Official Tricklining Rulebook

Of The

AMERICAN
TRICKLINE
ASSOCIATION

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Introduction

This document describes the rules and procedures for trickline competitions certified by the American Trickline Association. Any competition that has been designated as an official American Trickline Association sanctioned event must adhere to all of the rules and procedures listed in this document with no exceptions.

Scoring System

Fundamental Principles

The American Trickline Association scoring system follows the fundamental principles described below. Amendments to the rules and procedures may be made insofar as they continue to uphold these fundamental principles.

This system must **measure the skill of tricklining** – Tricklining is the act of performing complex body movements on a slackline hereafter referred to as "tricks." The skill of tricklining is defined in greater detail below.

This system must be **accurate –** meaning that the most skillful trickliner should always be ranked first, the second most skillful trickliner should always be ranked second, and so on.

This system must be **fair** – meaning that an athlete's rank should not depend on the specifics of the competition structure (such as where they are placed in a bracket).

This system must be **numerical –** meaning that the system must provide clear guidelines for assigning a numerical score to an athlete's performance.

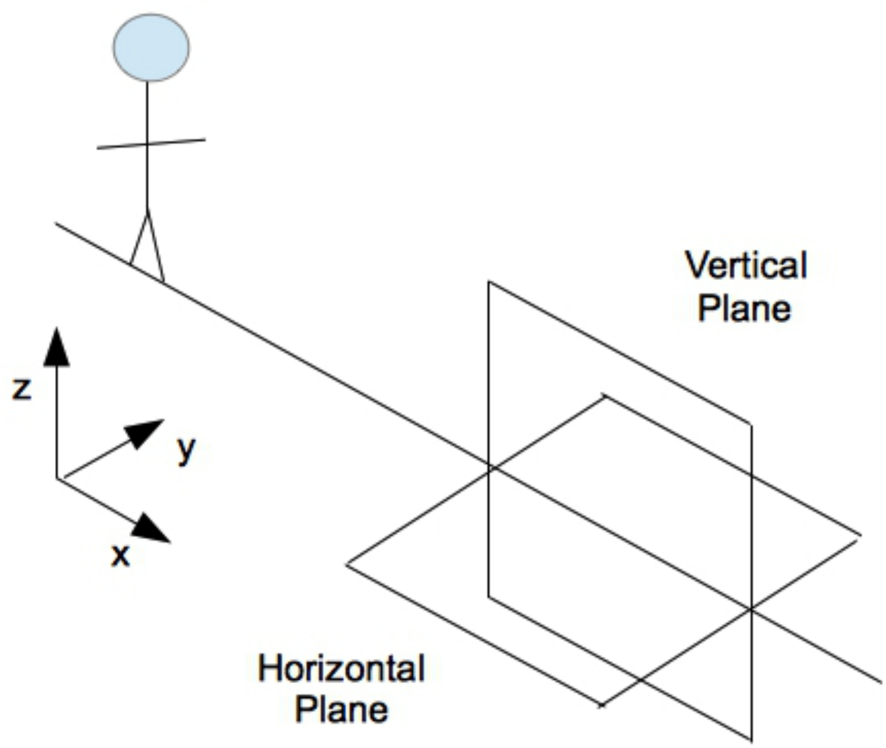
This system must be **transparent** – meaning that the scoring system must be publicly available and understandable to any person inclined to read the rulebook in its entirety.

The Skill of Tricklining

Tricklining is defined as the act of performing complex body movements on a slackline in a competitive setting. These body movements are hereafter referred to as "tricks." A trick corresponds to a well-defined, identifiable body movement. Tricks can be performed in immediate succession to form difficult sequences of tricks hereafter known as "combinations" or "combos." A combination can always be broken down into a sequence of individual tricks. The most skilled trickliner is the trickliner who consistently performs the widest variety of the most difficult tricks and combinations. An athlete's score is directly related to the difficulty of the tricks and combinations they perform.

Technical Specifications

It is necessary to define technical terminology that will be used throughout this document. Key planes and axes are defined in the diagram below.



Classification of Tricks

Slackline tricks can be placed into three categories. These categories are general, meaning they have no mention of specific tricks, and they are complete such that any particular trick must fall into exactly one of these categories. Any trick that seems to fall into multiple categories is considered a "combination" and should be broken into more basic movements that fit into exactly one category.

Contact – Contact tricks are movements in which the line exerts a non-zero upward force on the athlete throughout the execution of the trick. The athlete is in some way supported by the line for the duration of the trick.

Air – Air tricks are movements performed while the line is not applying a supporting force on the athlete. During the execution of these tricks the athlete travels through the air and is typically not in direct contact with the line.

Mounts and Dismounts - A mount is a movement in which the athlete begins on the ground and ends on the line. A dismount is a controlled movement in which the athlete begins on the line and ends on the ground.

The contact and air categories can be further divided into subcategories.

Subcategories of Contact Tricks

Static - Static tricks are stationary positions assumed on the line. During the execution of a static pose there is no energy transfer between the line and the athlete although there is a non-zero upward force applied on the athlete by the line.

Examples of static tricks are: Buddha, Plane, Elbow-Lever

Bounces - Bounces are any movement or position assumed while energy is transferred between the line and the athlete. Without energy transfer the move is considered static. An athlete must transfer enough energy to the line to completely lose contact with the line for an observable period of time for the movement to be considered a bounce. Bounces are transition tricks because they can always be followed by air tricks.

Examples of bounces are: Buttbounce, Chestbounce, Backbounce

Dynamic – Dynamic tricks are tricks that involve energy transfer in the X and/or Y direction and body motion in the horizontal and/or vertical planes. They may or may not involve upward and/or downward energy transfer between the athlete and the line.

Examples of dynamic tricks are: Cartwheel, Forward Roll, Inward Dropknee Twist

Subcategories of Air Tricks

Grabs – Grabs are movements in which the body is placed in a position other than the takeoff or landing position while in midair.

Rotations – Rotations are movements in which the body rotates about one or more of its internal axes.

Defining "Difficulty"

A trickliner's skill is, in part, determined by the "difficulty" of the tricks and combinations that they perform. To assign a numerical value to an athlete's performance, each trick must have a numerical value associated with it and there must be a formulaic method for combining these values. Furthermore, to accurately measure the skill of tricklining, the value must be directly related to the underlying "difficulty" of the trick.

