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Ergonomics — Computer manikins and body templates —

Part 1: General requirements

Ergonomie — Mannequins informatisés et gabarits humains —

Partie 1: Exigences générales

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 15536-1 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 122, *Ergonomics*, in collaboration with Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 3, *Anthropometry and biomechanics*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

ISO 15536 consists of the following parts, under the general title *Ergonomics — Computer manikins and body templates*:

— *Part 1: General requirements*

The following parts are under preparation:

— *Part 2: Structures and dimensions*

Introduction

The structure of safety standards in the field of machinery is as follows.

a) Type-A standards (basis standards) give basic concepts, principle for design, and general aspects that can be applied to machinery.

b) Type-B standards (generic safety standards) dealing with one or more safety aspect(s) or one or more type(s) of safeguards that can be used across a wide range of machinery:

— type-B1 standards on particular safety aspects (e.g. safety distances, surface temperature, noise);

— type-B2 standards on safeguards (e.g. two-hand controls, interlocking devices, pressure-sensitive devices, guards).

c) Type-C standards (machinery safety standards) dealing with detailed safety requirements for a particular machine or group of machines.

This part of ISO 15536 is a type-B standard as stated in ISO 12100-1.

When provisions of a type-C standard are different from those which are stated in type-A or type-B standards, the provisions of the type-C standard take precedence over the provisions of the other standards for machines that have been designed and built according to the provisions of the type-C standard.

This part of ISO 15536 concerns requirements which are, to a great extent, independent both of the state of the art in the currently rapidly developing field of computer manikins and body templates, and of the availability of up-to-date, detailed and representative anthropometric data.

The physical characteristics of the human body are one of the starting points in the design of spaces, furniture, machines and other equipment. Computer technology is advancing rapidly and allows the construction of computer manikins to model the human body and to simulate human activities. Anthropometrically accurate manikins or body templates can be used, for example, to visualize the geometric relationship between the human body and the physical environment. Various functions of evaluation can also be integrated into the manikin and manikin system, for example, indication of reach zones, visualization of viewing fields, biomechanical calculation of required strength, and simulation of movements.

Computer manikins are intended to reduce the need for real test persons and the evaluation of physical models and prototypes. However, real persons provide not only their true physical dimensions but also their differing functional and perceptual capabilities as well as their assessment of the ease of performance, comfort and other properties of the design (see ISO 15537).

The computer manikin permits quick, easy and early identification of possible dimensional shortcomings. Critical dimensions restricting operations, such as fitting into a confined space or reaching objects can be quickly assessed in relation to extreme body measurements. The dimensioning would otherwise require tests with a large number of test persons.

In the use of manikins, several ergonomic aspects (e.g. anthropometric, postural, visual, strength-related, dynamic) are addressed in one and the same test situation. As a universal design tool, the manikin is particularly useful for entirely novel designs, when no recommendations on the dimensions exist and no reference situations for full-scale evaluation are available. In the design process, the use of computer modelling with a manikin facilitates information exchange and collaboration between different specialists and users.

When used appropriately, computer manikins accelerate the entire design process and reduce the costs of designing. The ergonomic design process is presented as a whole in EN 614-1.

The use of computer manikins does not ensure appropriate design solutions automatically, and they can even be misused. The designer may use them inappropriately, for example, by permitting awkward postures, or by providing too little space for movements. It is possible that he or she is not aware of the inherent limitations of computer manikins, either in anthropometric, postural or biomechanical respects. As the complexity of the manikin systems increases, the links to the data on these human characteristics can also become difficult or impossible to trace.

The manikins and manikin systems available so far vary with respect to the functions and features they afford, as well as to their accuracy and usability. At the present developmental stage, the most sophisticated manikin systems may require powerful hardware and specially trained users, and they may be unavailable to many designers. The most simple ones may be easy to use but are of restricted value for designing. The systems may also differently emphasise such components as anthropometric accuracy, biomechanical capabilities, graphical visualisation, geometric design, simulation and animation. The choice of manikin and the associated design system is, to a great extent, a trade-off between these different features.

