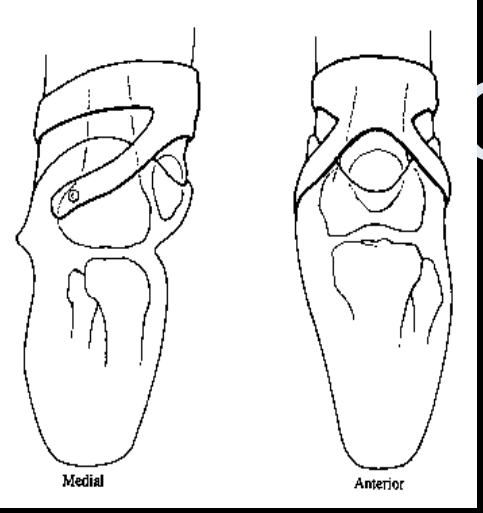
BK Suspension





Cuff suspension - most common Medial wedge suspension

Old BK Prosthesis



Roll On Locking Liner

Roll On Locking Liner

Shuttle lock

Lanyard lock

Prosthetic Prescription

Roll On Locking Liner

Shuttle lock

Prosthetic Prescription

Hypobaric Sealing Membrane

Seal in locking system

Hypobaric Sealing Membrane

Seal in locking system

Augmented Vacuum Systems

Harmony VASS (Vacuum Assisted Socket System)

Augmented Vacuum Systems

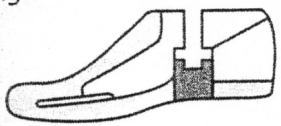
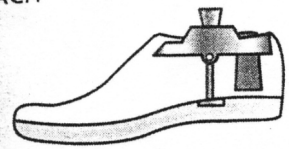
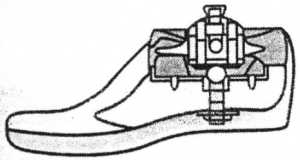
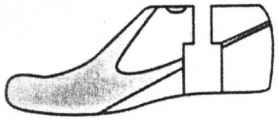
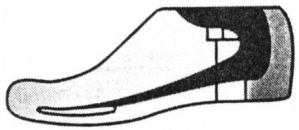
Harmony VASS (Vacuum Assisted Socket System)

Prosthetic Component - Transtibial

- Socket: interface
- Suspension: attach
- Shank: long bones
- (Joints)
- Foot&ankle assembly

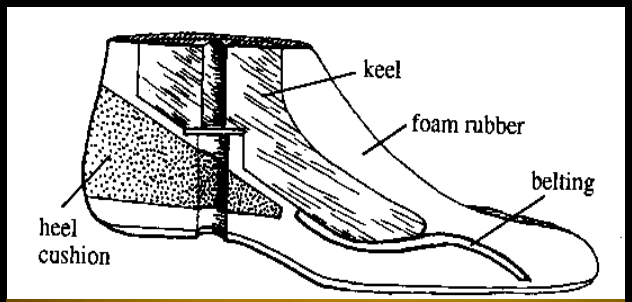
Prosthetic Foot

TABLE 3 Overview of Prosthetic Feet and Ankles

Generic Class	Basic Function	Primary Indication	Major Advantages	Chief Limitations
Single-axis 	Simplicity	Limited ambulation or maximum durability required	Inexpensive and durable	Rigid forefoot; not energy-efficient
SACH 	Rapid foot flat	To enhance knee stability	Biomechanical stability in early stance	Abrupt dorsiflexion stop increases knee hyperextension moment; increased weight, maint-enance, initial cost
Multiaxial 	Hindfoot inversion/eversion; internal/external rotation	To accommodate uneven surfaces	Reduces stresses on skin and prosthesis	Increased weight, maintenance, initial cost
Flexible-keel 	Smooth, easy rollover	To make ambulation easier	Comfortable and reliable	Limited pushoff; increased cost
Dynamic-response 	Dynamic pushoff	To increase activity level	Subjective sense of dynamic responsiveness	Increased cost

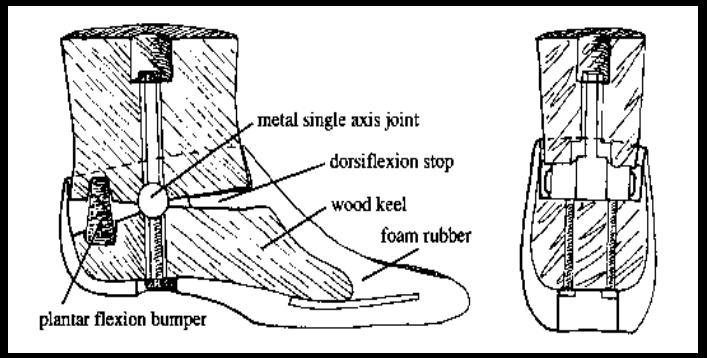
Prosthetic Prescription

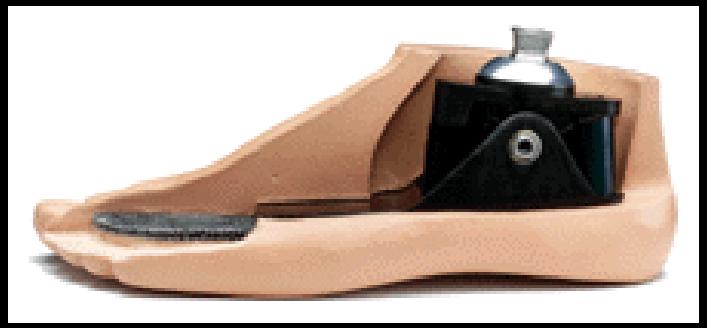
Foot and Ankle Assembly
Solid Ankle Cushion Heel (SACH) Foot



