



# **BIOMECHANICS AND KUNG FU: BRINGING TRADITIONAL MARTIAL ARTS AND PROSTHETICS TOGETHER**

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**INTERNSHIP LOCATION: NEXT STEP PROSTHETICS**

# RESEARCH QUESTION

- Is there a mechanical barrier in current prosthetics that dissuades prosthetic users from participating in certain activities that require high ankle mobility?
- Can that barrier be overcome by intentional selection of specific prosthetic parts?



# SIGNIFICANCE

- Opens up new forms of physical activity by reducing physical barriers
  - Kung fu and other martial arts
  - Yoga
  - Anything that requires complex ankle flexibility
- Overcoming physical barriers sets the stage for overcoming mental barriers and increasing quality of life



# WHAT IS THE GOAL?

- Increase ankle flexibility for martial stances
- **Stances:** Combinations of weight distribution, foot orientation, and body position adopted during martial arts
- Used for building strength and flexibility, rooting into the ground, and supporting strikes

# THE FURIOUS FIVE

- Balance Stance
- Horse Stance
- Bow Stance
- Cat Stance
- Twisted Stance



# BOW STANCE

- **Bow Stance:** Consists of a narrower ‘front’ stance in which the front knee is over the front ankle and the back heel is planted into the ground for support



# CAT STANCE

- **Cat Stance.** Similar to balance stance the ball of the raised foot is lightly placed on the ground and the stance holder sinks on their back leg.

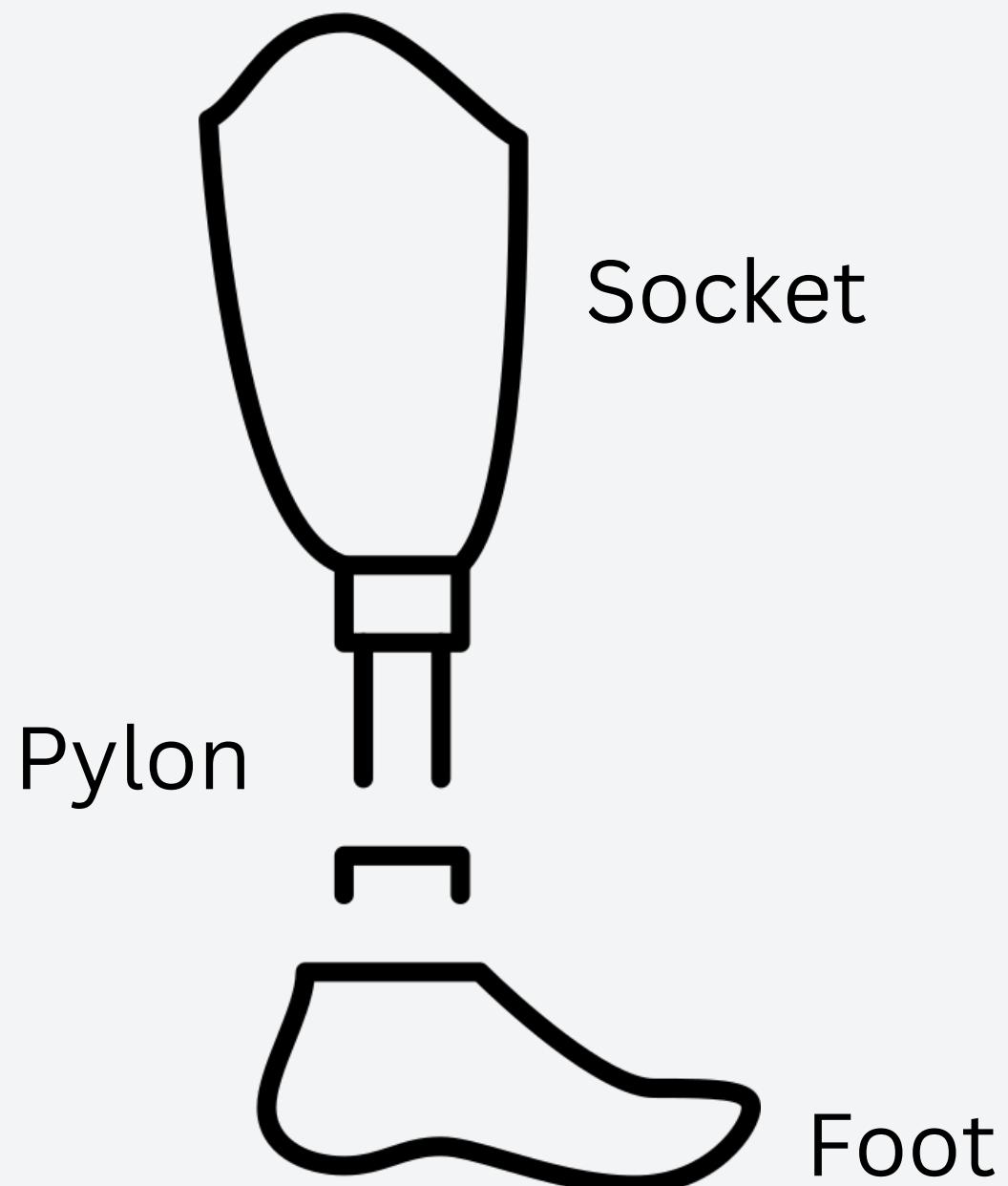


# TWISTED STANCE

- **Twisted Stance:** The back foot is raised to the ball of the foot, front foot twists outward so the toes point perpendicular to the back foot's toes.