Difficulty is often used in a subjective and personal sense, for example "trick A is difficult **for athlete A**." This rulebook uses the term "difficulty" to refer to underlying "objective difficulty." It is not possible for any person to **directly** assign a meaningful numerical value to the difficulty of a trick because that value will always reflect their personal opinion of the trick. Each trick must be assigned a value **indirectly**, by breaking it down into the specifics of what makes the trick difficult and objectively assigning values to these properties. To achieve this, a set of "difficulty dimensions" is defined for each category of tricks. Each trick within a category is given a score along each of the dimensions defined for that category. The dimensions are normalized such that the highest value a trick can receive in any dimension is "1" and the lowest value it can receive is "0." These normalized scores are treated as independent components of a "difficulty vector" and the point value for each trick is calculated by finding the magnitude of the difficulty vector. This strategy allows new tricks to be scored quickly and methodically and it avoids unproductive discussions over difficulty values for particular tricks, which can be fraught with personal opinion.

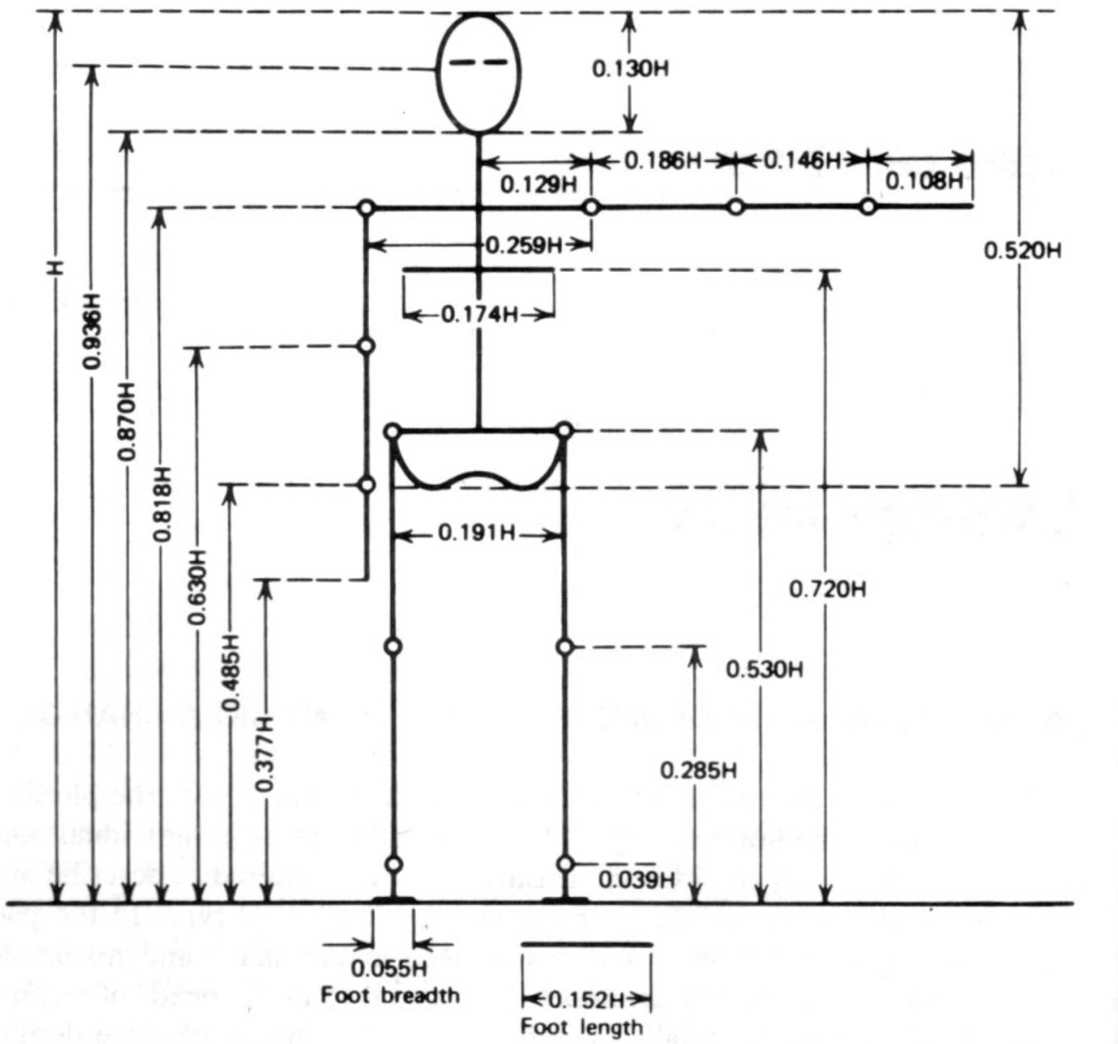
Objectively, there are two main factors that contribute to the difficulty of a trick. A trick can be difficult for physical reasons (the laws of physics dictate that particular positions are less stable than others, or that some moves require more energy than others) or for biomechanical reasons (muscle tissue in human arms cannot apply as great a force as muscle tissue in the leg, it is difficult to spot a landing because of the position of the human eyes in the skull). Each of the more specific "difficulty dimensions" below are derived from one of these two factors; the factor is explicitly stated as the dimension's "factor type." Because each dimension is derived from one of these objective factors it is possible to objectively assign each trick a value along each dimension.

Each trick has been placed into one of the categories above and has been computationally modeled along the applicable dimensions. If a more detailed study of tricks is conducted these values should be updated to reflect the new data.

The method of determining trick difficulties described above is sufficient to fix the relative difficulty of tricks within a category. In order to compare tricks across categories one trick in each category is designated as the "**unit trick**." Unit tricks may be thought of as the quintessential trick in each category and the difficulty of each unit trick is considered to be equivalent to one another. Selecting unit tricks is one source of subjectivity in this system. To minimize the impact of any individual opinion, the unit tricks will be decided by polling the trickline community and may be adjusted from time to time.

The Human Body

To reason about the difficulty of tricks, it is necessary to have a clear model of the human body upon which assumptions and calculations may be based. The basic ratios of all major body segments to the height of the body are given in the diagram below from Drillis and Contini "*Body Segment Parameters*" 1966.



