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Performance evaluation protocol for digital fitting systems —

Part 1: Accuracy of virtual human body representation

Protocole d'évaluation de la performance des systèmes d'habillage virtuel —

Partie 1: Fidélité de la représentation du corps humain virtuel

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 133, *Clothing sizing systems - size designation, size measurement methods and digital fittings*.

A list of all parts in the ISO 20947 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

Digital fitting systems are used for evaluating the fit of a garment without making physical patterns or physical garments. In a digital fitting system, a virtual garment is made using virtual patterns, and the fit of physical garment(s) on a physical human body is assessed by draping a virtual garment on a virtual human body or a virtual fit mannequin (fit form). Such systems are useful for designers and manufacturers, educationalists and retailers of garments because the system helps to improve the fit of garments and productivity. It can also be useful for consumers for assessing the fit of mass-produced garments, for online shopping or for selecting an appropriate size.

The digital fitting system enables examination of the fit of a garment by placing a virtual garment on a virtual human body. Greater accuracy in examining the fit of the virtual garment requires a virtual human body representing the human body accurately. There are several methods for creating the virtual human body. The most popular is the use of a 3D body scan data of a human body, scan data of a fit mannequin representing a specified human form and a parametric model created from body dimensions.

This document defines the virtual human body system that forms the basis of the digital fitting system. This document establishes not only the basic functional requirements of this system but also the protocol for assessing the quality of the virtual human body. The protocol is expected to enable users of digital fitting systems (designers, educationalists and retailers) to choose the virtual human body system most appropriate for their purposes and, at the same time, realize easier performance evaluation of digital fitting systems that make use of the virtual human body (including virtual fit mannequin) model. Since the accuracy of scan-derived measurements and surface shape depends on the accuracy of 3D body scanner system used, manual measurements are used for quantitatively evaluating the accuracy of a virtual human body. Accuracy of scan-derived measurements should be evaluated according to ISO 20685-1.

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Performance evaluation protocol for digital fitting systems —

Part 1:
Accuracy of virtual human body representation

1 Scope

This document focuses on the method of quantifying the differences in body dimensions and visualizing shape differences between the human body and a virtual human body model. This document provides a performance evaluation protocol for virtual human body representation systems, which create virtual human body (including virtual fit mannequin) models based on 3D body scan data and/or body dimensions data of a human body. The required accuracy of a virtual human body depends on the purpose and use of the digital fitting system.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 8559-1, *Size designation of clothes — Part 1: Anthropometric definitions for body measurement*

ISO 18825-1, *Clothing — Digital fittings — Part 1: Vocabulary and terminology used for the virtual human body*

ISO 18825-2, *Clothing — Digital fittings — Part 2: Vocabulary and terminology used for attributes of the virtual human body*

ISO 20685-1, *3-D scanning methodologies for internationally compatible anthropometric databases — Part 1: Evaluation protocol for body dimensions extracted from 3-D body scans*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
digital fitting system
fitting system that provides qualitative and/or quantitative evaluations of overall and/or specific simulation garment fit through analysis of the distribution of surface strain, gap between body and garment, heat map, cross section, surface wrinkles, seam drop, garment balance, etc.

3.2
virtual human modelling system
system for creating a *virtual human body* (3.3.2) for a specific market or individual

Note 1 to entry: Asymmetrical shape assumed to match the body shape of the individual.

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3.3
virtual human model
three-dimensional model in digital format

[SOURCE: ISO 18825-1: 2016, 2.1.1]

3.3.1
parametric human body
virtual human model (3.3) with changeable parameters such as size and shape, etc.

Note 1 to entry: Parametric human body is created by modifying the parameters of the exemplar model imported from the 3D model library. The exemplar models vary by country as they are based on a database. Therefore, a parametric human body can be made on the basis of height variations, BMI (body mass index) and so on.

Note 2 to entry: The parameters of the parametric human body are presented in the parametric human body software. The parameters of the parametric human body can be added depending on the purpose of users.

Note 3 to entry: to entry See Figure 1.