# ANATOMY OF A LOWER LIMB PROSTHETIC

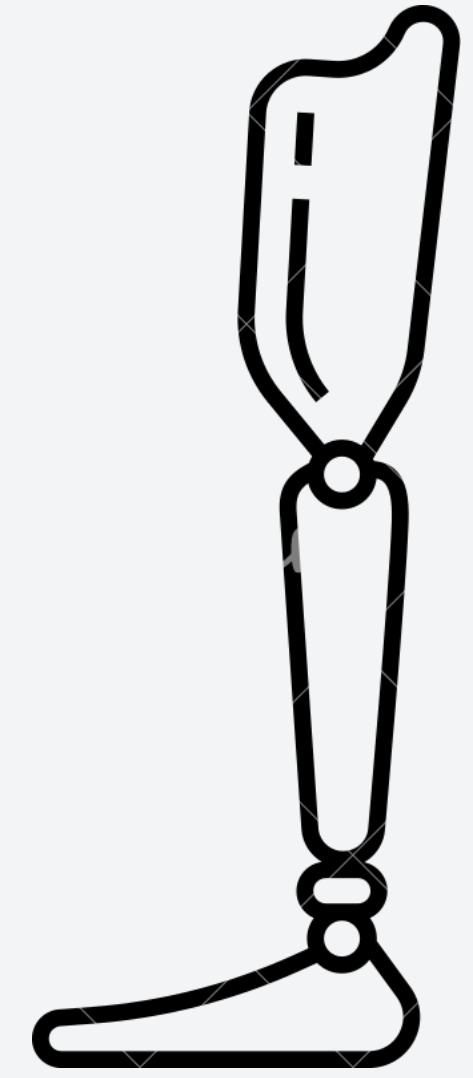


# TYPES OF SOCKET

- *Suction*: Passive suction holds the socket on the residual limb.
- *Vacuum*: Similar to suction sockets, vacuum sockets have an active one-way valve to create a vacuum.
- *Pinlock or Strap*: Both are very similar, the liner has a small adapter that has either a pin that locks into the socket or a strap that is used for holding the socket in place.

# TYPES OF JOINT

- *Rigid*: Immobile joint, uncommon except for pirate cosplay
- *Mechanical*: Joints that only bend when weight is applied in the correct area.
- *Microprocessor*: Computer-assisted joints where a micro-processing unit changes the resistance of the joint based on the gait cycle
- *Power*: A motorized joint, similar to a microprocessor but with actual motors assisting with joint movement.