Broad experience of the field and a high level of care are necessary when choosing and using the manikin system, and for controlling the effects of other external parameters, however sophisticated the manikin system may be.

Ergonomics — Computer manikins and body templates —

Part 1:
General requirements

IMPORTANT — The application of this part of ISO 15536 should be verified by practical tests with real persons.

1 Scope

This part of ISO 15536 establishes the general requirements for the design and development of computer manikins, body templates and manikin systems. It addresses their anthropometric and biomechanical properties, taking into account their usability and restrictions for structural complexity and functional versatility, and is also intended as a guide for the selection of manikins and manikin systems and for the evaluation of their accuracy and usability for the specified use. It specifies the documentation of the characteristics of manikins and manikin systems and their intended use, for the guidance of their users. It provides means for ensuring that computer manikins and body templates for the design of work space are appropriately accurate and reliable in their anthropometric and biomechanical aspects. It aims to ensure that users of manikins are able to choose an appropriate manikin system for particular design tasks and use it in an appropriate way. It sets requirements only on the static accuracy of the manikin, but provides recommendations on the other factors that can influence the accuracy of the analyses and determinations performed using them.

2 Normative references

The following referenced documents are indispensable for the application 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 7250, *Basic human body measurements for technological design*

ISO 9241-11, *Ergonomic requirements for office work with visual display terminals (VDTs) — Part 11: Guidance on usability*

ISO 12100-1, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology*

EN 614-1, *Safety of machinery — Ergonomic design principles — Part 1: Terminology and general principles*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100-1 and the following apply.

3.1
computer manikin
two-dimensional (2D) or three-dimensional (3D) graphical computer representation of the human body based on anthropometric measurements, link and joint structure, and movement characteristics

3.2
computer manikin system
computer modelling system consisting of a computer manikin, tools for controlling and manipulating the manikin (e.g. posture, anthropometric measurements), functions for mimicking human characteristics and behaviour (e.g. biomechanical, strength, movements), and means to position the manikin in relation to the computer model of the physical environment

3.3
body template
physical two-dimensional, usually articulated, contour model of the human body based on anthropometric measurements

4 Accuracy

4.1 General

Several factors affect the accuracy of the analysis and determinations performed with the help of a manikin. Some depend on the anthropometric, structural, functional and biomechanical accuracy of the manikin itself; some on the knowledge and experience of the user of the manikin, for example, how appropriately the fine adjustments of the posture are done, or how deep the manikin is set in a cushioned seat surface. The required accuracy depends on the work tasks and the criticality of the dimensions (e.g. access, reach).

This part of ISO 15536 sets requirements only on the static accuracy of the manikin (see 4.2 to 4.3), but provides recommendations on the other factors which can influence the accuracy of the analyses and determinations performed with their help. These factors are described and discussed in Annex A.

4.2 Static accuracy of manikins

The structure and shape of the manikin shall conform with the shape and anthropometric measurements of the human body (see 6.4). Particular attention should be given to the design of a manikin so that the measurements of a manikin match the measurement of a human being in corresponding postures (e.g. standing and sitting).

The conformity of a computer manikin with the available population data on anthropometric measurements shall be checked by measuring the manikin in accordance with ISO 7250. By measuring horizontal or vertical distances between selected points, the measurements of the manikin can be compared with population data (or those presented for the European population in ISO 15534-3), and the accuracy in standard positions can be determined (see 6.5).

4.3 Specific issues of anthropometric accuracy

4.3.1 Effect of slump

The standardised postures in which the anthropometric measurements are taken are erect, whereas in natural postures the body is slightly slumped. The variation of the relevant measurements in standing and sitting postures should be considered by allowing the relevant fine adjustment in the posture of the trunk, or by a relevant slump factor (in upright postures this varies normally from 10 mm to 60 mm).

4.3.2 Soft tissue deformation

The body consists of both hard tissues such as bones which are rigid, and soft ones such as muscles and fat which deform when the posture is changed, or when subjected to pressure. The manikin should have provisions for taking account of deformable tissue, for example, in the area of the buttocks so that the height of the trunk remains correct when changing from standing to sitting.