Contact Tricks

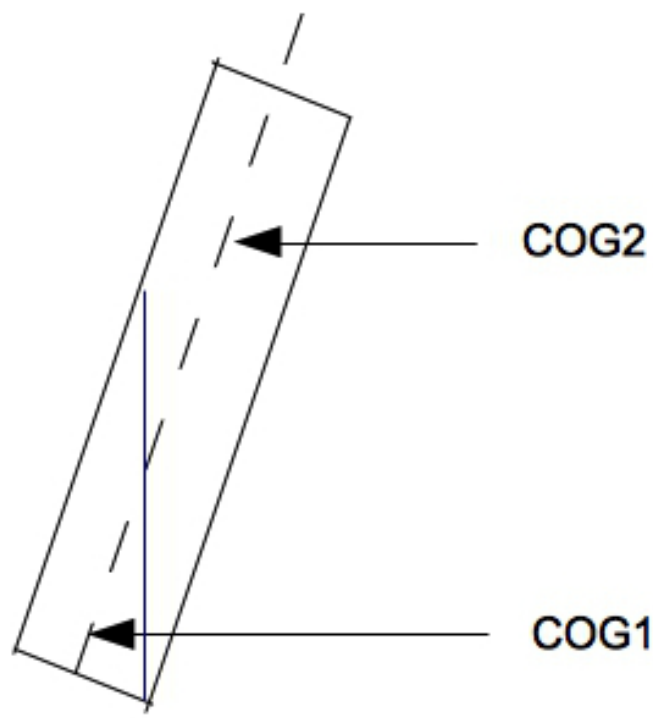
The difficulty dimensions for contact tricks are described in detail below.

Center of Gravity

Factor Type – Physical

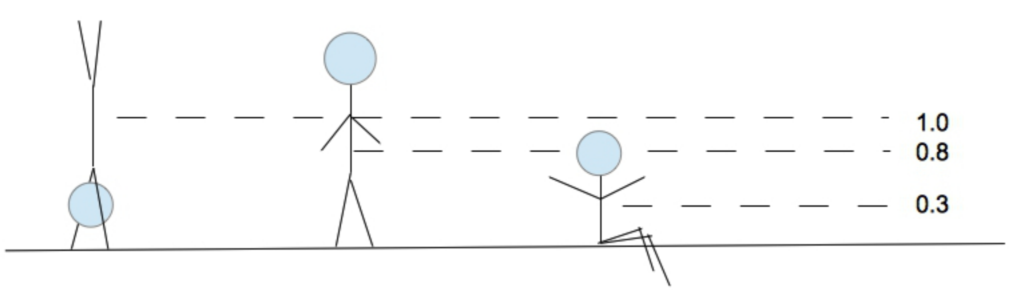
Definition - The position of the athlete's center of gravity along the z-axis relative to the line during the execution of the trick.

How it Determines Difficulty – An object experiences a tipping force if its base of support is not directly beneath its center of gravity. Depending on how far the object tips and the location of its center of gravity, the force of gravity may act to restore it to its original position (as a stabilizing force) or to tip it (as a destabilizing force). Stability is determined by the amount an object can tip while still experiencing a stabilizing gravitational force. For the same angular shift a higher center of gravity is more likely to result in a destabilizing force. The diagram below shows an object in an unstable position. If the object's center of gravity is at COG1 it experiences a stabilizing force. If its center of gravity is at COG2 it experiences a destabilizing force.



Thus, one component of the intrinsic stability of a position is determined by the height of an athlete's center of gravity in that position.

How to Score - The maximum height of an athlete's center of gravity is attained when the athlete performs a fully outstretched one-arm handstand. This position places the heaviest parts of the body highest above the line. To score a trick in this dimension, compare the athlete's center of gravity while executing the trick to the maximum possible center of gravity. The resulting fraction gives the score for center of gravity.



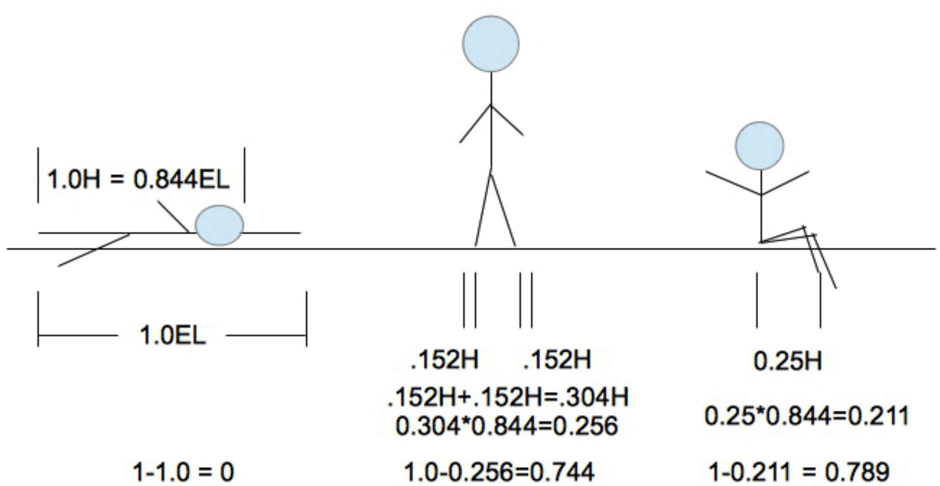
Area of Contact

Factor Type – Physical

Definition – The total area of the athlete's body that is in direct contact with the line during the execution of the trick.

How it Determines Difficulty – When an athlete is in direct contact with the line the downward force of their weight is applied to the line through the parts of the body that make contact with the line. The line, in turn, applies an equal and opposite force to the athlete through their body such that he or she is able to maintain his or her position above the line. The athlete uses the force of the line to maintain his or her balance. A large area of contact gives the athlete many options for controlling and correcting his or her movements. Thus a trick with a large area of contact implies less precision is necessary.

How to Score – The maximal area that can be in contact with the line is achieved when the athlete lays flat on the line with an arm outstretched in contact with the line (this is referred to as an athlete's extended length or "EL"). In this position the athlete's entire span is in contact with the line. To score a trick in this dimension, compare the total area of contact during the execution of the trick with the maximal area. Subtract this fraction from one to arrive at the score for area of contact. To find the area of contact of a particular trick use the body segment parameters above in conjunction with the conversion from height (H) to extended length (EL) calculated in the appendix.