Prosthetic Prescription

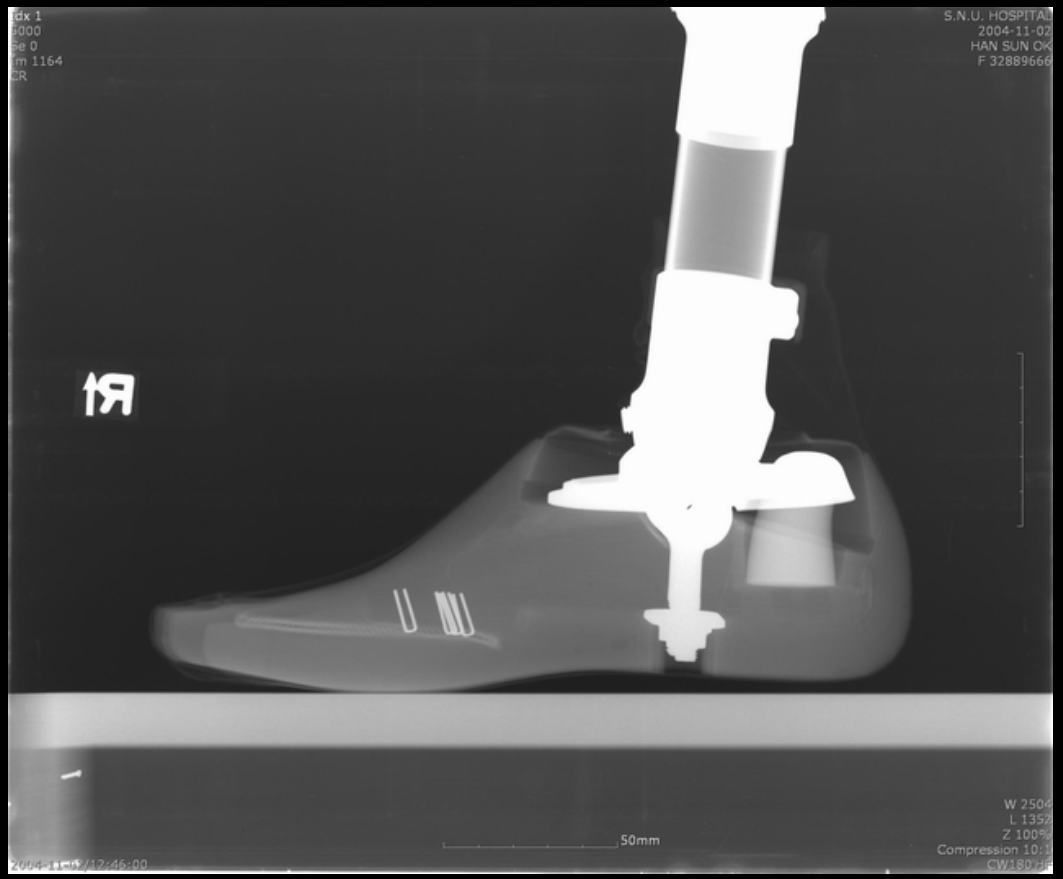
Foot and Ankle Assembly
Single Axis Foot



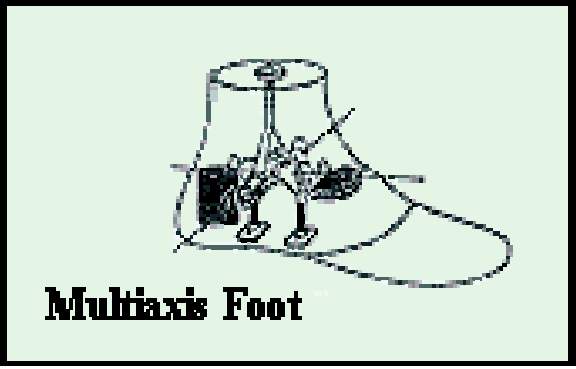


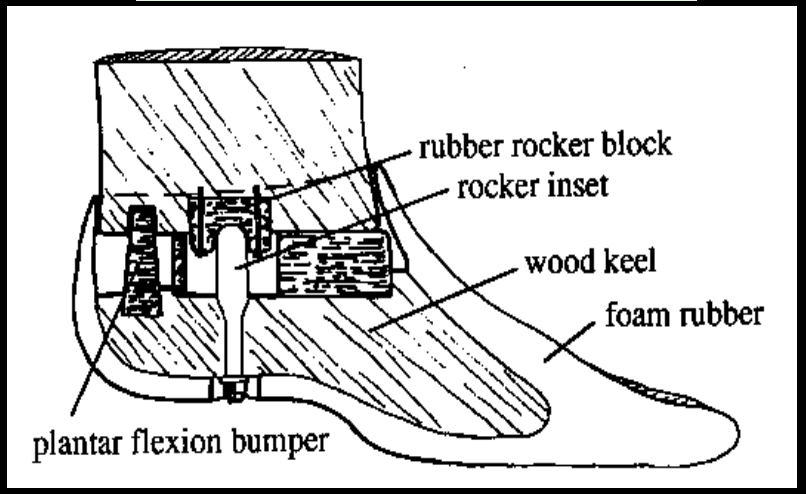
Prosthetic Prescription

Foot and Ankle Assembly
Single Axis Foot



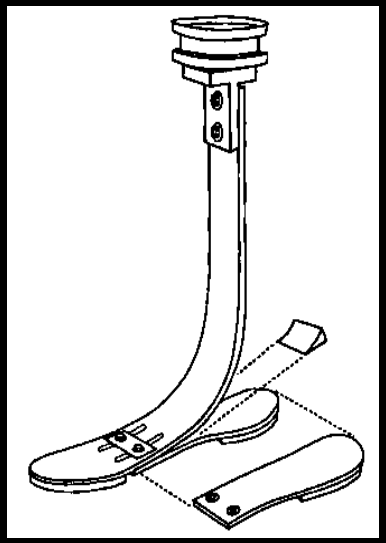
Foot and Ankle Assembly
Multi - Axis Foot