Operators (mm, inch)
Stature (1883,7, 74,2)
Leg Length (944,4, 37,2)
Shoulder Width (402,1, 15,8)
Arm Length (574,4, 22,6)
Neck (340,2, 13,4)
Upper Arm (322,7, 12,7)
Lower Arm (273,7, 10,8)
Bust (960,9, 37,8)
Waist (748,5, 29,5)
Abdomen (828,5, 32,6)
Hip (934,1, 36,8)
Midthigh (533,1, 21,0)
Knee (348,9, 13,7)
Calf (376,8, 14,8)

Figure 1 — Examples of parameters of a male adult body

[SOURCE: ISO 18825-1: 2016, 2.1.1.1]

3.3.2
virtual human body
virtual clone (3.3.2.1) for digital fitting in the apparel industry, including information such as size, shape, cross section, body texture and skeletal structure

Note 1 to entry: Also called “fashion avatar”. In computing, an avatar is the graphical representation of the user or the user’s alter ego or character.

Note 2 to entry: The virtual human body is classified into two key types: virtual clone and virtual twin.

Note 3 to entry: In this document, virtual human body includes at least virtual clone, virtual twin and virtual fit mannequin model.

[SOURCE: ISO 18825-1: 2016, 2.1.1.2, modified — Note 3 to entry has been added.]

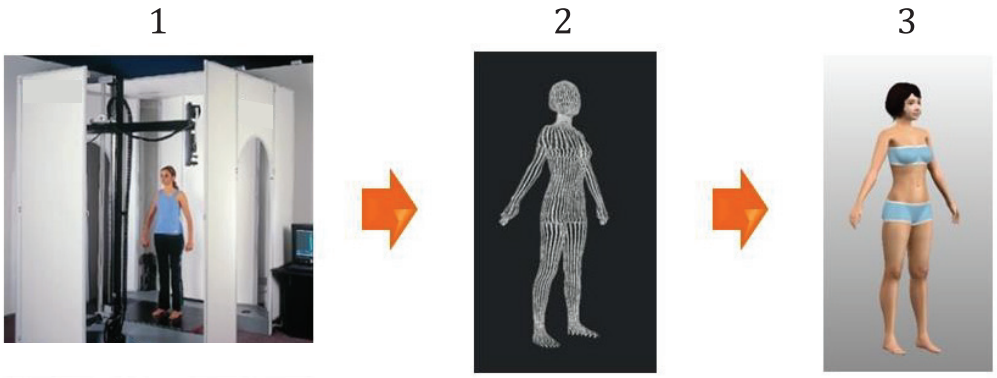
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3.3.2.1
virtual clone
virtual shape
virtual human body (3.3.2) that is created by forming three-dimensional surface data from a 3D body scanned, using surface modelling processes including noise elimination, hole-filling and mesh generation

Note 1 to entry: It is essential that a user be scanned first to create a virtual clone.

Note 2 to entry: The virtual clone is identical to the body shape of the user.

Note 3 to entry: See Figure 2.



Key
1 3D scanning
2 3D scanned point cloud
3 virtual clone

Figure 2 — Process of creating a virtual clone

[SOURCE: ISO 18825-1: 2016, 2.1.1.2.1]

3.3.2.2
virtual twin
virtual size
virtual human body (3.3.2) morphed according to body dimensions acquired either through manual or automatic measurements

Note 1 to entry: The virtual twin is a *parametric human body* (3.3.1) as it can be altered with parameters.

Note 2 to entry: The virtual twin is not identical to the user; but is a close approximation that can be altered by entering parameters retrieved from a population database.

Note 3 to entry: See Figure 3.

Note 4 to entry: A virtual twin can be created directly from the person being scanned or as in case of most digital systems from an existing library.

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a) Body measurements **b) 3D model library** **c) Virtual twin**

NOTE Body measurements are necessary to create a virtual twin.

Figure 3 — Process of creating a virtual twin

[SOURCE: ISO 18825-1: 2016, 2.1.1.2.2, modified — "that is applied" has been replaced by "according to" and Note 4 to entry has been added.]

3.3.2.3
virtual fit mannequin
virtual human body (3.3.2) that represents an actual human body model in digital format used for garment visualization

Note 1 to entry: The model is used for draping simulation (3D form and design realization for example) and examining silhouette and fit of a garment.

Note 2 to entry: See Figure 4.