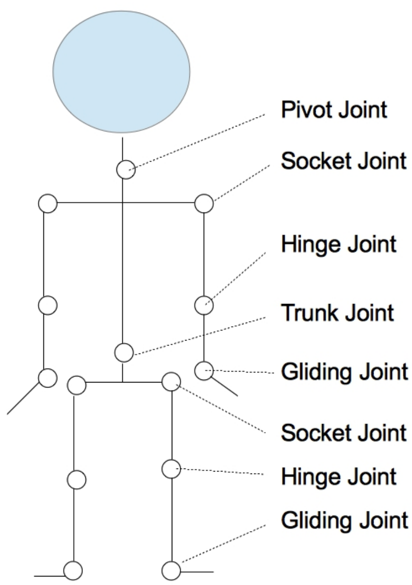
Freedom of Center of Mass

Factor Type – Biomechanical

Definition – The volume that the center of mass of the athlete can be moved through by adjusting his or her free body segments while performing a trick. Free body segments are segments that are not restricted to a position by virtue of executing the trick.

How it Determines Difficulty – The human body is not a rigid object. Moving a body segment causes the athlete's center of mass to shift. As long as the athlete's center of mass remains above their base of support they will stay on the line. This category measures how much freedom the athlete has to move his or her center of mass to correct destabilizing forces.

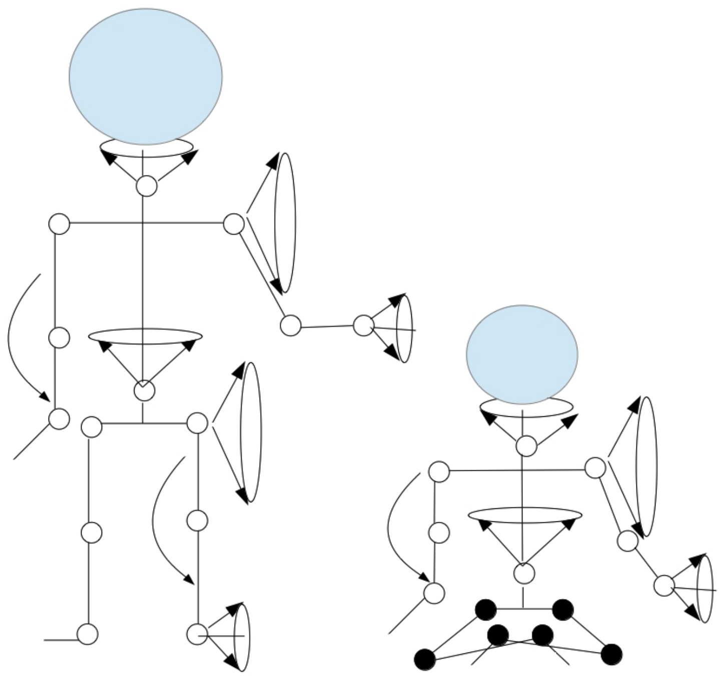
How to Score – The maximum freedom of an athlete's center of mass occurs when none of the athlete's joints or segments is restricted (this is referred to as complete freedom or "CF"). To score a trick in this dimension, determine the amount the athlete can shift his or her center of mass while executing the movement in question. Divide the freedom of mass during the trick by the maximal freedom and subtract from one to score this category. Ideally, measurements of the freedom of mass should be expressed as a volume that constrains the athlete's center of mass. Calculating this volume is fiendishly difficult in practice so we approximate it by summing the distance or area that the center of mass of each free segment can move through. Our model of the human body is made up of 5 types of joints each with different ranges of motion.



Type of Joint	Range of Motion θ	Range of Motion φ
Pivot Joint	180 degrees	180 degrees
Socket Joint	270 degrees	225 degrees
Hinge Joint	135 degrees	0 degrees
Trunk Joint	225 degrees	180 degrees
Gliding Joint	180 degrees	90 degrees

The freedom of mass of a segment is determined by the range of motion of the joint that a free segment is connected to and the mass of the free segment. To compute the freedom of mass of a particular segment, locate the segment's proximal joint and multiply the range of motion of the joint together with the distance from the joint to the center of mass of the free segment (in our model this is always ½ the length of the segment) and the mass of the free segment. This calculation is described by the equation below where ROM_θ is the range of motion of the joint in the theta direction, ROM_ϕ is the range of motion of the joint in the phi direction, l_{COM} is the distance from the joint to the center of mass of the segment, and m is the mass of the segment. (Note: hinge joints have only a single degree of freedom and therefore only admit motion in the theta direction. When computing the freedom of mass of a segment attached to a hinge joint, only the ROM_θ should be considered).

$$FOM_{segment} = ROM_\theta ROM_\phi l_{COM} m$$



Representation of Complete Freedom   Representation of Freedom of Mass During Buddha

Dynamic Tricks

During a dynamic trick the athlete moves his or her body through a series of positions. It is possible to compute a difficulty score using the dimensions above for each position in the series however there is no obvious way to select a single position for which to compute the trick's score. As such, the difficulty of a dynamic trick is computed by finding the positions in the sequence that maximize each difficulty dimension and using these maximum values as the components of the trick's difficulty vector. This is expressed mathematically as follows where v_i is the difficulty vector of a single position in the sequence and V is the overall difficulty vector of the dynamic trick.

$$v_1 = [\, v_{11}, v_{12}, \dots, v_{1n}]$$
$$\vdots$$
$$v_k = [\, v_{k1}, v_{k2}, \dots, v_{kn}]$$
$$V = [\max(v_{11}, \dots, v_{k1}), \dots \max(v_{1n}, \dots, v_{kn})]$$

Air Tricks

The difficulty dimensions for air tricks are described in detail below.

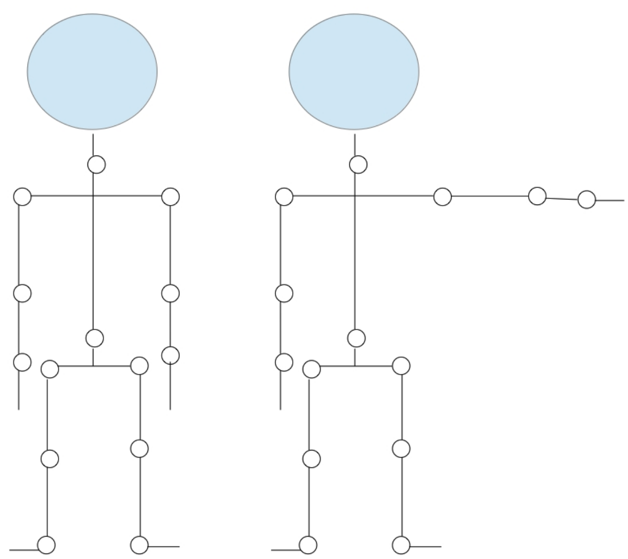
Degree of Extremity

Factor Type: Biomechanical

Definition – A measurement of the position of the body relative to its resting position when a grab has been fully assumed.

