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IEEE SA 3D BODY PROCESSING INDUSTRY CONNECTIONS

FUNCTIONAL ANATOMY, TERMS, AND COMMON FOOT CONDITIONS

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FUNCTIONAL ANATOMY, TERMS, AND COMMON FOOT CONDITIONS

INTRODUCTION AND ABSTRACT

This paper provides a brief overview of some important functional anatomy terms and concepts from a medical perspective. The scope of this paper is not to serve as a comprehensive review of all the factors that are important in footwear design but to introduce functional anatomical and biomechanical terms and concepts along with a brief discussion of the most common foot conditions and their relevance to the health implications of footwear. This paper is considered a companion paper to IEEE SA 3D Body Processing Industry Connections *Comprehensive Review of Foot Measurements Terminology in Use* paper.

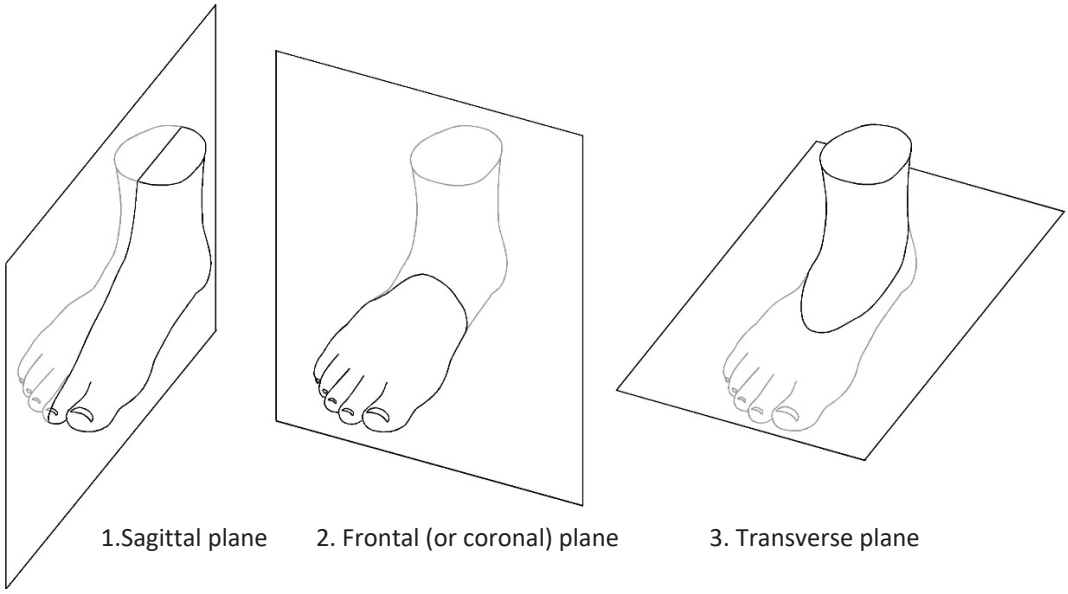
Footwear has been customized to address pain and pathology since shoes were first worn. Medical professionals (and some bespoke footwear manufacturers) currently provide this service for those with foot pathology but the emerging technologies will enable more access to custom footwear on a dramatically larger scale. Many early adopters of mass customized footwear will likely have foot conditions that have not been satisfactorily addressed with off-the-shelf shoes. Footwear manufacturers and retailers cannot be expected to diagnose and treat medical conditions but nevertheless, those providing custom footwear will need a basic understanding of some anatomical and biomechanical concepts.

To follow are sections on terminology, functional anatomy, biomechanics, and common conditions of the feet. The terms and concepts discussed in this paper can be found in most medical textbooks on anatomy and the musculoskeletal system. The references used for this overview are listed at the end of the paper and numbered as [1], [2], [3], [4], [5].

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1. TERMINOLOGY OF ORIENTATION AND MOTION

There are three cardinal planes that are used as reference points for describing orientation and motion. An anatomical plane can be thought of as a 2D slice through the 3D human body. Each of these imaginary planes has an axis through the center of the body that divides the body in half. The three cardinal planes can also be applied to anatomical segments such as a limb or the foot. In the context of this paper, we will describe the planes of the foot (FIGURE 1).



1.Sagittal plane 2. Frontal (or coronal) plane 3. Transverse plane

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1. **Sagittal plane** divides body into left and right halves. Motions in the sagittal plane are flexion and extension for the foot.
2. **Frontal** (or **coronal**) **plane** divides body into front and back halves. Motions in the frontal plane are inversion and eversion for the foot.
3. **Transverse plane** divides body into top and bottom. Motions in the transverse plane are abduction and adduction for the foot.