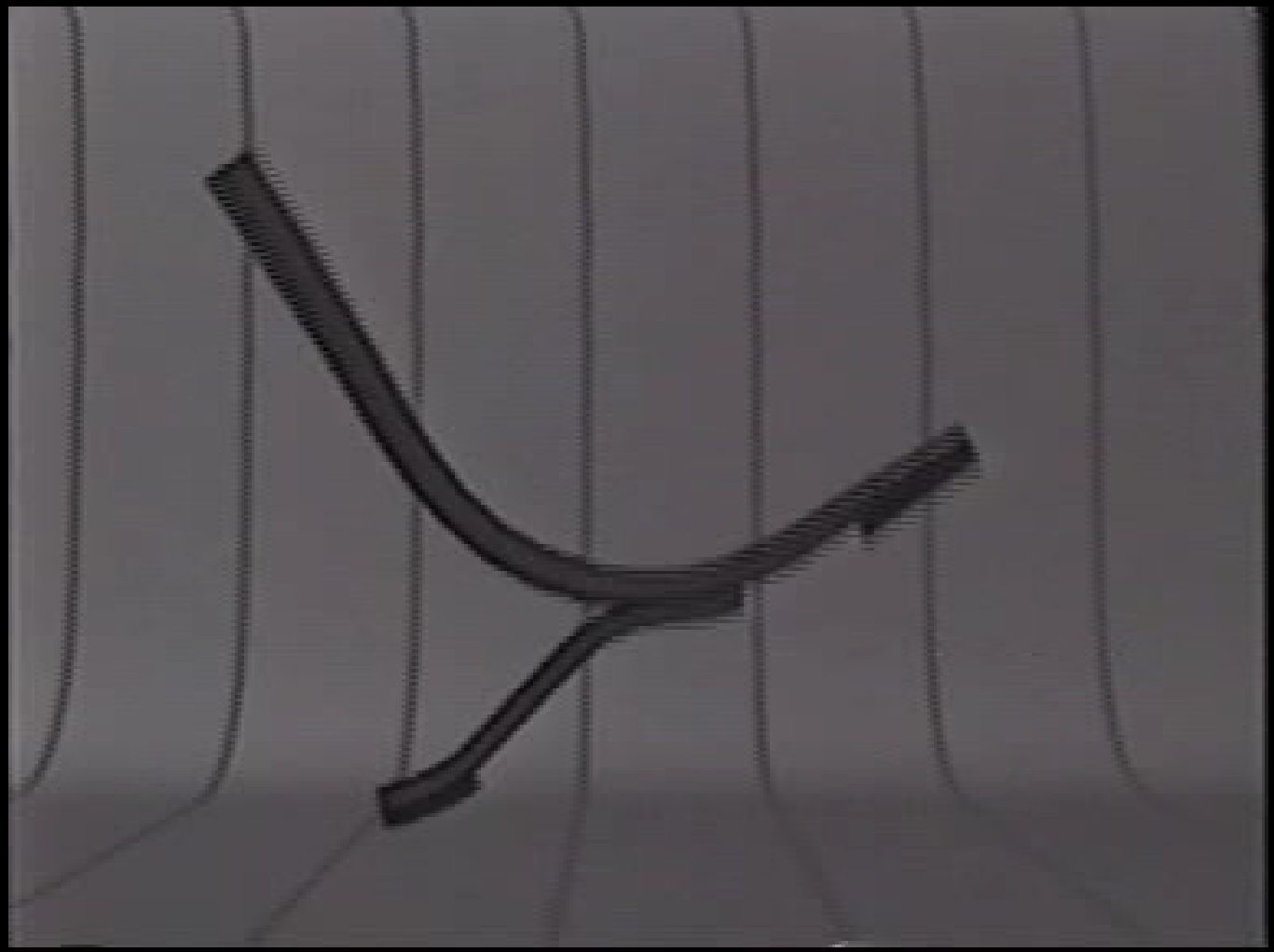


Prosthetic Prescription

Energy Storing Foot - Flex Foot



The most popular energy storing foot

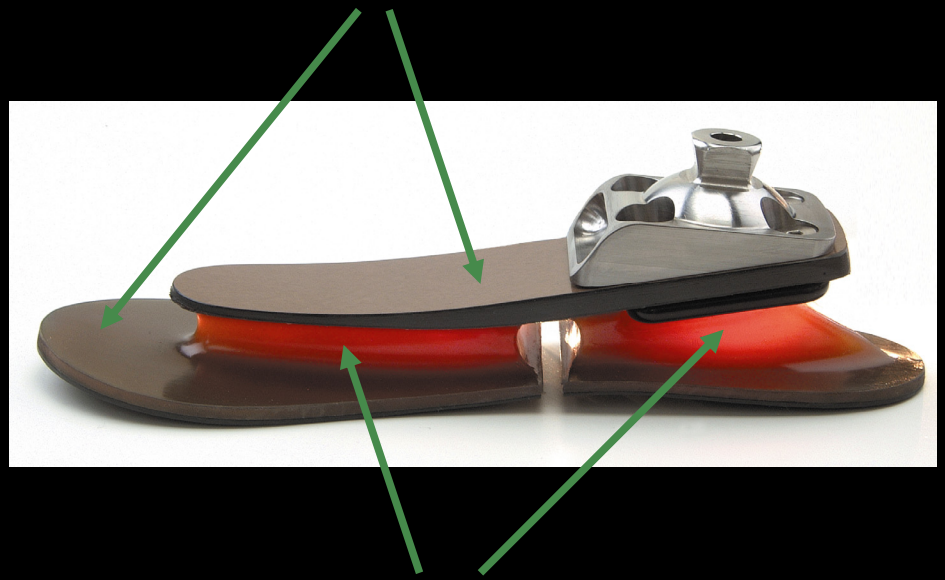


Prosthetic Prescription

Ceterus

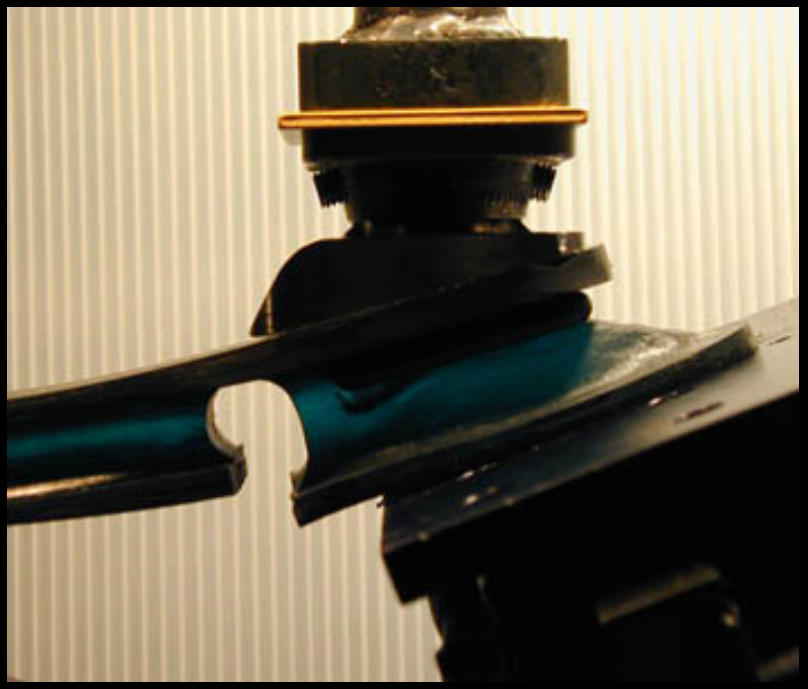
Prosthetic Prescription

LuXon Foot

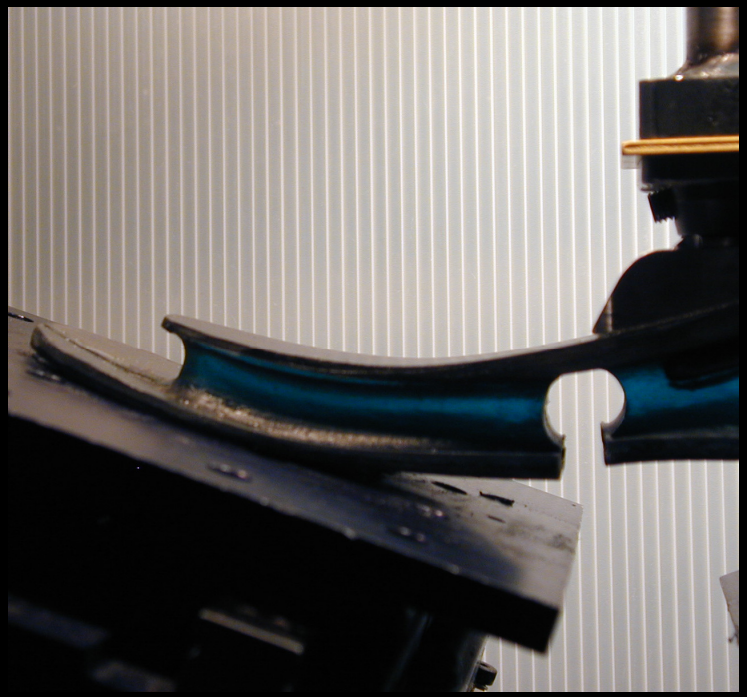
- 

Prosthetic Prescription

LuXon Foot



HEEL LOADING



TOE LOADING

Prosthetic Prescription

LuXon Foot

Prosthetic Prescription

LuXon Foot

Prosthetic Prescription

Shock Absorbers and rotatory unit

Prosthetic Knee

Components of AK prosthesis

- Socket - Interface
- Suspension
- Knee Unit
- Shank
  - - exo vs. endoskeletor
- Foot and ankle assem

Length of Stump

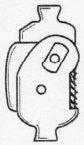
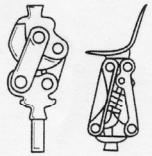
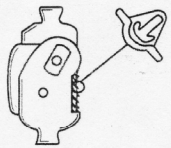
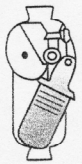
Length of Stump