How it Determines Difficulty – Each joint in the human body has a finite range of motion determined by the type of joint, the body tissue surrounding the joint, and the length of the muscle that spans the joint. It is more difficult to move a body segment near the extremities of its range of motion than to keep it close to its resting position.

How to Score – There are over 200 joints in the human body. Accounting for the positions of each of these joints during a trick is impractical. Instead we only consider the position of the major joints included in the following set – {Neck, 2x Shoulder, 2x Elbow, 2x Wrist, Trunk, 2x Hips, 2x Knees, 2x Ankles}. Each joint in this set has between one and three degrees of freedom that allow the distal body segment to flex/extend, adduct/abduct, and rotate medially/laterally. The maximum degree of extremity occurs when all joints are oriented such that they are at the edge of their range of motion along each degree of freedom. To score a trick in this dimension divide the position of each joint along its degrees of freedom by the magnitude of the maximal position along that degree of freedom, sum the results, and divide by the maximal degree of extremity.



Body at Rest
Zero Extremity

Left Arm Abducted
Non-Zero Extremity

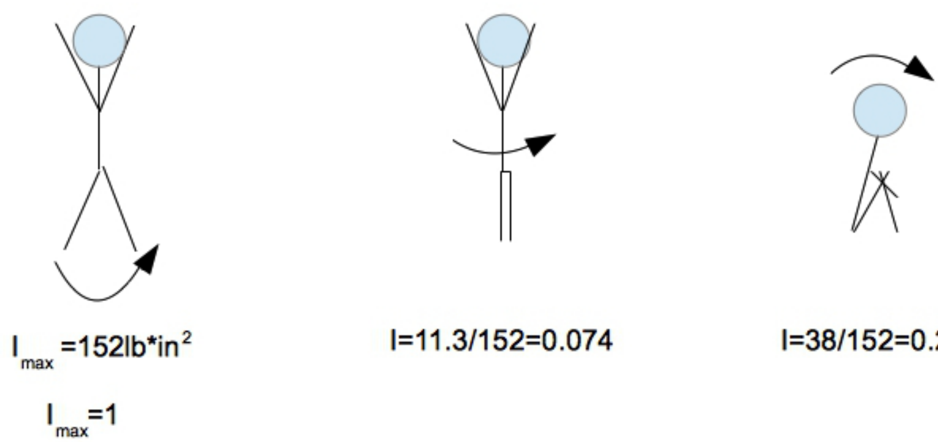
Rotational Inertia

Factor Type - Physical

Definition – A measurement of the rotational inertia of the human body in a particular position. The rotational inertia of the body does not impact the difficulty of a trick unless the athlete actually rotates during the trick. Thus, this dimension only applies when the athlete performs a rotation and the amount and direction that the athlete rotates determines how much this dimension contributes to the point value of the trick.

How it Determines Difficulty – Rotational inertia is a physical measure of an object's resistance to rotation. It is determined by the distribution of mass about the axis of rotation. The further the mass is from the axis of rotation, the larger the rotational inertia, and the more difficult it is to perform a rotation. An athlete can adjust his or her rotational inertia during the execution of a trick by changing his or her body position.

How to Score – The maximal rotational inertia of the human body is achieved when an athlete is in the spread eagle position, rotating about their frontal axis (through the navel). To score a trick in this category first calculate the rotational inertia of the body about each primary axis of rotation (x, y, and z) and divide it by the maximal rotational inertia. These normalized moments of inertia measure how difficult it is for an athlete to rotate about each of their primary axes relative to the most difficult rotation a body can perform.



When an athlete performs a rotation, count the number of turns the athlete makes about each of their primary axes. Multiply the number of turns about an axis by the normalized rotational inertia of the athlete about that axis and sum the results. To account for the fact that the amount of energy required to perform a rotation increases as the square of the absolute rotation, multiply the result above by the total number of rotations. This procedure is described by the equations below where $\bar{n}$ is a 3-tuple whose components represent the total number of turns about each of the athlete's primary axes, n_T is the total number of turns, and I_x, I_y, and I_z represent the normalized rotational inertia of the athlete about the x, y, and z axes respectively.

$$\bar{n} = [n_x, n_y, n_z] \qquad n_T = n_x + n_y + n_z \qquad R(\bar{n}) = n_T[n_x I_x + n_y I_y + n_z I_z]$$

It is possible to perform any rotation in two distinct directions. In a right-handed coordinate system the directionality of a rotation is indicated by its sign (either positive or negative). The direction of a rotation has no direct impact on the difficulty of a trick and therefore does not contribute to a trick's difficulty value. However, performing the same absolute rotation in two different directions would be considered two distinct tricks and should not be subjected to the repetition function discussed below.

Execution Modifiers

Not every trick is executed the same way every time. Occasionally, an athlete may execute a trick in such a way that significantly reduces its difficulty. The score that this system assigns to a trick is designed to be directly proportional to the difficulty of the trick. To account for actions that reduce the difficulty of a trick we introduce the concept of execution modifiers. Execution modifiers can be applied to any trick and may decrease the point value of the trick. In order to accurately apply execution modifiers we must clearly define when an execution modifier is applicable. Each category of trick has its own execution modifiers.

Contact Tricks

When competing on a trickline that can be mounted from the ground it's possible for athletes to use the competition surface to help stabilize themselves when executing contact tricks. This practice, called "dabbing," makes it significantly easier to remain on the line. Since dabbing affects the difficulty of a contact trick it must also impact the difficulty value of the trick. As such, our system includes rules for applying dab deductions to contact tricks.

In order for rounds to be globally comparable, it must be very easy for all judges to agree on when a dab has occurred and on the severity of the dab. With this goal in mind, the American Trickline Association has adopted a rudimentary system for dab deductions. The formal criteria describing each type of dab is listed below. The number in parenthesis represents the deduction multiplier applied to the trick when the dab is performed.

Clean (1.0) – No portion of the athlete's body makes contact with the competition surface until after the athlete's momentum has shifted from downward to upward.

Light Dab (0.75) – The athlete makes contact with the competition surface during the down-bounce of a contact trick (before their momentum has shifted from downward to upward).

Heavy Dab (0.5) – The athlete makes contact with the competition surface during the down-bounce of a contact trick and performs a clear "pumping motion" with any of the joints that connect to the dabbing limb.