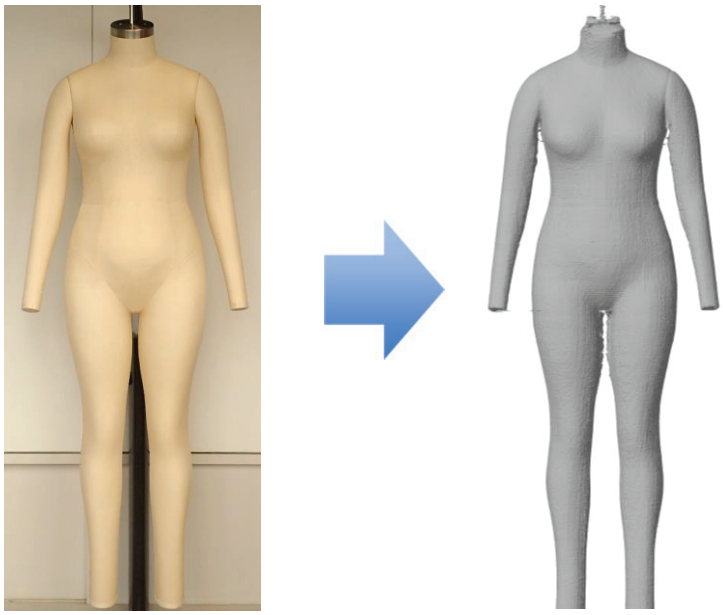


Figure 4 — Process of creating a virtual fit mannequin

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3.4
virtual standing position
posture of a *virtual human model* (3.3) used for measuring dimensions and fit

Note 1 to entry: In a virtual standing position, the head is in the Frankfurt plane, the long axes of the feet should be parallel to one another and 200 mm apart. The upper arms are abducted to form a 20° angle with the sides of the torso and the elbows are straight. But the palms face toward the torso. This position shall be used for evaluating the fit of garments.

3.5
virtual cross section
closed contour extracted from the plane cutting a virtual body segment perpendicular to its main axis or the three principle axes

Note 1 to entry: See Figure 5.

Note 2 to entry: The main axis is the axis that connects the joints on either side of the virtual body segment.

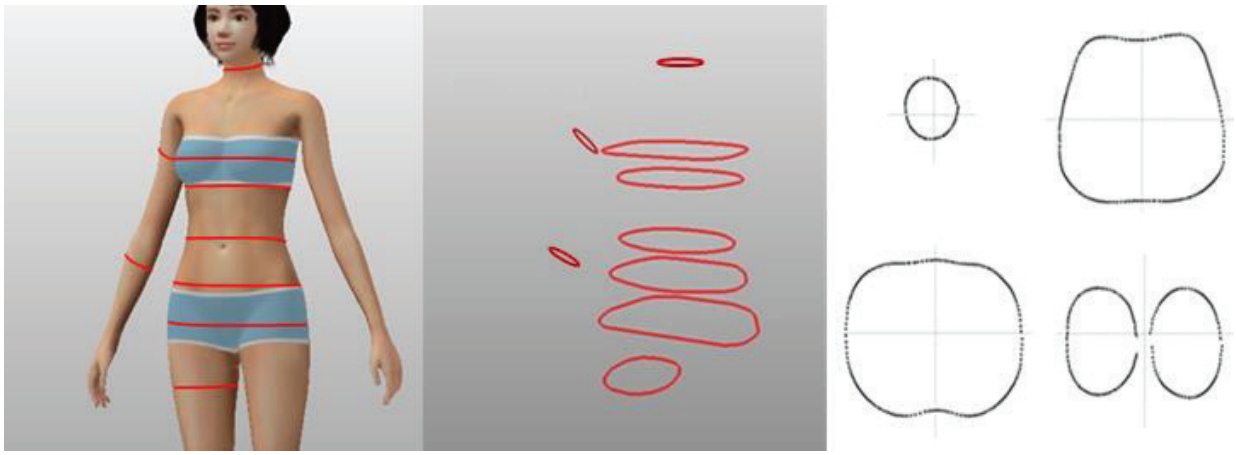


Figure 5 — Examples of virtual body cross sections

[SOURCE: ISO 18825-1: 2016, 2.2.2]

3.6
virtual body landmarks and levels
points that define the characteristic of the body shape of the user in the *virtual standing position* (3.4)

Note 1 to entry: For example, points of bone prominence, peak points on a convex or concave surface, or points like the bust point can be virtual body landmarks.

Note 2 to entry: On a physical body, a virtual fit mannequin or a physical fit mannequin, the landmarks and the levels are defined in the same manner.

Note 3 to entry: Some of the landmarks are evaluated in terms of their levels in this document (see Table 1).

Note 4 to entry: When a physical body or a physical fit mannequin is 3D scanned, markers for the landmarks can be put on it to extract their positions.