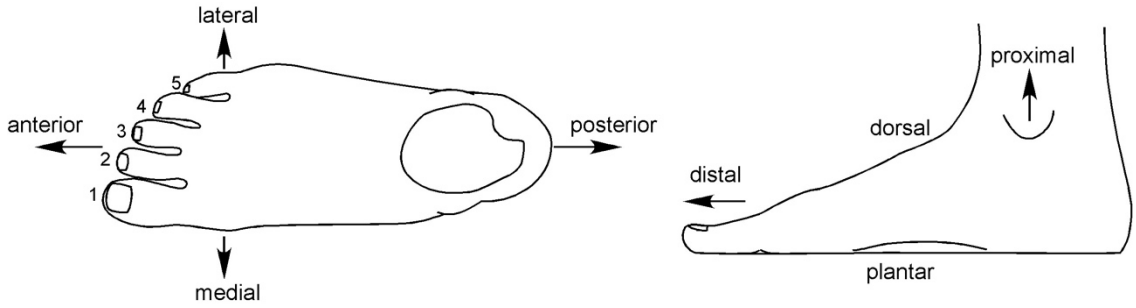
FIGURE 1 Cardinal Planes as shown on the foot

Orientation terms are useful to provide location and reference points when discussing anatomy (FIGURE 2). The terms "**media**l" and "**latera**l" refer to the sagittal plane axis. Medial means toward the midline and lateral means away from the midline. The big toe side of the foot is referred to as the medial side and the little toe is the lateral side. The terms "tibiale" and "fibulare" are occasionally used as synonyms for medial and lateral respectively since the tibia bone of the lower leg is medial and the fibula is lateral.

"**Distal**" and "**proximal**" are also used in reference to the trunk or the transverse plane axis. Distal means farther away from the trunk while proximal means closer to the trunk. For example, the toes are distal while the heel is proximal. The top of the foot is referred to as "**dorsa**l" and the bottom as "**plantar**." The digits are numbered 1–5 medial to lateral. The front of the lower leg and ankle are referred to as **anterior** and the back as **posterior**.

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Superficial and **deep** are used to describe structural locations in relation to the anatomical surface**.** For example, the bones are deep to the skin and the skin is superficial to all other structures. Each of the terms can also be used in reference to other structures. For example, the arch is distal to the heel and the fourth digit is lateral to the second digit.



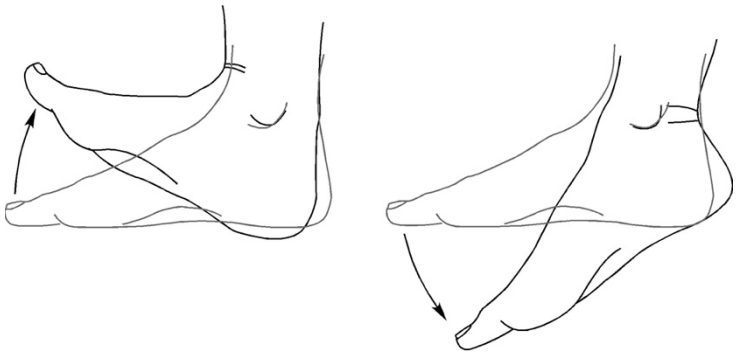
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FIGURE 2 Terms of Orientation

Motion

Motion terms are useful when describing movement of the segments of the foot and ankle. Because there are 33 joints in each foot, movement is very complex and many joints function together to create motion in more than one plane at a time and these motions occur rapidly in precise sequences during each foot step. Each of the terms described below are paired with a second term in order to describe movement in opposite directions.

Flexion and extension are motions in the sagittal plane (FIGURE 3 and FIGURE 4). Flexion refers to a movement that decreases the angle between two segments while extension increases the angle. For example, bending the knee is flexion (the angle between the thigh and lower leg is decreased) and straightening the knee is extension (the angle between the thigh and low leg is increased). In the foot and ankle, more specific terminology is required because there are so many segments that can be used as reference points. In the foot and ankle, "**dorsiflexion**" and "**plantarflexion**" are used. Dorsiflexion of the ankle or toes refers to bending the ankle or toes up (or towards the dorsal surface of the foot) while plantarflexion refers to bending the ankle or toes down (or towards the plantar surface of the foot).



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FIGURE 3 Dorsiflexion and plantarflexion of ankle joint

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