4.3.3 Joint movement

Joint mobility affects anthropometric accuracy. For example, the shoulder and the centre of rotation of the shoulder joint are mobile, which greatly affects forward and upward reach. The user of the manikin should be made aware of the type of reach of the manikin (e.g. convenient/maximal reach). Consideration of the shoulder movement should be realized by the appropriate function of the manikin, or by providing the user of the possibility to adjust the location of the joint rotation centre within the range of its movement. For more information on joint movement, see A.3.3.

5 Usability

5.1 General

Computer manikin software systems shall be easy to use in order to be accepted and implemented into the design process according to EN 614-1. The usability of the manikin systems also affects the accuracy of the analysis performed with their help. Usability features of manikin systems are described in 5.2 to 5.8. General requirements on the usability of software applications shall be according to ISO 9241-11.

5.2 Clarity

The structure and interface of the manikin system shall be clearly understandable to allow quick learning and ease of use.

5.3 Consistency

The interface of the software, for example, dialogues and menus, should be as far as possible consistent with other computer programs that are used by the designer, such as the design software (CAD), animation software, and ergonomic/human factors application programs for evaluation.

5.4 Effectiveness

The software routines of computer systems should be short and simple. These include access routines needed to move from one software application to another, or to transfer the manikin or the environment from one application to another. Also, the number of steps in the user procedures should be limited and the difficulty of choice in each step should be kept as low as possible.

5.5 Versatility

It has to be possible to manipulate the manikin (size, posture) and modify the environment within the same software application. It is necessary that the manikin system also allows the user to specify and illustrate the viewing fields, reach and angular limits, e.g. preferred and maximal working area (see ISO 14738). The versatility of the manikin system is greatly affected by the architecture and design of the software (e.g. modularity and open-system architecture, see A.7).

5.6 Ease of changing anthropometry

The anthropometric measurements of the manikin shall be readily changeable, e.g. by selecting the required percentile of the measurement or by changing the measurements directly; in both cases the percentiles shall be indicated to the user. Relevant to the design needs, the combinations of different body segment percentiles shall be available, and be suitably explained. It shall be possible to adjust the anthropometric measurements between the 1st and 99th percentile of the intended population (see A.5.2).

5.7 Ease of changing posture

The posture shall be easy to change for testing certain operations, e.g. for momentary reaching to an object and reverting back to the initial posture. The manikin system shall allow easy selection of, or change to, basic postures, e.g. standing, sitting, stooping and kneeling. The manikin shall also be easy to position, in order that it either is or is not in contact with objects in the environment.

5.8 Ease of visual judgements

The adjustments of the measurements or postures shall be easy to perceive by the user and facilitated in appropriate ways in order to achieve the required accuracy. This presupposes sufficient indication of the surface or contour of the body, in addition to indicating the joints to be moved, and the direction and magnitude of the movement. This may require the use of landmarks if the manikin has hair or wears clothing and shoes, or reference lines showing the change of the joint angles.

In order to judge whether a posture or object to be reached is within acceptable limits, it should be possible to display viewing fields, reach and comfort zones clearly when needed.

The positioning of the manikin in relation to the seating arrangements requires indication of certain reference points, e.g. the seat index point (SIP).

6 Documentation

6.1 General

The developer of the manikin and manikin system is responsible for documentation of their characteristics and intended use, as well as for the guidance to the user. Requirements for this documentation are presented in 6.2 to 6.9.

6.2 Intended use

The intended use of the manikin shall be documented, e.g. animation, anthropometric and biomechanical evaluations, together with any limitations in its use, particularly from an anthropometric point of view. Also documented shall be the types of analyses and evaluations for the manikin system, for example:

— automated evaluation functions or evaluation by visual judgement only;

— animation of movements or a still picture presentation only;

— analyses of geometric relations such as viewing, reach, access and collision;

— evaluation of strength requirements based on biomechanical calculations.

In addition, the intended user group shall be documented, e.g. engineers, ergonomics experts. The design domain shall be documented, e.g. machinery design, architectural design. The requirements concerning experience in anthropometry, workplace design and computing techniques to utilise the full power of the software in complex applications shall be documented as well.