[SOURCE: ISO 18825-1:2016, 2.2.4]

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Table 1 — Virtual and physical body landmark points and levels

No.	Virtual body landmark points	Male/Female
1	Virtual back neck-base point	both
2	Virtual shoulder point (Right and Left)	both
3	Virtual axilla point	male
4	Virtual bust point	female
5	Virtual underbust point	female
6	Virtual midriff level	female
7	Virtual side waist point (Right and Left)	both
8	Virtual back waist point	both
9	Virtual top hip level	both
10	Virtual hip point	both
11	Virtual crotch point	both
12	Virtual gluteal fold point	both
13	Virtual elbow point (Right and Left)	both
14	Virtual wrist point (Right and Left)	both
15	Virtual side neck-base point (Right and Left)	both
16	Virtual landing heel point	both

3.6.1
virtual back neck-base point
most posterior point at the back neck-base on the midsagittal plane with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

[SOURCE: ISO 18825-2:2016, 2.1.5]

3.6.2
virtual shoulder point
most lateral point of the shoulder ridge line passing through the cross section covering the middle plane of the torso and arm with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

[SOURCE: ISO 18825-2:2016, 2.1.6]

3.6.3
virtual axilla point
lowest point under the axillary passing through the cross section between the torso and arm with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

[SOURCE: ISO 18825-2:2016, 2.1.7]

3.6.4
virtual bust point
most anterior point of the bust with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

Note 1 to entry: This point is used for a female.

[SOURCE: ISO 18825-2:2016, 2.1.10, modified — Note 1 to entry modified.]

3.6.5
virtual underbust point
lowest point or its level under the bust projection with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

Note 1 to entry: This point is used for a female.

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[SOURCE: ISO 18825-2:2016, 2.1.11, modified — "or its level" has been added, Note 1 to entry has been modified.]

3.6.6
virtual midriff level
midway between the levels of the virtual underbust point and virtual side waist point

Note 1 to entry: This level is used for a female.

Note 2 to entry: [SOURCE: ISO 8559-1:2017, 3.1.21, modified — Term and definition modified to apply to the virtual human body, Note 1 to entry modified.]

3.6.7
virtual side waist point
most concave point or its level of the (right) side waist when viewed from the front with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

[SOURCE: ISO 18825-2:2016, 2.1.12]

3.6.8
virtual back waist point
point of the back waist on the midsagittal plane at the level of the *virtual side waist point* (3.6.7) with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

[SOURCE: ISO 18825-2:2016, 2.1.13]

3.6.9
virtual top hip level
midway between the level of the virtual side waist point and virtual side hip point

[SOURCE: ISO 8559-1:2017, 3.1.24, modified — Term and definition modified to apply to the virtual human body.]

3.6.10
virtual hip point
most posterior point of the hip when viewed from the front when the *virtual human body* (3.3.2) is in a *virtual standing position* (3.4)

[SOURCE: ISO 18825-2:2016, 2.1.15, modified — “when viewed from the front” has been added.]

3.6.11
virtual crotch point
lowest point of the torso on the midsagittal plane with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

[SOURCE: ISO 18825-2:2016, 2.1.16]

3.6.12
virtual gluteal fold point
most concave point on the sagittal plane passing through the *virtual hip point* (3.6.10) between hip and thigh or its level with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

[SOURCE: ISO 18825-2:2016, 2.1.20]

3.6.13
virtual elbow point
most protruding point of the elbow

[SOURCE: ISO 18825-2:2016, 2.1.17]

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3.6.14
virtual wrist point
most concave point of the extended line of the little finger passing through the cross section between the arm and hand with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

[SOURCE: ISO 18825-2:2016, 2.1.18]

3.6.15
virtual side neck-base point
intersection point of the concave contour line at the neck-base passing through the shoulder ridge line with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

[SOURCE: ISO 18825-2:2016, 2.1.4]

3.6.16
virtual landing heel point
lowest point or level of the posterior calcaneus with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

Note 1 to entry: The virtual landing heel point can reach the floor or the top of the shoe heel.

[SOURCE: ISO 18825-2:2016, 2.1.26, modified — "or level" has been added, Note 1 to entry has been modified.]

3.7
virtual body dimensions
size information on virtual body segments of the *virtual human body* (3.3.2) that corresponds to measured anthropometric dimensions of the user in the *virtual standing position* (3.4)

Note 1 to entry: See 6.2.