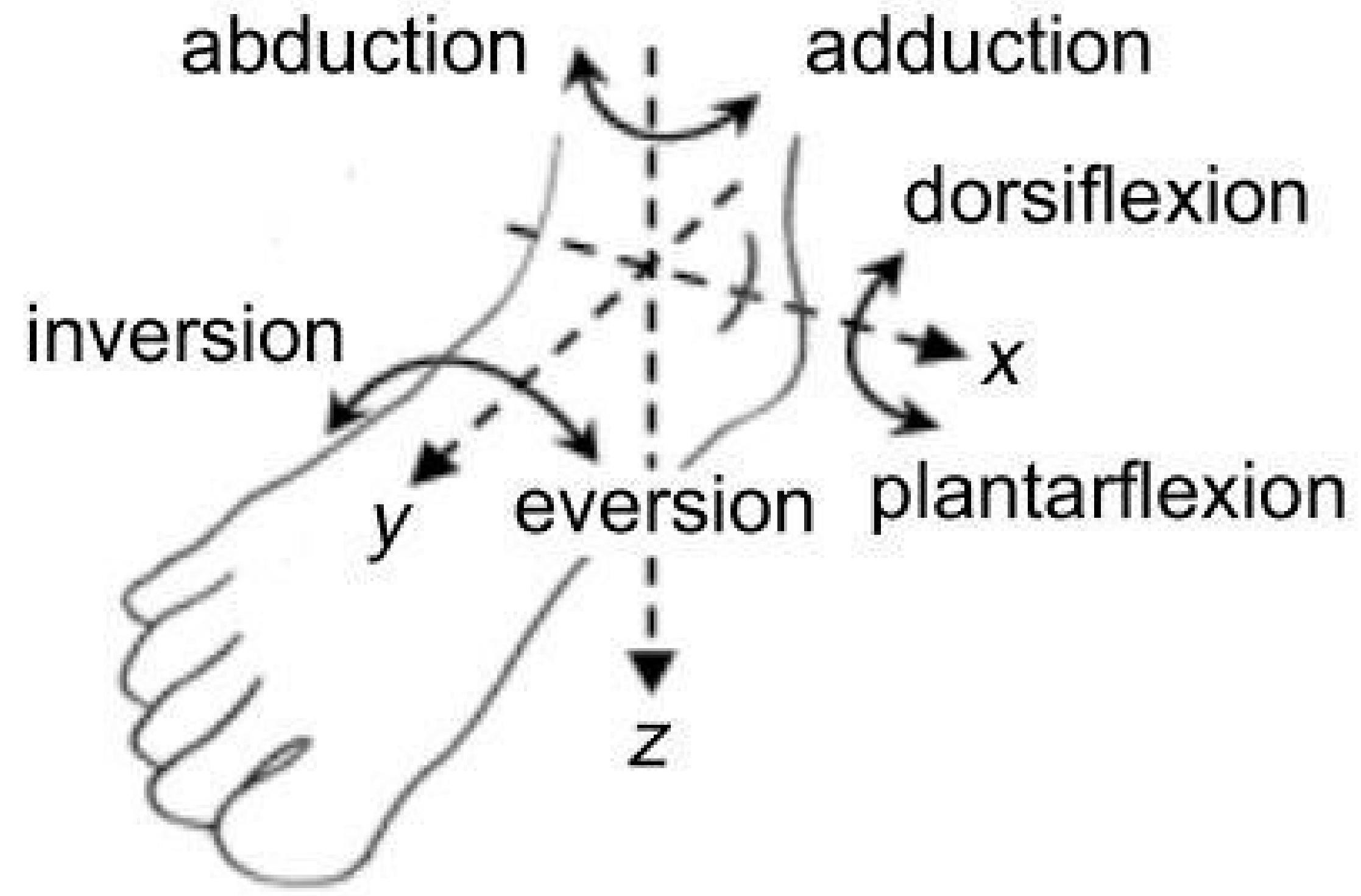
# TYPES OF FEET

- *Solid Footplate*: Singular Footplate
- *Bifurcated Footplate*: The footplate is split into two that provides extra ankle mobility.
- *Running Blade*: Long, curved, “blade” that mimics the spring power of a biological leg when running.



# THREE PLANES OF MOTION

- Transverse Plane: z
- Sagittal Plane: x
- Coronal Plane: y



# METHODOLOGY

01

PARTICIPANT SELECTION

02

DATA COLLECTION

03

COMPARISON AND HYPOTHESIS

04

TESTING SOLUTIONS

# DATA COLLECTION

- Asked each of my 3 participants to hold each stance while I collected information via a goniometer
- Because stances are asymmetrical I measured the front and back ankles in both versions (right and left)
- 27 measurements per side, with two sides for each of the three participants, led to a total of 162 ankle measurements.

# DATA COLLECTION



# DATA COLLECTION: RESULTS

Stance	Foot	Range on Coronal Plane	Average	Range on Sagittal Plane	Average
<b>Bow</b>					
Front	Front	2.667° - 18.333° of inversion	12.611°	0.667° - 8° of dorsiflexion	4.555°
	Back	43.333° - 20° of inversion	31.805°	3.333° - 11.667° of dorsiflexion	6.236°
<b>Cat</b>					
	Front		N/A		
	Back	0°	-	20° - 29.833° of dorsiflexion	24.528°
<b>Twisted</b>					
	Front	6.333° - 37.667° of eversion	20°	16° - 20.333° of dorsiflexion	18.389°
	Back	0°	-	1.333° - 17.333° of dorsiflexion	8.778°

# CONCLUSION AND HYPOTHESIS

At Any Given Time an ankle would need around

- $12.492^\circ$  of dorsiflexion
- $22.208^\circ$  of inversion and  $20^\circ$  of eversion $^\circ$

Average angles needed for the gait cycle (walking) are

- $5^\circ$  of dorsiflexion
- $0^\circ$  of inversion
- $0^\circ$  of eversion
- Largest Limiting factor: Dorsiflexion



# OPTION 1: SIDEKICK (SPACER REMOVED)

- ~13.5° Of Dorsiflexion
- Unique toe structure could be useful for twisted stance
- Not for daily use
- Will not automatically reset to neutral position



# OPTION 2: PROFLEX

- ~ 12.5° Of Dorsiflexion
- Comfortable for daily usage
- Toe structure will make twisted stance more difficult



# OPTION 3: RUNNING BLADE?

- Allows for stance work without a foot
- Comfortable enough for long periods of use
- Not for daily use
- Medial/lateral support through rocking on the blade.



# POSSIBLE NEXT STEPS

- Increase research on what prosthetic ankles are currently capable of
- Develop a unique ankle with an adjustable resistance
  - Adjustable dorsiflexion
  - Medial/lateral support
  - Different toe shape



# **ACKNOWLEDGMENTS**

Mike Kayser

Sifu Banks

Sheri Jordan

Maggie Lewis

Erin Kayser

LaoShi Harrison

LaoShi Combs

# **THANK'S FOR WATCHING**

Any Questions?