6.3 Data sources

The sources of anthropometric data used shall be documented. If the data are combined from different sources or pooled gender data, the resulting data shall be specified and tabulated in at least 5th, 50th and 95th percentile values.

6.4 Anthropometric accuracy in standard positions

For assessing the static accuracy of the computer manikin (see 4.2), at least the basic anthropometric measurements presented in Table 1 shall be determined. For each, the initial data (source, original, combined or pooled) as specified in 6.3, shall be documented. In addition, the same measurements shall be measured directly from the manikin when they are set to represent 5th, 50th and 95th percentiles. The difference between these values shall also be documented as a percentage of the initial value. Table 1 shows how the documentation of this comparison can be performed. The comparison will show inherent differences due to compromises on the stature path and possible choices concerning body types. For certain applications, the 1st and 99th percentile should also be used (see A.5.2).

Table 1 — Comparison between initial data and directly measured measurements of manikin in standard positions

Basic anthropometric measurements [a]	**P5**			**P50**			**P95**		
	Initial data	Manikin, measured	Difference %	Initial data	Manikin, measured	Difference %	Initial data	Manikin, measured	Difference %
1. Stature (body height)									
2. Sitting height (erect)									
3. Forward reach (grip reach)									
4. Shoulder breadth (bideltoid)									
5. Hip breadth, (sitting)									
6. Chest depth (standing)									
7. Body depth (standing)									
8. Chest breadth (standing)									
9. Elbow height, (standing)									
10. Shoulder–elbow length									
11. Knee height									
12. Thigh clearance									

[a] Descriptions of these anthropometric measurements are given in ISO 7250.

6.5 Assumptions and corrections — Posture

Any assumptions and corrections concerning the dimensional differences between the standardized and actual postures of the manikin shall be documented, e.g. corrections due to the effect of slump (see 4.3.1) and movement of shoulder joint (see 4.3.3). If they are an integrated feature of the manikin, they should be taken into account in the comparisons required in 6.4.

6.6 Assumptions and corrections — Clothing

Any assumptions and corrections concerning the clothing shall be documented (e.g. heel height of shoes).

6.7 Other characteristics influencing anthropometric accuracy

All characteristics of the manikin that influence the anthropometric or biomechanical accuracy, but which are not visible or obvious, shall be documented. These include the inner structure, as well as the type of coordinate system used to describe the orientation of the limbs, and whether any constraints are imposed.

The following, at least, shall be documented:

— the manner in which the anthropometric geometry of the manikin is represented (e.g. type of structure used to represent the surface, internal skeleton);

— whether a database of the anthropometric measurements of a specific population is provided;

— whether other databases can be incorporated;

— whether it is possible to specify the measurements of a certain individual.

6.8 Factors influencing biomechanical accuracy

When the manikin is used in biomechanical analysis, the details of the biomechanical models and equations used for calculations shall be documented, as well as the sources of data and quantities used (dimensions, masses, strengths).

6.9 Methods of control

Methods of controlling posture, balance, movements and interaction between the manikin and the environment shall be documented.

6.10 User guidance

User guidance (additional to technical manuals) with respect to anthropometric data used for selecting percentile options for specific evaluation tasks and other considerations like biomechanical properties shall be provided.

Requirements on the hardware and other software for using the manikin and manikin system shall be given. Possibilities for communication with other types of programs (import, export of data) as well as output media (plotters, printers, video recorders) shall be documented.

Annex A
(informative)

Factors affecting the anthropometric accuracy of manikins and of the analyses and determinations performed using them

A.1 General

In this annex, typical features of manikins and manikin systems are described and discussed in relation to the accuracy of the analyses performed using the manikins and systems and to their field of application.

A.2 Geometric representation

A.2.1 Two-dimensional human models

The two-dimensional (2D) body template is a physical human model used for the evaluation of conventional drawings of the designs. A 2D computer manikin is the simplest type of computer manikin and suitable for 2D design. These 2D human models are easy to conceive and manipulate and require little computing capacity. 2D manikins are suitable for sketching and can be applied for studying the postures and movements in only one plane at a time.