Length of Stump

Length of Stump

Prosthetic

TABLE 4 Overview of Prosthetic Knees

Generic Class	Basic Function	Primary Indication	Major Advantages	Chief Limitations
Single axis (Constant friction) 	Simplicity	Single-speed walking only if hip control is good or better or when maximum durability is required	Inexpensive and durable	Fixed cadence and low stability
Stance-control 	Increased weight-bearing stability	General debility; poor hip control	Improved knee stability	Delayed swing phase; must unload fully to flex or sit
Polycentric 	Positive stability and ease of flexion for swing phase; special design available that provides sitting cosmesis for long residual limbs	To enhance knee stability; special design available for knee disarticulation	Stable without disrupting swing phase; special design provides cosmesis for long residual limbs	Increased weight, maintenance, initial cost
Manual lock 	Knee of last resort	Ultimate knee stability	Eliminates knee flexion	Abnormal gait; awkward sitting
Fluid-controlled 	Permits cadence change; micro-processor control offers most normal gait pattern	Able to vary walking speed	Variable cadence; more natural gait; hydraulic stance control adds stability	Increased initial cost; may involve increased weight or maintenance

정상 보행의 조건
Requirements

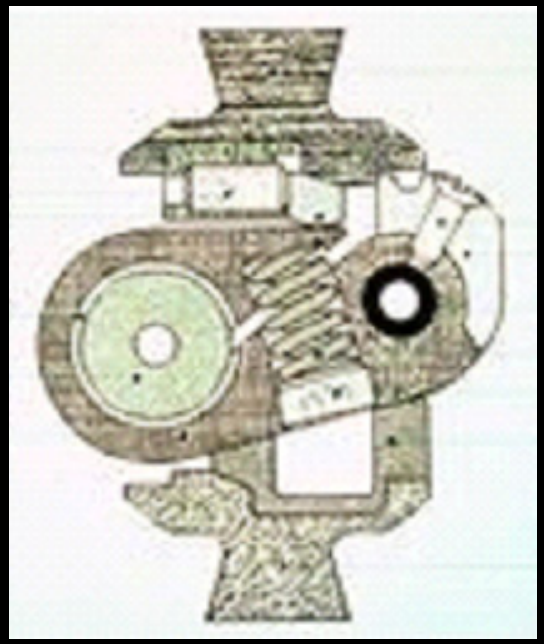
- Stable stance without collapse, fall
- Clear swing without obstruction or retardation
- Safe and smooth (non traumatic) transference of body weight from a leg to the other

