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Ergonomics of human-system interaction —

Part 514: Guidance for the application of anthropometric data in the ISO 9241-500 series

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Foreword

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This document was prepared by Technical Committee 159, *Ergonomics,* Subcommittee SC 4, *Ergonomics of human-system interaction*.

A list of all parts in the ISO 9241 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.

Introduction

The use of interactive systems takes place within a physical environment. The design of the physical environment is decisive with regard to the outcome of the interaction between a variety of sizes of users and the physical environment. As described in the system concept of ISO 26800, the physical environment is embedded in an organizational and a social and cultural environment.

This document deals with the physical environment in which a physically diverse user group is assigned to one or more workplaces, or spatial environments, to accomplish a task. The entirety of the spatial environments assigned to a user is called environment of use. The relevant physical attributes of the environment of use include issues such as air quality, thermal conditions, lighting, noise, spatial layout and furniture. Specifically, this document discusses concepts for the spatial layout of workplaces so that they match the physical anthropometric characteristics of the intended user population.

Ergonomics of human-system interaction —

Part 514:
Guidance for the application of anthropometric data in the ISO 9241-500 series

1 Scope

This document is intended to provide guidance in the use of anthropometric data within the ISO 9241-500 series.

2 Normative references

There are no normative references in this document.

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
anthropometric accommodation
percentage of individuals in the intended user population whose anthropometric measurement values are concurrently within specified values for all anthropometric variables of interest pertinent to the design of some object

3.2
multivariate accommodation
percentage of individuals in the intended user population whose anthropometric measurement values are concurrently within specified values for multiple anthropometric variables

3.3
percentile
percentage of the measurement values that are less than the given value

3.4
user population
group of people having some common environment or activity

Note 1 to entry: These groups can be as diverse as geographically defined populations or specified age groups.

3.5
univariate accommodation
percentage of individuals in the intended user population whose anthropometric measurement values are within specified values for a single anthropometric variable

3.6
weighting
assignment of a statistically determined multiplier to an individual's anthropometric data in order to reflect its relative importance in making the sample representative of the intended user population's anthropometry

4 Accommodation estimates are statistical inferences based on samples drawn from the intended user population

4.1 Population samples

4.1.1 Samples

In order to estimate anthropometric accommodation, the intended user population needs to be defined. For example, Japanese adult civilians between the ages of 18 and 70, or all Finnish children between the age of 0 months and 24 months.

The sample should be large enough to be statistically representative of the intended user population. Often, the extremes of the data, the largest or smallest measurements, are of great interest to designers. The sample should be large enough that those individuals whose measurements are in the extremes are well represented in terms of count, thus avoiding over-reliance on too few individuals in the extremes of the measurement distribution. According to the BIFMA G1 Guideline (BIFMA 2013)[4], "typically 1 000 or more individuals are needed for each gender to ensure good precision in the tails of the distribution where the design decisions are made".

Similarly, the sample should accurately reflect the demographics of the intended user population. For example, a sample of anthropometric measurements of military personnel are generally not representative of the civilian population as they are based on younger individuals who are likely fitter and leaner than the civilian population from which the military are drawn.

4.1.2 Weighting

In some cases, the sample of anthropometric data does not exactly match the demography of the intended users. For example, military data often do not exactly match civilian data on variables such as height, mass and age. A practical solution is to statistically weight individuals within the sample in proportion to their representation in the population of intended users[7]. However, as Gordon[6] has emphasized, the technique of statistically weighting the sample data is useful in representing the target population, but its utility does not extend to intended user populations that differ from the sample. For example, there are sufficient differences in the range of height between the Korean and Dutch populations that one cannot be weighted to represent the other.

4.2 Univariate accommodation estimates

The simplest accommodation estimates are those where only one variable, such as height, is involved. In such cases, a percentile value gives a useful estimate of accommodation. For example, a designer can want to design the ceiling of a room in an air terminal so that it provides a 20-cm clearance above the heads of at least 95 % of all males from anywhere in the world. Then, a design height that is 20 cm greater than the greatest 95th percentile value of males' height in ISO/TR 7250-2 would reasonably be expected to accommodate at least 95 % of all males worldwide. An even greater proportion of females would be accommodated as men are generally taller than women.

NOTE The air terminal designer notes that the tallest males in the ISO/TR 7250-2 data set are from the Netherlands, and that the 95th percentile value for their height is 195,9 cm. The designer adds 20 cm to the 95th percentile value and is reasonably confident that a ceiling height of 215,9 cm comfortably accommodates at least 95 % of all male travellers.

A similar accommodation estimate can be made using a 5th percentile value. Consider a situation where a protective grid with square openings is placed in front of a piece of rotating machinery. The size of the openings can be defined by the 5th percentile value of females' index finger breadth.

This opening would prevent at least 95 % of females' fingers from coming into contact with the rotating machinery. A larger percentage of males' fingers would be excluded as their fingers are generally larger than females.

4.3 Multivariate accommodation estimates

More often, multiple variables should be accommodated simultaneously in the design of a product. For example, a chair seat can have three dimensions of interest: seat depth, seat width, and seat height above the floor. In such cases, the use of multivariate techniques needs to estimate the proportion of users concurrently, or simultaneously, accommodated on all three variables.

The existence of a representative sample of anthropometric data enables several types of multivariate analyses. Two types are discussed here, the virtual fit test (VFT) and principal component analysis (PCA).

4.3.1 Virtual fit test (VFT)

One type of multivariate technique is the virtual fit test described by Parkinson and Reed[9], Reed and Parkinson[11] and partially anticipated in ANSI/HFES 100:2007, A.1.6[3]. In this technique, measurement values are first specified for all the variables of interest. Then, the number of individuals in the sample who are simultaneously accommodated for all the measurement values are counted and converted to a percent of the total.

For example, suppose that a designer wants to know what percentage of a user population will be accommodated by a proposed chair seat design if the chair seat depth is 400 mm, the chair seat width is 500 mm and the chair seat height is 450 mm. The designer defines an accommodated individual as an individual whose measurements are simultaneously less than or equal to the proposed seat depth, width and height measurements of 400 mm, 500 mm and 450 mm, respectively. The analysis shown in Figure 1 notes that about 78 % of a 50:50 mix of males and females are concurrently accommodated on all three dimensions.

In the next step, the designer counts all the individuals in the sample whose anthropometric dimensions for seat depth, width and height are simultaneously less than or equal to 400 mm, 500 mm and 450 mm, respectively. This count is generally done using a spreadsheet. The count of these individuals divided by the total number of individuals in the sample gives the estimate of the proportion accommodated.

The VFT technique is straightforward and can readily be implemented through the use of computer spreadsheets to analyse the anthropometric data of interest. It does not require any assumptions regarding the distribution of the anthropometric data, for example, whether or not it is Gaussian-distributed.

One limitation is that a representative sample of the population is necessary. A second limitation is that all variables of interest to the designer should either be present in the sample or be capable as being determined by combinations of variables present in the sample.