A.2.2 Three-dimensional human models

With three-dimensional (3D) computer manikins a diversity of human postures and movements can be modelled. Their geometric complexity varies from simple stick models roughly based on the human skeleton to wire-frame models partially representing the body surface, and surface models or more realistic modelling of the internal structures of the human body. Stick models may be needed when computing capacity is not sufficient for specific applications, for example, in complex real-time simulation and biomechanical calculations. Detailed surface definitions can give a realistic appearance of the human body.

Three-dimensional manikins can create some difficulties in the perception and manipulation of postures and the control of movement. Moreover, construction of the 3D environment is time-consuming. Thus, 3D manikins are generally less suitable for preliminary design, but effective for visualisation and evaluation of the more developed design alternatives.

A.3 Structural features

A.3.1 Number of segments and joints

A large number of body segments and moving joints enables more natural and more versatile movements of the body, especially in extreme postures of the trunk and neck. For determining dimensions for normal standing or sitting postures, a smaller number of segments is sufficient. Two-dimensional manikins normally have from six to eleven moving joints, enabling their posture to be manipulated relatively easily joint by joint. Three-dimensional models may have as few as fifteen joints, but as many as seventy when the fingers and components of the spinal column are to be represented in their functional anatomical detail.

A.3.2 Degrees of freedom of joint movement

Each joint has degrees of freedom (axes of rotation) which vary from one in the finger joint to three or more in the spine for anterior/posterior and lateral bending and rotation. The shoulder joint is multi-axial, and the centre of its rotation is movable within a fairly large area. For practical reasons, such as ease of manipulation of the posture, some of the joint movement options may be constrained.

A.3.3 Joint structure

When the links and joints of a computer manikin are more simple than in the human body, errors can result. For example, if the pectoral girdle is modelled without a mobile shoulder blade and with only a simple ball and socket joint for the gleno-humeral joint, the natural movements of the arm when reaching forward cannot be simulated. Forward reach will be too short and the resulting error considerable. On the other hand, in the knee joint, the axis of rotation shifts slightly when the knee angle changes, but the resulting inaccuracy is small when modelling the knee joint with a simple hinge joint having a fixed axis of rotation.

A.3.4 Angular limits

Each joint may have angular limits determined for the joint movements. These limits may indicate the whole range of the movement which is possible, described by dynamic anthropometric data. They may also indicate comfort limits among the population, determined for specific activities such as assembly operations or in steering a vehicle, or, limits for the evaluation of the work activity associated with machinery.

A.4 Functional features

A.4.1 Postures

The manikins should be able to mimic the variety of natural postures of humans. The changing of the postures as a whole by visual judgement depends on the large number of degrees of freedom of the joint movements and can cause problems. Therefore, a set of predetermined (standard) basic postures (e.g. standing, sitting, stooping) are normally needed.

In some applications the control of balance is a prerequisite for maintaining a certain posture. In order to examine the balance of the whole body in static postures, data on the masses of the body segments and the location of their centres of mass are required. The calculations can be automated and typical postural behaviour can be integrated so that postures can be maintained and continual movements, such as walking, simulated.

The relation of strength to posture, balance and comfort should be recognized. Strength cannot be assessed properly without specification of posture. Full strength capacity can only be exerted in certain postures, when the body is in balance, and when comfort is not severely affected.

A.4.2 Indication of reach zones and recommended work areas

Checking of the reach capability can be done by changing the posture or by indicating the reach zones and recommended hand movement areas for work operations, e.g. by showing reach envelopes. The limits of the recommended work areas depend on several factors, for example, the weight of objects to be handled, frequency of movements and duration of the work task.

A.4.3 Indication of viewing fields

The viewing fields for eye movement or peripheral views, as well as comfortable sight lines can be visualized in various ways. Recommendations or limitations concerning viewing distances can also be visually demonstrated.

For specific applications, the relevant standard should be considered.