Outcomes of Prosthetic Rehabilitation

Knee Unit – Single Axis with Constant Friction

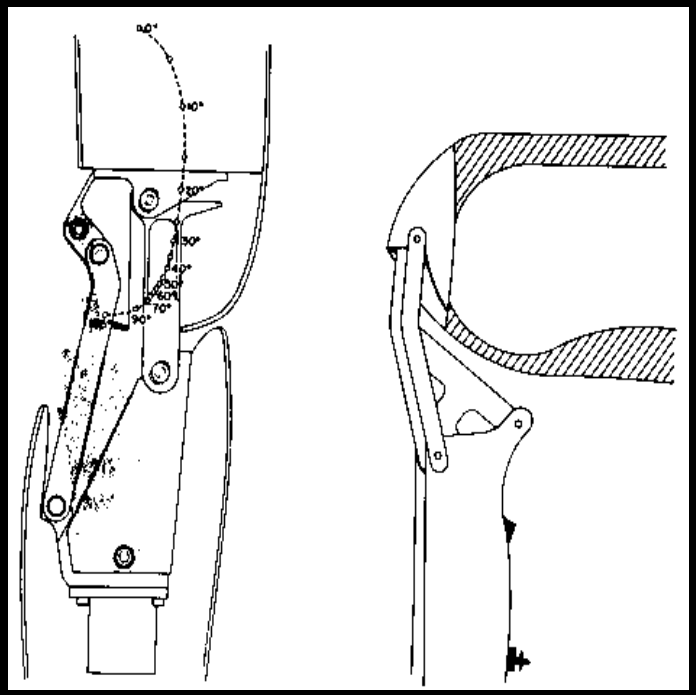
Prosthetic Prescription

Knee Unit - Safty knee



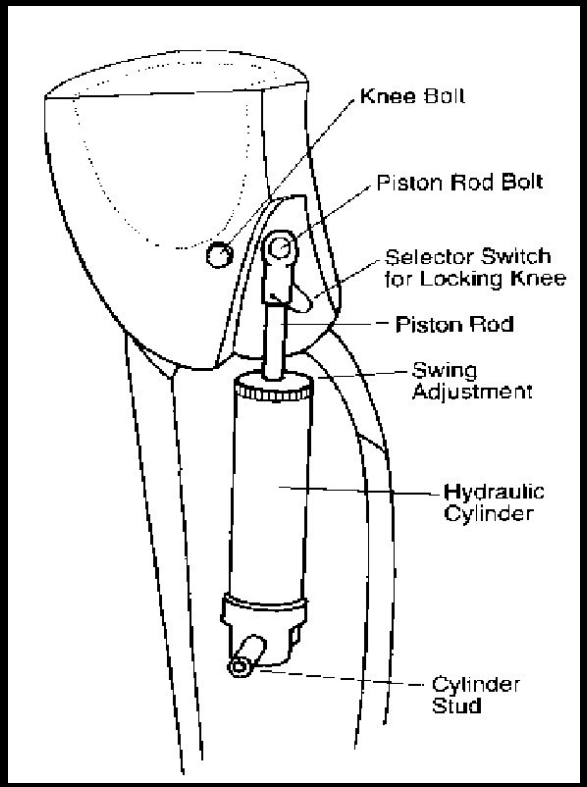
Prosthetic Prescription

Knee Unit - Polycentric knee



Stable at stance
Shorten leg at swing

Knee Unit - Hydraulic knee



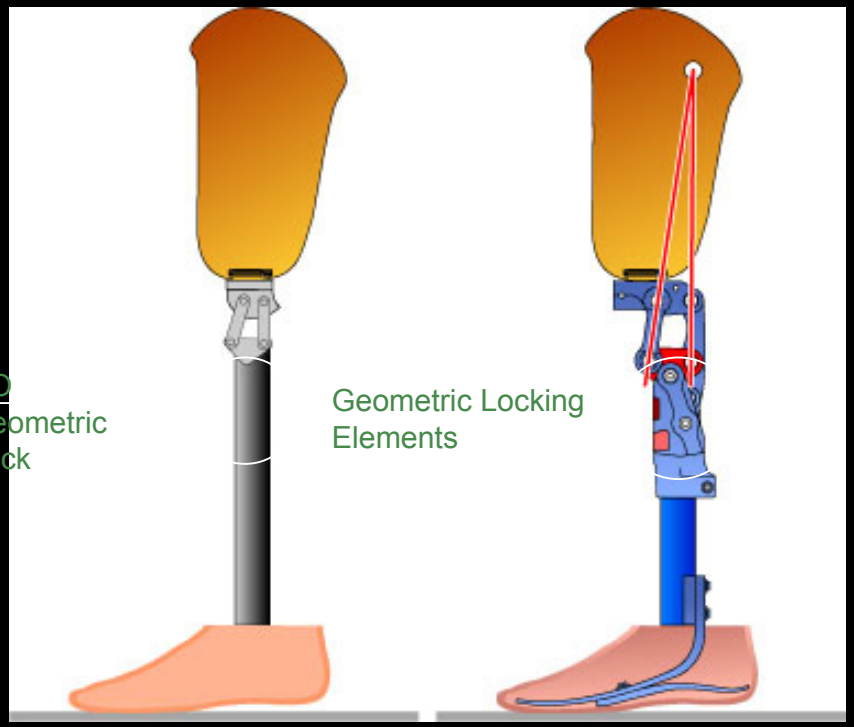
Prosthetic Prescription

Knee Unit - Hybrid

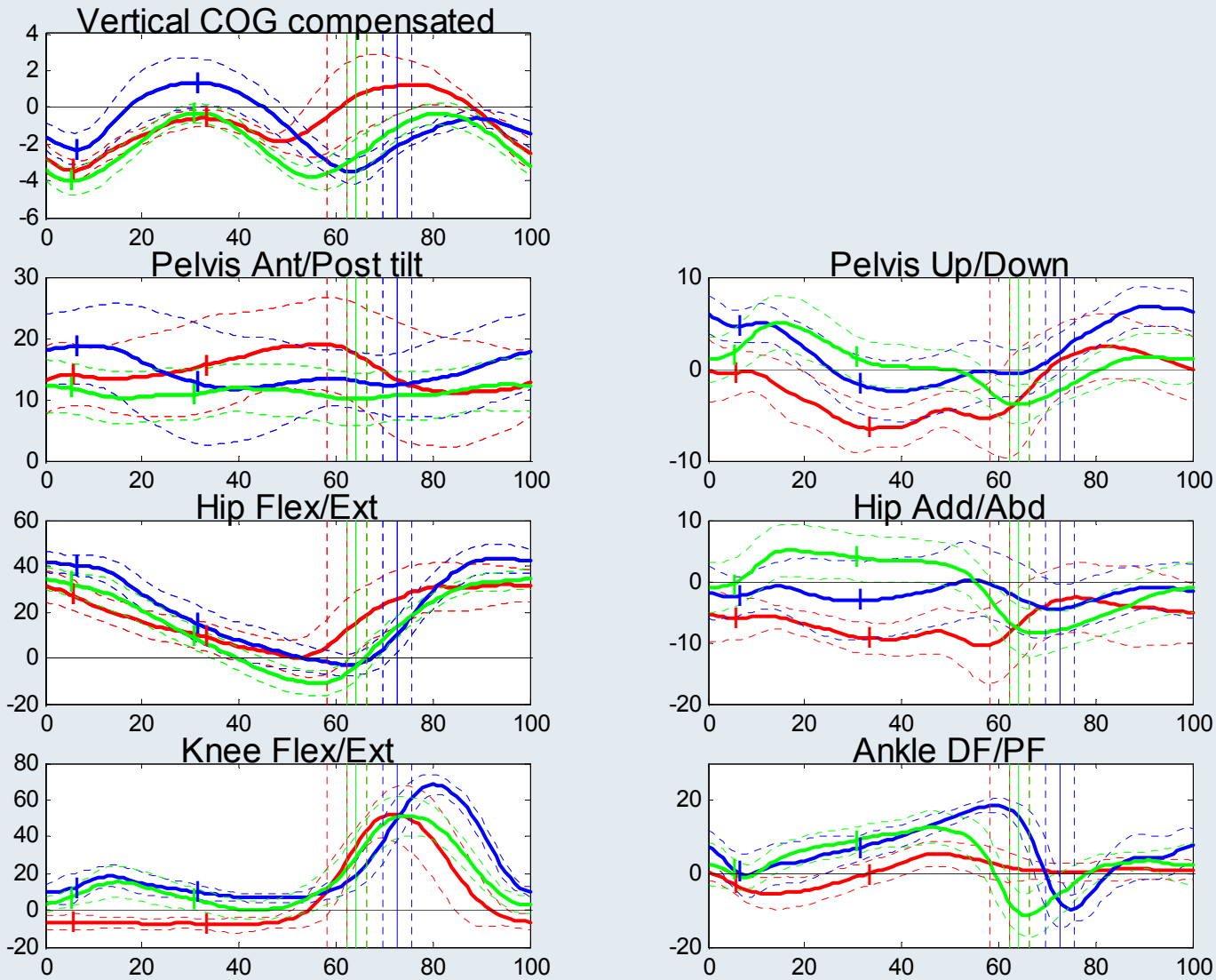
- Stable at stance
- Shorten leg at swing
- With swing cadence control

Geometric Lock

Seven Axis = STABILITY



- Enhanced stability over 4-Bar systems.
- Less hip extensor action required for knee stabilization.
- Upper 4 Axes ‘lock’ under heel load.
- Cannot release until toe load is applied.