3.7.1
virtual chest girth
horizontal girth of the torso passing through the *virtual axilla point* (3.6.3) with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

[SOURCE: ISO 18825-2:2016, 2.2.17]

3.7.2
virtual bust girth
horizontal girth of the torso passing through the *virtual bust point* (3.6.4) with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

[SOURCE: ISO 18825-2:2016, 2.2.18]

3.7.3
virtual underbust girth
horizontal girth of the torso passing through the *virtual underbust point* (3.6.5) with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

[SOURCE: ISO 18825-2:2016, 2.2.19]

3.7.4
virtual waist girth
horizontal girth of the torso passing through the *virtual side waist point* (3.6.7) with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

[SOURCE: ISO 18825-2:2016, 2.2.20]

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3.7.5
virtual hip girth
horizontal girth of the torso passing through the *virtual hip point* (3.6.10) with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

[SOURCE: ISO 18825-2:2016, 2.2.22]

3.7.6
virtual thigh girth
horizontal girth of the leg at the level of *virtual gluteal fold point* (3.6.12) with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

[SOURCE: ISO 18825-2:2016, 2.2.23, modified — "virtual crotch point" has been changed to "virtual gluteal fold point".]

3.7.7
virtual chest height
vertical distance between the *virtual landing heel point* (3.6.16) and *virtual axilla point* (3.6.3) with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

3.7.8
virtual bust height
vertical distance between the *virtual landing heel point* (3.6.16) and *virtual bust point* (3.6.4) with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

[SOURCE: ISO 18825-2:2016, 2.2.2]

3.7.9
virtual underbust height
vertical distance between the *virtual landing heel point* (3.6.16) and *virtual underbust point* (3.6.5) with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

3.7.10
virtual waist height
vertical distance between the *virtual landing heel point* (3.6.16) and *virtual side waist point* (3.6.7) with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

[SOURCE: ISO 18825-2:2016, 2.2.3]

3.7.11
virtual hip height
vertical distance between the *virtual landing heel point* (3.6.16) and *virtual hip point* (3.6.10) with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4).

[SOURCE: ISO 18825-2:2016, 2.2.4]

3.7.12
virtual thigh height
vertical distance between the *virtual landing heel point* (3.6.16) and *virtual gluteal fold point* (3.6.12) with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

3.7.13
virtual arm length
sum of the distance of the straight line between *virtual shoulder point* (3.6.2) and *virtual elbow point* (3.6.13), and the distance of the straight line between virtual elbow point and *virtual wrist point* (3.6.14) with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

Note 1 to entry: In case 'virtual arm length' is used to mean 'surface length', it should be marked that there has been a change in meaning.

Note 2 to entry: In this document virtual arm length is mainly used to mean surface length.

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[SOURCE: ISO 18825-2:2016, 2.2.10, modified — Notes 1 and 2 to entry have been modified.]

3.7.14
virtual upper arm girth
maximum girth of the upper arm perpendicular to the main axis of the upper arm and passing through the *virtual axillia point* (3.6.3) with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

[SOURCE: ISO 18825-2:2016, 2.2.14]

3.7.15
virtual wrist girth
girth of the forearm perpendicular to the main axis of the forearm and passing through the *virtual wrist point* (3.6.14) with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

[SOURCE: ISO 18825-2:2016, 2.2.16]

3.7.16
virtual inside leg height
vertical distance between the *virtual landing heel point* (3.6.16) and virtual crotch with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

[SOURCE: ISO 18825-2:2016, 2.2.5, modified — The term "virtual crotch height" has been deleted.]

3.7.17
virtual centre back waist length
surface distance between the virtual centre back neck-base point and the virtual centre back waist point with the *virtual human body* (3.3.2) in the *virtual standing position* (3.4)

[SOURCE: ISO 18825-2:2016, 2.2.9, modified — "Centre" was added to the term and to the definition.]

3.7.18
virtual shoulder width
horizontal distance between right and left *virtual shoulder points* (3.6.2)

Note 1 to entry: In case 'virtual shoulder width' is used to refer to 'surface length', it should be marked that there has been a change in meaning.

[SOURCE: ISO 18825-2:2016, 2.2.8]

3.7.19
virtual shoulder slope
values, in degrees, of the angles of inclination of a line joining the(virtual) shoulder point and the (virtual) side neck-base point against the horizontal plane

Note 1 to entry: The difference (in mm) between levels of the (virtual) shoulder point and the (virtual) side neck-base point may be used (see ISO 8559-1:2017, Figure 115).

3.7.20
virtual shoulder length
surface distance between a *virtual shoulder point* (3.6.2) and a *virtual side neck-base point* (3.6.15) in the right and left side of a *virtual human body* (3.3.2)

4 Basic requirements of virtual human modelling system

4.1 General

The virtual human modelling system shall have the following functions.

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