A.4.4 Movement patterns

The movements of the limbs and trunk of the computer manikin should resemble natural human movements as far as possible. Because of the large number of degrees of freedom, predetermined integrated movement patterns can be used in the control of the movements. This may require data on trajectories of joints and segments during movements or, alternatively, development of optimisation algorithms.

A.4.5 Biomechanical evaluation

By means of biomechanical calculations, loads acting on different parts of the human body can be calculated in static postures or during movements. Such calculations are based on external forces and their directions and points of action, together with data modelling the geometrical structure of the human body. These geometrical structures may incorporate additional data on masses of the segments, mass centres, moments of inertia of the body segments, to a degree depending on the required fidelity or allowed complexity. It is also possible to calculate the torque required in specified joints to accomplish the simulated movements. By comparing the resulting values with limit values, it is possible to evaluate the ergonomic suitability of postures and movements.

A.5 Anthropometric features

A.5.1 Fixed or parametric anthropometry

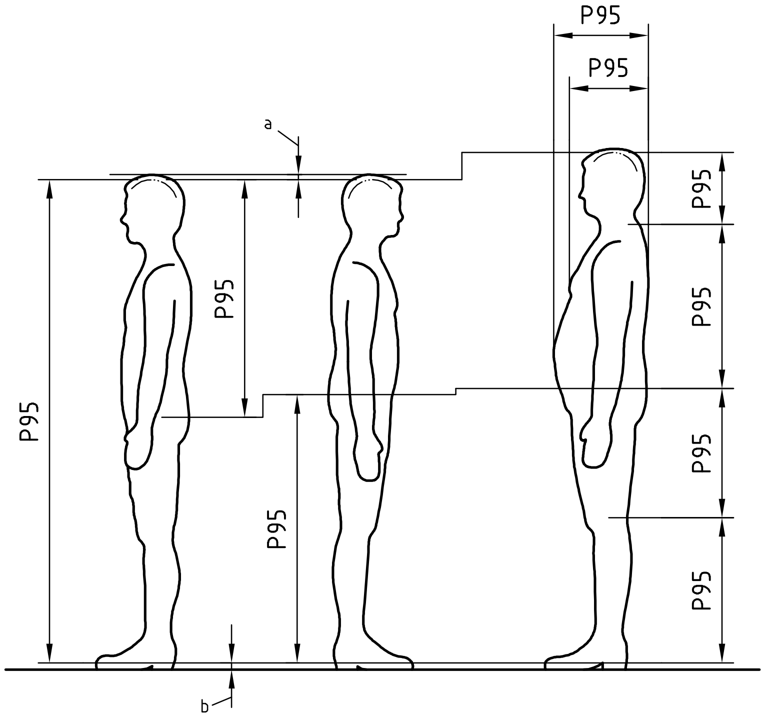
The anthropometric variables of the computer manikin may be selected as fixed options representing, for example, different genders, different age groups, statistical size groups or body types. This is typical of 2D manikins. The manikin may also be parametric, i.e. anthropometric as well as angular data are stored in files as parameters. This allows the selection of the user population and within this any anthropometric option, depending on how the data are arranged and how they can be manipulated.

A.5.2 Percentile options

The available anthropometric data on adult populations are normally statistically arranged by gender and age. Within the combinations of these groups, the dimensions are presented as percentiles, for example as P5, P50, and P95 for general design purposes. In some anthropometric standards for the design of machinery, gender data are pooled for these percentiles, as shown in ISO 15534-3. In this part of ISO 15536, the 1st and 99th percentiles are also required for safety considerations.

If genders are represented separately, the basic data representing both men and women should be available. Ideally, the dimensions of the manikin should be separately adjustable, as percentile values as well as absolute values. For practical reasons, however, the designer may need a small number of predetermined body size options representing average as well as extreme sizes.