Vertical COG compensated
Pelvis Ant/Post tilt
Pelvis Up/Down
Hip Flex/Ext
Hip Add/Abd
Knee Flex/Ext
Ankle DF/PF

Shock absorbing mechanisms to reduce impact forces

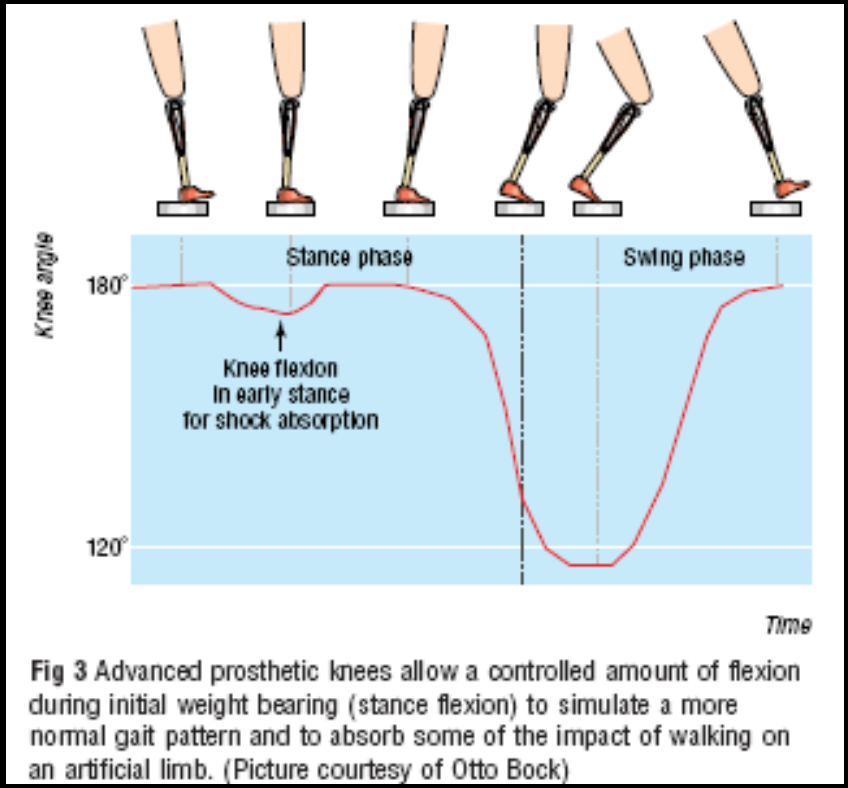


Fig 3 Advanced prosthetic knees allow a controlled amount of flexion during initial weight bearing (stance flexion) to simulate a more normal gait pattern and to absorb some of the impact of walking on an artificial limb. (Picture courtesy of Otto Bock)

Linda J Marks, John W Michael. BMJ 2001;323:732–5Clinical review: Science, medicine, and the future, Artificial limbs