Air Tricks

Dabs, as defined for contact tricks, cannot apply to air tricks since it is impossible to contact the competition surface while executing an air trick. As such, there are no execution modifiers for air tricks. However, it should be noted that actual rotation, not intended rotation, should always be scored. Thus, if an athlete attempts a Mojo-Flat Spin and only rotates ¾ of the way around they should only be scored for ¾ of the rotation and not the full rotation.

Repetition

The ability to perform a wide variety of difficult tricks demonstrates greater skill than the ability to perform a single trick or combination repeatedly. This scoring system discourages repetition of a particular trick or combination by devaluing tricks or combos based on the number of times they have been performed. Repeated tricks are devalued according to the following repetition function where x is the number of times the trick has been performed.

$$r(x) = \begin{cases} 1 & \text{if } x = 1 \\ \dfrac{3}{2(x^2 - x)} & \text{if } x > 1 \end{cases}$$

According to this function, the second time a trick or combination is performed it is worth ¾ its original value, the third time it is worth ¼ of its original value, and so on. This function has the following important property.

$$\sum_{x=1}^{\infty} r(x) = 2.5$$

This property implies that the maximum score that an athlete can obtain by repeating a trick or combo is 2.5 times the trick or combo's original value.

Combinations

When two tricks are linked together in immediate succession they form a combination or "combo." Tricks performed in a combo are more difficult than tricks performed in isolation. As such, performing tricks in a combo nets the athlete additional points. For completing a combo and reestablishing control of the line an athlete is awarded a bonus equal to 0.5 times the combined value of the two tricks in the combo. Combos are also subjected to the repetition devaluation function.

Athletes are awarded a bonus for reestablishing control of the line after a combo. An athlete reestablishes control if they hold a single contact trick through one full period of the line's vibration or if they stop the vibration of the line without falling off. For example, if the athlete stands on the line after completing a combo and maintains contact with it while it moves through one full up-and-down cycle the combo is considered complete. Less intuitively, during a sticky-buttbounce or sticky-chestbounce the athlete also maintains contact with the line in a fixed position through a full vibrational period of the line. Thus, these tricks also signal the successful completion of a combo and the beginning of another. If an athlete does not reestablish control after a combo (for example by falling off the line) all tricks that the athlete landed according to the landing criteria below should be scored and the combo multiplier should be adjusted to from 0.5 to 0.1.

Landing Criteria

A common source of dispute when judging trickline competitions is determining whether or not an athlete "completed" a trick. In other words, "did the athlete execute the trick well enough for the trick to be scored?" As with dabs, it is important to have an objective method for deciding when a trick should be scored so that scores remain globally comparable. The American Trickline Association has adopted the following criteria for determining when a questionable trick or combo should be scored.

Contact Tricks - A contact trick is scored if the athlete rides the line through the entirety of the up-bounce of the trick. If after losing contact with the line it snaps upward the contact trick is not considered landed and should not be scored. If the contact trick is performed statically then the athlete must exit the static position and assume another stable position in order for the trick to be scored.

Air Tricks - An air trick is scored if the athlete rides the line through the entirety of the down-bounce of the contact trick that immediately follows it. At the bottom of the down bounce the athlete's velocity and momentum shift from downward to upward. If this shift does not occur the trick is not considered landed and should not be scored.

Combos - A combo is scored as complete if the athlete reestablishes control of the line after completing the combo. An athlete is considered to have reestablished control if they hold a single contact trick through one full period of the line's vibration or if they stop the vibration of the line without falling off.

How to Score a Trick

The equation for scoring a trick is presented below where $\bar{v}$ is the trick's difficulty vector, $\bar{n}$ is the trick's turn tuple, x is the number of times the trick has been executed by this athlete in this round (including the current execution), and q is the execution modifier for the trick.

$$f(\bar{v}, \bar{n}, x, q) = \begin{cases} [|\bar{v}| + R(\bar{n})] * r(x) & \text{if } q = \text{CLEAN} \\ 0.75 * [|\bar{v}| + R(\bar{n})] * r(x) & \text{if } q = \text{LIGHT\_DAB} \\ 0.50 * [|\bar{v}| + R(\bar{n})] * r(x) & \text{if } q = \text{HEAVY\_DAB} \end{cases}$$

How to Score a Combo

The equation for scoring a combo is presented below where $\bar{v}_1$ and $\bar{v}_2$ are the difficulty vectors of the first and second tricks respectively, $\bar{n}_1$ and $\bar{n}_2$ are the turn tuples of the first and second tricks, q_1 and q_2 are the execution modifiers for the tricks, and x is the number of times the combo has been executed by this athlete in this round (including the current execution).

$$F(\bar{v}_1, \bar{n}_1, q_1, \bar{v}_2, \bar{n}_2, q_2, x) = \begin{cases} 0.5 * [f(\bar{v}_1, \bar{n}_1, 1, q_1) + f(\bar{v}_2, \bar{n}_2, 1, q_2)] * r(x) & \text{if athlete reestablishes control} \\ 0.1 * [f(\bar{v}_1, \bar{n}_1, 1, q_1) + f(\bar{v}_2, \bar{n}_2, 1, q_2)] * r(x) & \text{if athlete does not reestablish control} \end{cases}$$

Adding Tricks

Tricklining is growing at a rapid rate and new tricks are landed every year. When a new trick is landed it must be placed in a category and scored along each of the difficulty dimensions within that category to produce a difficulty value for the trick. To be prepared for a competition, tricks should be scored as soon as the movement is well enough understood to be placed in a category and must be added by the time they have been landed.

Competition Format

The scoring system described in this document does not require a specific competition format to correctly order competitors. An acceptable competition format need only adhere to the following criteria.

Equal Rounds – Each athlete must be allowed to compete in an equal number of rounds during the competition.

Average Score –An athlete's final score used to determine their overall rank in the competition must be the average of at least two rounds. This requirement is meant to evaluate an athlete's consistency over the course of the competition, which is an important component of the skill of tricklining.

Sample Formats

A few sample competition formats are described below. Note that these formats are simply examples and should be treated as such; any competition format seeking sanctioning that meets the criteria above will be given due considered by the American Trickline Association.

Individual Runs – Each athlete is granted 3 two-minute runs on the line. Their overall score for the competition is calculated by averaging the scores from their best two runs. In the event of an injury scoring does not change. For example, if a competitor only completes a single run their score for the competition will be the score they received for that run averaged with zero.