However, determining percentiles from statistical data involves inherent problems, particularly concerning extreme percentiles. Small and large manikins cannot be constructed with all body segments having the same percentile value. For example, P5 and P95 manikins are normally fitted to match the P5 and P95 statures, which leads to much smaller deviation in all vertical measurements constituting the stature path, i.e. the height of head, neck, trunk, and lower limbs (see Figure A.1). The users should adjust the anthropometry of the manikin by identifying critical dimensions, and setting those dimensions to the specified 5th or 95th percentile value, and letting the other non-critical dimensions fall where they may to achieve integrity in stature. The P5 or P95 values of depth and breadth measurements can, in practice, be incorporated to the P5 or P95 statures, but this leads to combinations which are more rare in reality (small and thin, large and heavy).



a Height allowance for hair.

b Height allowance for shoes.

Figure A.1 — Problem of the common-percentile manikin

In practice, when accurate determinations of, for example, leg space or sitting height, are needed, at least two proportionally different types of extreme body size (P5 and P95) may be needed:

— P5 manikin having P5 stature and P5 leg length;

— P5 manikin having P5 stature and P5 sitting height;

— P95 manikin having P95 stature and P95 leg length;

— P95 manikin having P95 stature and P95 sitting height.

Furthermore, body type options, such as thin, average and heavy builds, are needed for determining the minimum space.

For determining some critical dimensions, manikins representing combinations of some extreme percentile measurements may be needed too. A typical example, needed in the design of any work station using a table top, is the combination of maximum abdominal depth and minimum upper arm length, indicating the shortest possible hand reach over the edge of the table. The combination of minimum abdominal depth and the maximum lower leg length indicates the deepest possible leg space depth (see ISO 14738). In special applications there may be a need to determine the dimensions of each body segment separately, such as their length, breadth and depth.

A.5.3 Multivariate options

Where several different anthropometric constraints, for example, sitting height, sitting eye height, sitting elbow height and knee height, are required for a design situation, the developer should consider multivariate approaches.

A.6 Availability and accuracy of anthropometric data

The availability and accuracy of data on anthropometric measurements determine the accuracy and validity of the computer manikin greatly. Data on anthropometric measurements in standardized postures are available for many populations of interest, but are lacking for many others, and to a great extent, the data are outdated. Population data required for detailed modelling of the body surface as well as those for biomechanical modelling are not presently available. In practice, only estimates for the required parameters are often used.

A.7 Other factors affecting accuracy

Other factors that influence the static and dynamic accuracy of a manikin are the roughness of the ways the body surface is modelled (e.g. polyhedral or ellipsoidal), representation of internal structures (bone, muscle or fatty tissue), and consideration of special clothing and equipment.

A.8 Integrated approach, modular design and open-system architecture

The structure and architecture of the manikin system software has a great influence on how well the manikin system can be enhanced to serve the special needs of its user. These also affect the possibilities for controlling the anthropometric accuracy of special applications, as well as the accuracy of the manikin and its functions as a whole. Two principal alternatives exist: an integrated or modular approach. The integrated approach (typical to earlier applications) provides a framework where the functions and data are interconnected, and one cannot be modified without affecting the inner workings of the other. This implies difficulties in specifying the characteristics and functions of the manikin and manikin system, and in tracing the links to the anthropometric and biomechanical data used. The modular approach offers a framework for breaking down the description of the manikin into manageable elements that can be drafted and controlled by specialists in appropriate technical fields.

A modular manikin system is composed of independent and compatible software objects, which in combination provide the ability to simulate human actions in the design and evaluation of work spaces and equipment. Examples of functional modules include structural components of the manikin, taken individually (e.g. hands, feet, neck), manikin creation, manikin positioning or posturing, movement control, vision, strength, balance, clothing, and personal equipment. A modular software design permits independent development and maintenance of manikin functions and the ability to selectively enhance components of a manikin system for applications that require highly precise or specialized data, such as helmet design or prosthesis development.

An open-system architecture is characterized by standardized and publicly available interface definitions. This approach provides modules for specific functions that are interchangeable and are not dependent on any specific supplier for development, integration, testing, maintenance or support. An open-system architecture promotes greater participation of specialized suppliers. The development and support of these specialized data and a functional algorithm can be difficult and sometimes impossible for suppliers of manikin systems because of economic reasons.

It is recommended that the application of this part of ISO 15536 be verified by practical tests with real persons.

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