M/29 SDS

AK Hydraulic Knee

Outcomes of Prosthetic Rehabilitation

Swing and Stance Phase Control

Mauch Knee

C-leg

Rheo knee

Recent Advances in Transfemoral Prosthesis – Stance Phase Control

Recent Advances in Transfemoral Prosthesis – Stance Phase Control

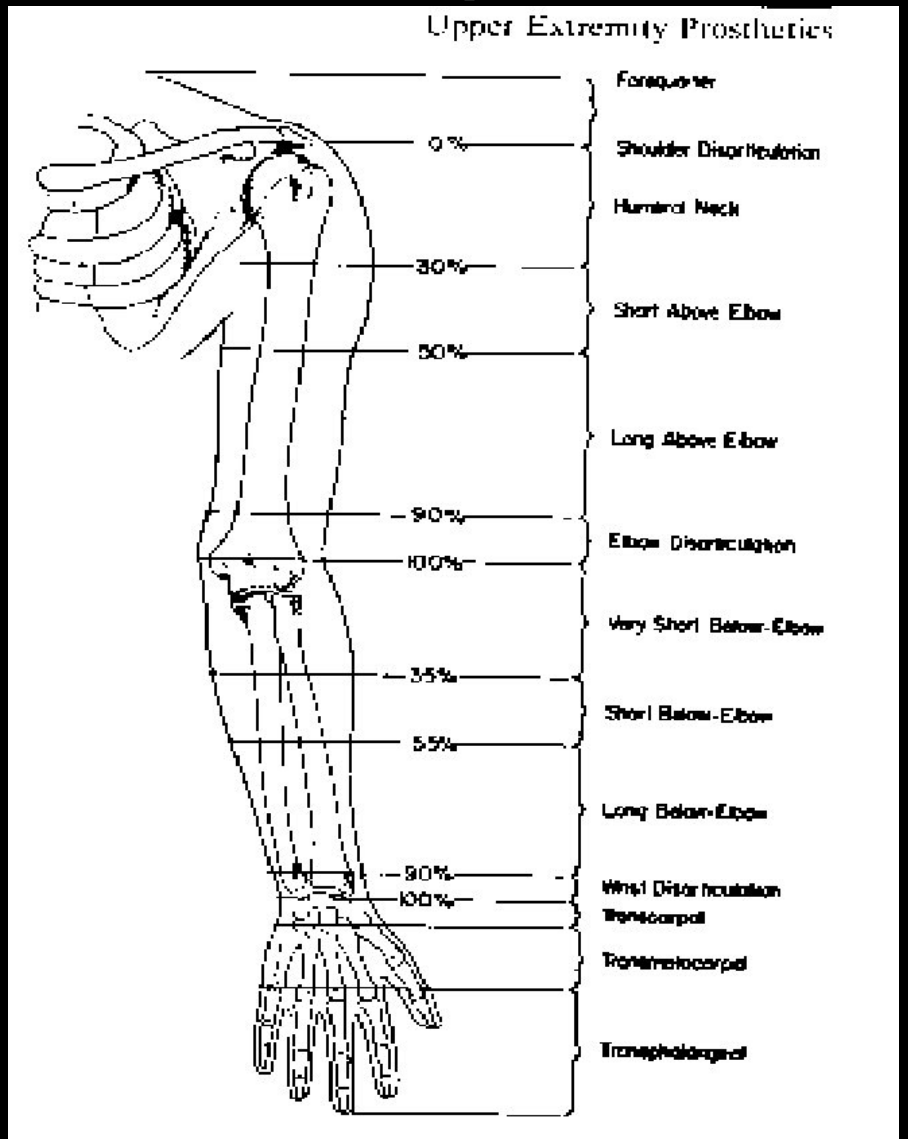
Microprocessor controlled movement

Mountain Climber


72

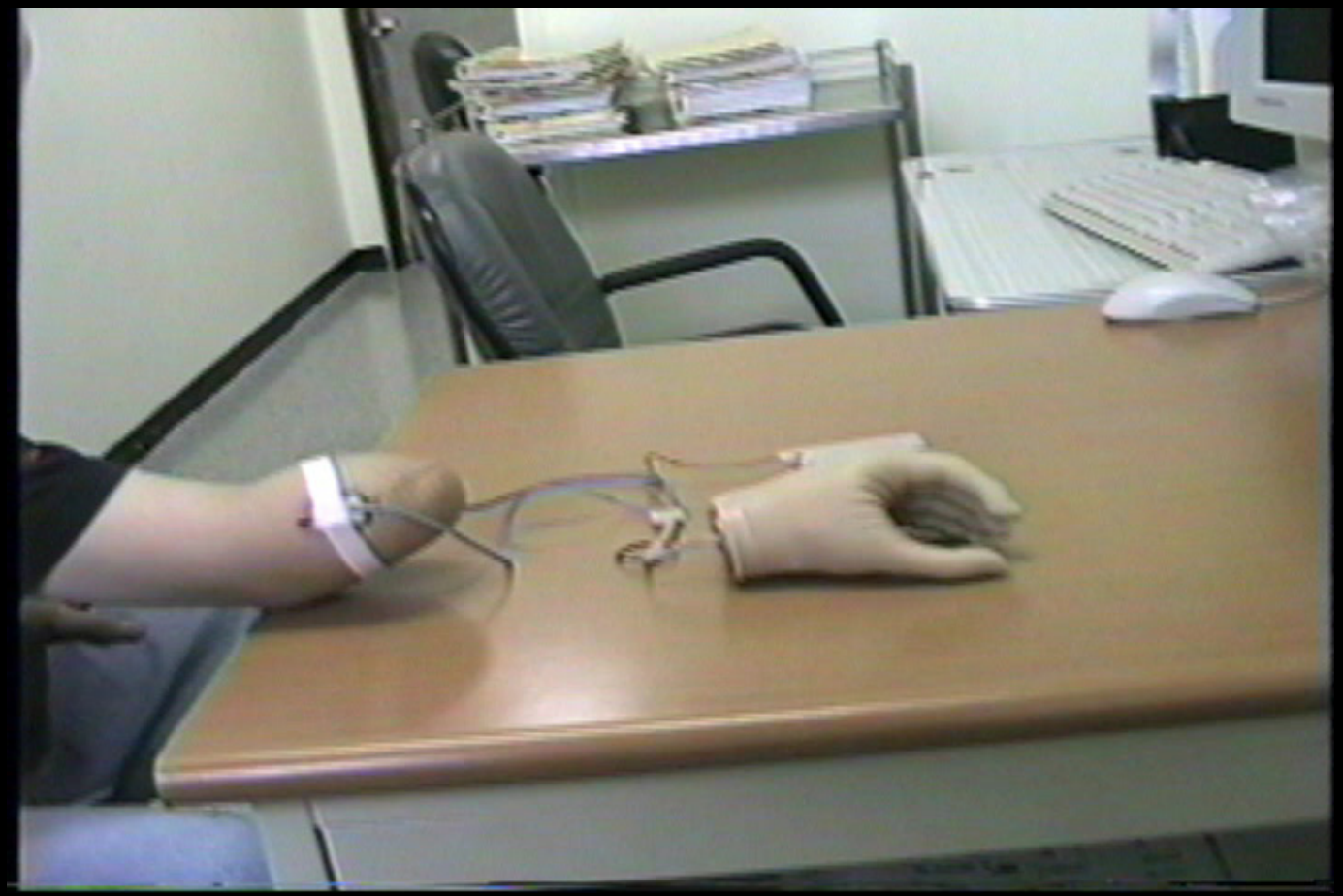
상지 의지

Level of Amputation in U/E



Upper Limb Prosthesis

Myoelectric Hand Video Clip



Prosthetic Checkup & Modification

Prosthetic Checkup & Modification