3-Heat Bracket – Each athlete is paired up against two other athletes and the pairs compete head-to-head. Athletes have their own two-minute clocks that run down when they are on the line. After they step off the line their clock stops, the other athlete mounts the line, and their clock begins. The round ends when both athletes' times have expired. At the end of the heat the scores from each athlete's two runs are averaged together and the bottom 3rd of the field is eliminated. This process is repeated two more times with the results of the final heat acting as the scores that determine the overall ordering of the last 3rd of the field. Note that in this competition format we essential conduct 3 mini-competitions where each mini-competition adheres to the format criteria above.

Recording Competition Results

Every athlete's raw trick-list and a full video of their performance must be recorded for every run. This list can either be hand-written or recorded electronically. The raw trick-sequences must be recorded because changes to the valuation of tricks would invalidate old scores. To handle valuation changes the scores can be recomputed from the raw trick-sequences whenever changes are made.

Judging Certification

To become a certified judge, candidates must complete a judging certification exam. The exam will consist of scoring several rounds of competition in real time. To pass the exam the candidate's score must be within a fixed number of points of the accepted scores for the rounds and the candidate must have correctly identified all tricks. The exam must be conducted in a controlled setting in the presence of an American Trickline Association administrator.

Appeals and Amendments

Appealing a Score

Using the system described in this document, an athlete's score for a particular round can be reproduced by simply watching a video replay of the round, tallying up the athlete's movements, and composing them according to the methods described above to reach a final score. If there is a scoring dispute that could alter the outcome of the competition then the round should be reviewed. Any movement or execution may be appealed and corrected and a judge's original score will be overthrown if either a majority of the competitors agree with the claim or two other certified judges agree with the claim.

Amending the Difficulty Value of a Trick

The difficulty value assigned to a trick is not set in stone. If a member of the community believes that the difficulty value of a particular trick is incorrect they may challenge the valuation. Challenges must contain a clear description of the rationale behind invalidating the old score including which difficulty dimensions were measured incorrectly and why as well as a detailed argument supporting the new score. If a challenge to a trick's difficulty value is accepted the trick's value will be adjusted immediately.

Adding/Removing Difficulty Dimensions

As the community's understanding of difficulty evolves, it is possible that a new difficulty dimension for a category of trick will emerge or that one of the previously accepted difficulty dimensions will be invalidated. Adding or removing difficulty dimensions is an involved process that requires reevaluating all tricks that the difficulty dimension in question applies to. Adding or removing difficulty dimensions requires a written proposal describing why the change is necessary and, for new difficulty dimensions, a description of the definition of the dimension, how it determines difficulty, and how to score it (analogous to the sections describing difficulty dimensions that appear in this document). The head judge of the American Trickline Association will review the proposal and decide whether or not the proposal will be accepted. If accepted, the proposal will be put to a vote which all certified judges will participate in. The proposal will be approved if a majority of certified judges vote in its favor.

Amending this Document

The methods for combining difficulty dimensions to reach a score, scoring rotations, devaluing repeated tricks, scoring combos, and the deductions for dabs and incomplete combos may need to be adjusted over time. Changing these aspects of the system requires a written proposal that clearly describes the flaw in the original method, the new method, and how the new method addresses the original flaw. The head judge of the American Trickline Association will review the proposal and decide whether or not the proposal will be accepted. If accepted, the proposal will be put to a vote which all certified judges will participate in. The proposal will be approved if a majority of certified judges vote in its favor.

Additional Concerns

Safety

Safety measures should be introduced to the extent that the integrity of the sport is not compromised by the introduction of said measures. An athlete suffering a severe or fatal injury is a traumatizing event not only for the athlete but also for the athlete's friends and family, the community at large, and the public perception of the sport. Minimizing injury is vital. The hardness of the ground and the associated dangers of falling from the line do not play a part in the demonstration of a competitor's skills. If an athlete suffers a career-ending injury both the athlete suffers and the sport suffers because the athlete can no longer contribute to the sport.

Padding - The competition surface should be padded such that if an athlete were to make a catastrophic error the implications of that error would be mitigated. For guidance in this matter we turn to gymnastics. Wherever possible 4" thick mats should surround the line to reduce the implications of a mistake.

Space – All area within 10ft of the line must be kept clear at all times. This space is designated for competitors only. No spectators are allowed within this space

Entertainment

If competitions were not entertaining there would be no spectators, no funding, and no public outlet for the sport. Any additions to a competition that enhance the entertainment value of the event may be incorporated so long as they do not compromise the rules and procedures described in this document. Some examples of acceptable enhancements are music, giveaways, emcees, video replays, visible timers, etc.

Athlete's Rights

All athletes competing in an American Trickline Association sanctioned event have the following rights.

Right to Review – An athlete has the right to review the score for any round, whether they participated in the round or not. A review may be conducted at any time (even long after a competition is completed) but only reviews conducted within the first 24hrs after scores have been posted will impact the outcome of the competition.

Right to Equal Practice – Every athlete has the right to an equal amount of practice time on the line before the competition. Should they choose to exercise this right a timer must be used to control the rotation of athletes during warm-up.

Appendix

Derivation of the Repetition Function

The repetition function is designed such that the maximum number of points an athlete can obtain from repeating a single trick or combo is 2.5 times the original value of the trick or combo. The repetition function is discrete which suggests that it should be derived from the integral of a continuous function. Noting that the integral of $\frac{1}{x^2}$ from 1 to infinity is 1, a function with the desired behavior can be derived from the following function:

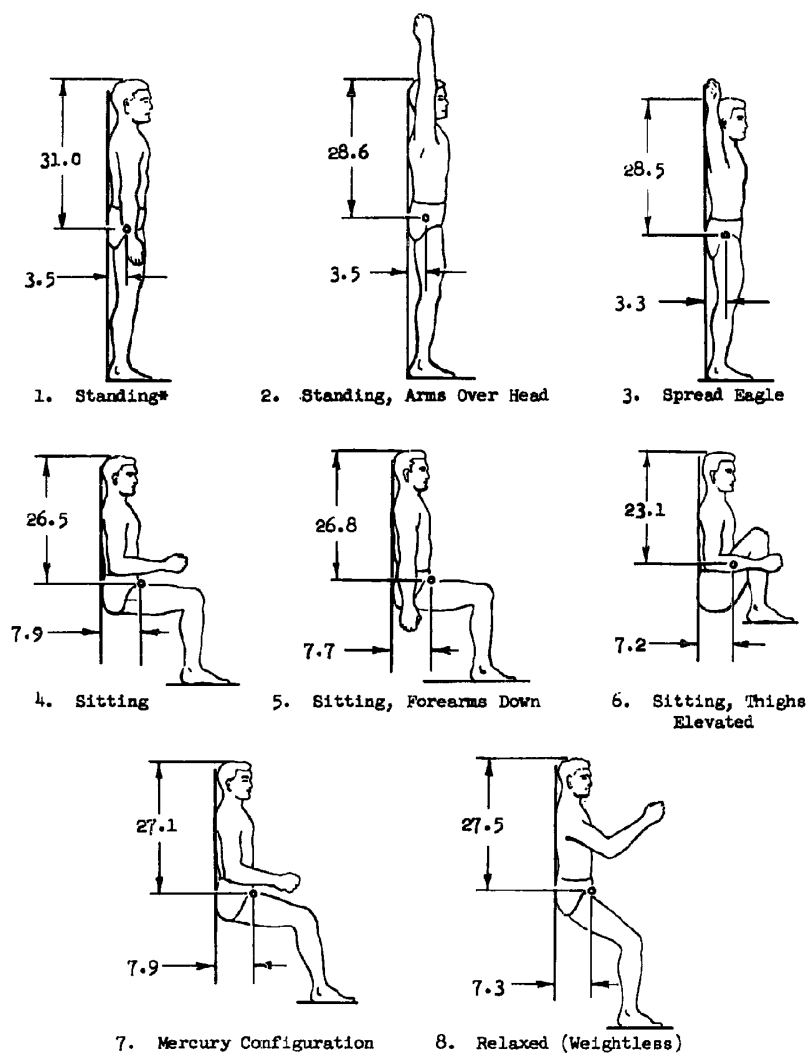
$$f(x') = \frac{3}{2}\int_{x'-1}^{x'} \frac{1}{x^2}\,dx \text{ for } x > 1$$

Conversion Between Height and Extended Length

Data for the extended length (vertical grip reach) of males and females is presented below from Pleasant's anthropometric data. The conversion from height (H) to extended length (EL) is as follows:

H/EL = Stature/(Vertical Grip Reach)=69.1/81.9=0.844

Common Body Positions



*Dimensions are in inches.
Body symmetry with respect to the sagittal plane is assumed.

Rotational Inertia in Various Positions

ARITHMETIC MEANS AND STANDARD DEVIATIONS OF SAMPLE CENTERS OF GRAVITY AND MOMENTS OF INERTIA

		Axis	Center of Gravity (in.)		Moment of Inertia (lb.in.sec.^{2})	
			Mean	S.D.	Mean	S.D.
1.	Standing	x	3.5	0.20	115.0	19.3
		y	4.8	0.39	103.0	17.9
		z	31.0	1.45	11.3	2.2
2.	Standing, Arms Over Head	x	3.5	0.22	152.0	26.1
		y	4.8	0.39	137.0	25.3
		z	28.6	1.33	11.1	1.9
3.	Spread Eagle	x	3.3	0.19	151.0	27.1
		y	4.8	0.39	114.0	21.3
		z	28.5	1.90	36.6	7.9
4.	Sitting	x	7.9	0.36	61.1	10.3
		y	4.8	0.39	66.6	11.6
		z	26.5	1.14	33.5	5.8
5.	Sitting, Forearms Down	x	7.7	0.34	62.4	9.7
		y	4.8	0.39	68.1	12.0
		z	26.8	1.16	33.8	5.9
6.	Sitting, Thighs Elevated	x	7.2	0.37	39.1	6.0
		y	4.8	0.39	38.0	5.8
		z	23.1	0.78	26.3	5.1
7.	Mercury Configuration	x	7.9	0.34	65.8	10.3
		y	4.8	0.39	75.2	14.0
		z	27.1	1.14	34.2	5.6
8.	Relaxed (Weightless)	x	7.3	0.33	92.2	13.3
		y	4.8	0.39	88.2	13.3
		z	27.5	1.44	35.9	5.4

Sample Size 66

Mean Age 33.2 yrs. S.D. Age 7.2 yrs.

Mean Weight 166.4 lbs. S.D. Weight 19.8 lbs.

Mean Stature 69.4 in. S.D. Stature 2.9 in.

Segment Masses as a Fraction of Total Mass

SEGMENTAL WEIGHT/BODY WEIGHT RATIOS FROM SEVERAL CADAVER STUDIES*

Source	Harless (1860)	Braune and Fischer (1889)	Fischer (1906)	Dempster (1955)	Dempster† (1955)	This Study
Sample Size	2	3	1	8	8	13
Head	7.6%	7.0%	8.8%	7.9%	(8.1)%	7.3
Trunk	44.2	46.1	45.2	48.6	(49.7)	50.7
Total Arm	5.7	6.2	5.4	4.9	(5.0)	4.9
Upper Arm	3.2	3.3	2.8	2.7	(2.8)	2.6
Foreram & Hand	2.6	2.9	2.6	2.2	(2.2)	2.3
Forearm	1.7	2.1	.....	1.6	(1.6)	1.6
Hand	0.9	0.8	.....	0.6	(0.6)	0.7
Total Leg	18.4	17.2	17.6	15.7	(16.1)	16.1
Thigh	11.9	10.7	11.0	9.7	(9.9)	10.3
Calf & Foot	6.6	6.5	6.6	6.0	(6.1)	5.8
Calf	4.6	4.8	4.5	4.5	(4.6)	4.3
Foot	2.0	1.7	2.1	1.4	(1.4)	1.5
Sum‡	100.0	100.0	100.0	97.7	100.0	100.0

External Sources

This rulebook incorporates information from the following external sources.

Drillis R, Contini R. Body Segment Parameters. New York, New York: Office of Vocational Rehabilitation; 1966. Report No.: No. 1166-03.

Drillis, Rudolfs, Renato Contini, and Maurice Bluestein. Body Segment Parameters, A Survey of Measurement Techniques. Publication. N.p.: n.p., n.d. Print.

United States of America. Air Force. Wright-Patterson Air Force Base, Ohio. Weight, Volume, and Center of Mass of Segments of the Human Body. By Charles E. Clauser. N.p.: n.p., 1969. Print.

Santschi, W. R., J. DuBois, and C. Omoto. Moments of Inertia and Centers of Gravity of the Living Human Body. Tech. no. AMRL-TDR-63-36. Los Angeles: North American Aviation, 1963. Print.